A Study of the Materials and Techniques of Francis Bacon (1909-1992)

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A Study of the Materials and Techniques of Francis Bacon (1909-1992)

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Abstract

The materials and techniques used by Francis Bacon were studied through the examination of paintings and the scientific analysis of paint samples.

Samples were taken from 21 complete works by Bacon, and from 17 abandoned canvases left in the Artists' studio, most of which had had large sections cut out and removed. The works sampled range in date from c.1945 to c.1990. Materials left in Bacon's studio, now preserved at Dublin City Gallery The Hugh Lane were also studied and 100 items were sampled. Samples were analysed using Gas Chromatography Mass Spectrometry (GCMS), Scanning Electron Microscopy with Energy Dispersive X-Ray Analysis (SEM-EDX), Polarised Light Microscopy, Fourier Transform Infrared Spectroscopy (FTIR) and Pyrolysis Gas Chromatography Mass Spectrometry (PyGCMS) to identify both pigments and binders.

A reference collection of synthetic organic pigments was subjected to analysis using FTIR and PyGCMS in order to build up reference data for the identification of these materials in paint samples. Major FTIR peaks are reported for over 120 different pigments, and pyrolysis products from over 70 pigments. PyGCMS was used to analyse many pigments which have not previously been studied in the literature by this method, including diketopyrropyrrole, isoindolinone and perylene types.

The existing literature on Bacon's materials and techniques was surveyed, and information from letters, receipts and other documentary sources was compiled.

Supports, primings, pigments and media were compared for the paintings studied, revealing a great deal of consistency in materials used over a long working life. Oil paints were used throughout for figures, but a range of different paints are used in backgrounds to create different textural effects, with household emulsion paints found on several works from the 1970s and 80s. The conservation issues arising from Bacon's use of materials are also explored.

The results were used to examine a small number of test cases to see how similar materials were to those in Bacon's usual practice. Results showed strong similarities to works examined in the study in some cases.

List of Contents

Volume 1

<u>Volume 2</u>

Appendices

List of Tables

List of Figures

Participating Institutions

Dublin City Gallery The Hugh Lane, Dublin, Republic of Ireland

Sainsbury Centre for Visual Arts, University of East Anglia, Norwich

Tate, London

Ulster Museum, Belfast, Northern Ireland

National Museum Wales, Cardiff

Whitworth Gallery, Manchester University, Manchester

Manchester City Art Gallery, Manchester

Hatton Gallery, Newcastle University, Newcastle-upon-Tyne

Image credits

Acknowledgments

Francis Bacon's work has been widely studied, but little attention has been paid to the materials he used. As a paintings conservator I have become interested in the conservation of modern paint materials, and their introduction to artists' palettes. Examining the materials and techniques of Francis Bacon allows us to look at his work from a new angle. The Estate of Francis Bacon were particularly interested in a study of this kind being carried out to assist with determining authenticity of works.

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Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work.

Name: Joanna Elizabeth Russell

Signature:

Date:

Introduction: Research aims and context

Francis Bacon (1909-1992) is widely recognised as one of the most important artists of the twentieth century. His iconic paintings have provided us with some of the most memorable and distinctive images in post-war art. Bacon's unique paintings, captivating personality and colourful private life have long made him a subject of fascination. Many aspects of his work have been explored, including his use of photographic source material and the meaning behind his works. However, little work has been carried out into the materials and techniques used to create his paintings. In this research, analytical methods are used to identify the materials present in samples of paints used by Bacon to better understand the work of this highly significant artist.

This study has a number of aims, the first of which is to develop some of the methods used for the analysis of modern organic pigments in works of art, in particular using Pyrolysis Gas Chromatography Mass Spectrometry (Py-GCMS) and Fourier Transform Infrared Spectroscopy (FTIR). The range of new synthetic organic pigments available to artists has greatly increased over the course of the twentieth century, and satisfactory methods for their identification are still being explored in the literature, as set out in Chapter 2. In Chapter 4 the analysis of reference samples of pigments is described, in an attempt to build up a set of reference data. This information will have wide applicability to the identification of these pigments in modern paintings and in other museum objects, as well as for the examination of paint in forensic investigations.

The second, most important aim of this research is to produce a timeline of materials used by Bacon in paintings throughout his career. This output will have a number of uses. Firstly, this information can be used to help in the authentication of works by comparison of materials in questioned works with those identified in this study. It could also provide a framework for dating paintings, through comparison with works of known date. Secondly, the information will be extremely important for the care and conservation of these paintings and help conservators to make better informed choices in the treatment of these works in the future. Thirdly, the identification of materials and methods used by Bacon will provide an insight into the work of this important artist. It hopes to shed new light on Bacon's practice by our becoming better acquainted with the process by which his art was created. As well as being of great value to Bacon scholars, this will also allow wider trends in the use of materials by 20^{th} century artists to be traced.

It is anticipated that a pattern exists in the use of materials by Bacon, which can be reconstructed through the identification of individual materials in a sample of his paintings. This pattern might change over time due to various influences, for example, the development of artistic style and aesthetics, the introduction of new materials and the work of other artists. If such a pattern can be identified it can be used to help authenticate and date works.

The literature on Bacon is extensive and covers many aspects of his work in detail. It therefore seems appropriate to set out the limits to the scope of this research. This study deals only with Bacon's paintings and has not examined any of the relatively small number of works on paper that have come to light since the artist's death. It also does not deal with the 'working documents' – the photographic source material used by Bacon in many cases as substitutes for a preliminary sketch, some of which appear to have been manipulated by the artist through the use of paint, tearing and creasing. The origin and identity of these items is a subject of ongoing research and has brought to light many new insights into the ways these were used as objects in the studio (Harrison, 2005; Harrison & Daniels, 2008; Finke, 2009b). The subject matter and iconography of Bacon's work, an area of continued discussion, is also not addressed here.

Francis Bacon achieved considerable success during his own lifetime, with major exhibitions of his work held at galleries all over the world, including two large retrospectives of his work at the Tate Gallery, the first held in 1962, and the second in 1985. His works continue to provoke a great deal of interest and are shown regularly in international exhibitions, as well as commanding high prices in auction salerooms.

Increased attention to Bacon's work has been prompted by the centenary of his birth in 2009, resulting in several exhibitions and new publications. A high-profile exhibition was held jointly between the Tate, London; Prado, Madrid and Metropolitan Museum of Art, New York in 2008-9 to commemorate this event (Gale & Stephens, 2008). Another exhibition held at Dublin City Gallery The Hugh Lane was timed to open on the anniversary itself, and included displays of a large number of photographs and illustrations found in Bacon's studio (Dawson & Harrison, 2009). A book of essays focussing on new research has also been published to mark Bacon's centenary (Harrison, 2009).

The relocation of Bacon's studio to Dublin City Gallery The Hugh Lane and the cataloguing of its contents has opened up new opportunities to study the Artists' materials and methods. The work to remove the studio contents was carried out in 1998, including the creation of a database documenting each item. The studio (and selected items from it) has been on view to the public since May 2001. Much of the vast amount of material contained in the studio (over 7000 items, including photographs, books, tools and paints) has yet to be studied in depth. The artists' materials and discarded canvases contained there will form an important aspect of this study, examined in Chapter 5.

Bacon's paintings have in recent years broken records at the auction houses, and have become some of the most expensive items of British art ever sold. Bacon's habit of leaving behind, discarding or destroying his paintings has meant that many undocumented works exist. Even some 'destroyed' canvases, with the major part of the composition cut away, have appeared at auction.[1] While it is questionable whether such pieces can be considered as authentic Bacon works, they clearly have a market. The Estate of Francis Bacon is currently funding the preparation of a Catalogue Raisonné to document Bacon's oeuvre. This is a much-needed undertaking, since the Alley and Rothenstein Catalogue Raisonné of Bacon's work was published in 1964, 28 years before Bacon's death (Alley & Rothenstein, 1964).

Bacon received no formal artistic training and developed his own individual style in his paintings. He worked in London throughout his life and associated with other artists working there from the 1930s onwards, including Graham Sutherland, John Minton and Lucian Freud. However, he frequently alienated fellow artists by his scornful criticism of their work. Even for artists such as Picasso and Giacometti whose work Bacon admired, he would generally reserve his praise for only a very small part of their work. Discussions of Bacon's work have often cast him as a lone figure, rather than as part of a wider artistic movement, but he has sometimes been described as part of R. B. Kitaj's 'School of London', a group of artists active in post-war London focussing on figurative subjects, including Lucian Freud, Michael Andrews and Frank Auerbach.

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[1] Ewbank Clarke Gammon Wellers Auctioneers, *Robertson items from the Studio of Francis Bacon*, 24 Apr 2007. Online Catalogue: http://www.ewbankauctions.co.uk/asp/searchresults.asp?st=U [Accessed 27 February 2010]

His work has had a lasting influence on a wide range of art and popular culture ranging from the work of contemporary artists Maggi Hambling and Damien Hirst to films *Last Tango in Paris* and *Alien* (Dios, 2009). He has been seen as an inspirational figure by the Young British Artists of the 1990s, both for his work and his bohemian artistic lifestyle (Collings, 1997). The series of interviews carried out with David Sylvester have also provided one of the most detailed and influential discussions by an artist about the nature of art in the twentieth century (Sylvester, 1993).

Chapter 1 Francis Bacon

In this chapter, a biography of Francis Bacon is given, followed by a brief discussion of some of his artistic influences. The reasons for the adoption of modern paints by artists' are explored, followed by a review of technical studies carried out on the work of twentieth century artists. Finally, the existing literature on Bacon's materials and techniques is reviewed.

1.1 A Brief Biography of Francis Bacon

During his lifetime, Francis Bacon refused to give his consent for a biography to be published. This has led to three biographies being published in quick succession after his death. *The Gilded Gutter Life of Francis Bacon* by Daniel Farson (1993) and *Francis Bacon His Life and Violent Times* by Andrew Sinclair (1993) were both published in 1993, and *Francis Bacon Anatomy of an Enigma* by Michael Peppiatt came out in 1996 (Peppiatt, 1996). Given that these volumes provide a much fuller picture of Bacon's life than it is possible to cover here, only a brief outline of Bacon's life will be given. The volumes by Sinclair and Peppiatt follow the more rigorous format of a scholarly biography, while Farson's book gives a very personal account of Bacon from the point of view of a friend and former drinking companion.

Bacon was born on 28th October 1909 in Dublin in a nursing home at 63 Lower Baggot Street, the second of five children. His parents were English and the family moved between Ireland and England as Francis was growing up. His father, Captain Eddy Bacon, trained racehorses and the family lived in a series of country houses in Ireland, surrounded by dogs and horses which exacerbated Bacon's asthma. Bacon described himself as having 'had no upbringing at all', reading little and being unaware of art (Alley & Rothenstein, 1964). His schooling seems to have been somewhat erratic, due to the family's frequent moving and Bacon's own ill-health. His exposure to war and violence in his early life are often considered to be important formative experiences, first in London during the First World War, then in Ireland at the start of the Troubles. His relationship with his father, an overbearing and violent man, was difficult. At the age of 16, he was reportedly thrown out of the family home when his father discovered him wearing his mother's underwear.

Escaping to London in 1926 with the help of an allowance from his mother, he took a series of odd-jobs. In 1927 Bacon was escorted to Berlin by an uncle figure, possibly a friend of his father's, arranged in a misguided attempt to straighten the boy out. In fact the uncle seems to have taken advantage of Bacon and then moved on, leaving him to enjoy the excitement and freedom of the city.   After two months in Berlin he moved on to Paris. It was here that Bacon described his first experiences of great art, seeing a Picasso exhibition which was to inspire much of his early attempts at art, and Poussin's *Massacre of the Innocents* in Chantilly, which he later described as having 'the best human cry in painting' (Sylvester, 1993, p.34).

Back in London, Bacon began to work as a furniture designer from around 1929, setting himself up in 17 Queensbury Mews West with his former nanny Jessie Lightfoot.   He also met businessman Eric Hall around this time, who became his lover, eventually leaving his wife and children to move in with Bacon in 1936. Bacon's furniture designs were featured in *The Studio* magazine, in an article entitled 'The 1930 Look in British Decoration'. His designs were sleek and stylish, using tubular steel and glass as the principal materials, the appearance of which echoed structures which were later to appear as rails and frames in paintings (Alley & Rothenstein, 1964, p.9).   He also designed rugs with abstract patterns.   In 1930 he began to associate with Roy de Maistre, an Australian artist and sometime furniture designer. It appears that de Maistre introduced Bacon to the world of oil painting and was surprised by Bacon's questions about technique 'that a schoolchild could answer' coming from someone with obvious artistic sensibility (Johnson, 1995). De Maistre may also have introduced Bacon to his contacts in the art world, including the painter Graham Sutherland.

One of Bacon's first known oil paintings *Crucifixion* from 1933 was featured in the critic Herbert Read's publication *Art Now* and Bacon experienced a brief flush of success when the painting was bought by the collector Sir Michael Sadler, who subsequently commissioned a further painting. However, his first one-man exhibition in February 1934 attracted scathing reviews, and Bacon, discouraged, destroyed all the works which had not already been sold.   A further blow came in 1936 when his work was rejected for the 'International Surrealist Exhibition' in London, for being 'insufficiently surreal'.   Little is known about his works in the years from then up until 1944, as Bacon claimed to have given up painting entirely and did his best to destroy any stray remnants.   During the war, Bacon was not called up to fight due to his asthma, but spent some time as an ARP warden in London and later lived for a time in Petersfield, Hampshire.   In 1943 he moved into a studio at 7 Cromwell Place, with Jessie Lightfoot and Eric Hall, which had formerly been occupied by the painter Millais.

The work which Bacon considered to mark the beginning of his career as an artist was the *Three Studies for Figures at the Base of a Crucifixion* from 1944. He did not believe any of his earlier works to have any value, and excluded any paintings which predated it from most exhibitions organised during his lifetime. The impact of this work, with its tortured forms against a vivid orange ground, marked a powerful new force in the art world. Created towards the end of the Second World War, it seemed to depict the brutality and horror that had become part of everyday life in wartime. The work was shown in a group exhibition at the Lefevre Gallery in April 1945, causing shock and consternation amongst critics (Russell, 1971, p.10; Peppiatt, 1996, p.108-9). It was bought by Eric Hall who later presented it to the Tate.

In 1946 Bacon met the art dealer Erica Brausen, who bought his large *Painting* 1946 and subsequently opened the Hanover Gallery which was to represent Bacon until 1958. Bacon left for Monte Carlo soon after with the money from the sale of the painting (Alley & Rothenstein, 1964). He was to return frequently over the following years, lured by the luxury of hotels and casinos. It was in Monte Carlo that an important development in Bacon's technique was said to occur, when he started to use the reverse side of the canvas (see chapter 5, p.107). However Bacon had difficulty in producing work whilst living there and returned to London to create work for exhibitions, including his first one-man show at the Hanover Gallery held in November to December 1949. In 1950 Bacon taught for a few weeks at the Royal College of Art, as a substitute for his friend John Minton. He also visited South Africa later in this year, to visit his mother who had settled there.

Jessie Lightfoot died in 1951, leaving Bacon grief-stricken. He moved out of Cromwell Place soon after and was to lead an unsettled existence over the next 10 years, occupying a series of temporary studios. In 1952 Bacon formed a relationship with Peter Lacy, a former fighter pilot who had a sadistic streak, exacting violence both on the paintings and on Bacon himself, on one occasion pushing him through a glass window (Richardson, 2009). Lacy moved to Tangier in 1955, where Bacon visited him many times. Very few paintings appear to have been brought back from here despite letters to Erica Brausen describing work in progress. However, the strong light here may have influenced his palette which became much brighter and more colourful from 1956 onward. Bacon said he was able to complete only one painting in Tangier, *Painting*, 1958 (sometimes known as *Pope with Owls*) (Alley & Rothenstein, 1964, p.118).

In October 1958, due to mounting debts, Bacon broke his affiliation with the Hanover Gallery, and signed a new contract with Marlborough Fine Art. This association was to continue for the rest of Bacon's career. Late in 1959 Bacon rented a studio in St Ives for several months, one of the relatively few occasions where he appears to have worked successfully outside London.

During the 1950s Bacon had moved frequently and worked in different studios, often borrowed from friends. He settled at last in 1961, when he moved into 7 Reece Mews, a small flat in South Kensington with a studio in which he felt he could work. Despite its small size Bacon continued to work here for the rest of his days, long after the time when he could have afforded something grander. He did experiment with other apartments, but used these mainly for entertaining friends, finding he could work best at Reece Mews.[2] Also in 1961 Bacon commissioned photographer friend John Deakin to take photographs of friends including Lucian Freud, Henrietta Moraes and Isabel Rawsthorne, to uses as source material for portraits.

Bacon gained recognition in 1962 with a retrospective exhibition at the Tate Gallery, but the opening was overshadowed by the death of Peter Lacy in Tangier. Later the same year, the first of the interviews with David Sylvester was carried out, broadcast on BBC Radio in March 1963 (BBC, 1963).

In 1963 Bacon met and began a relationship with George Dyer. The story told by Bacon was that they met while Dyer was attempting to burgle Bacon's flat (Sinclair, 1993, p.197). Their relationship was turbulent and Dyer became increasingly dependent on drink, probably not helped by Bacon's financial generosity. On the eve of Bacon's prestigious exhibition at the Grand Palais in October 1971 he was found dead in his Paris hotel room, from an overdose of drink and drugs. This event affected Bacon deeply and he made several large triptychs in memory of Dyer in subsequent years.

From around 1964 Bacon took to making small portrait triptychs of friends, including George Dyer, Lucian Freud, and several friends from the Colony Room drinking club in Soho: Muriel Belcher, Henrietta Moraes and Isabel Rawsthorne. He also made many self portraits, particularly in the 1970s, when he reported having 'no-one left to paint' (Sylvester, 1993).

[2] A flat was bought in 1970 in Narrow Street, Limehouse, which was decorated in a style reminiscent of Bacon's early furniture designs (Peppiatt, 1996, p.255). However the light here was too intense and changeable, reflecting off the Thames outside, for him to work here successfully.

In 1974 he purchased an apartment in Paris, which he kept until 1984. It appears that several works were completed here, and from reports it became a similarly chaotic space to the Reece Mews studio (Peppiatt, 1996). In 1976 Bacon met John Edwards, a young man from the east end of London with whom he formed a stable paternal relationship that was to last for the rest of his life. Edwards was honest and down-to-earth, and Bacon seems to have found his lack of pretension about art refreshing. He also helped Bacon by taking photographs, clearing material from the studio and slashing unsuccessful canvases (Edwards & Ogden, 2001).

Bacon had many successful exhibitions throughout the world during the 1970s and 80s, including in New York, Caracas, Barcelona, Tokyo and Moscow (Gale & Stephens, 2008). A second major retrospective was held at the Tate in 1985 (Ades & Forge, 1985). After suffering various health problems, Bacon travelled to Madrid in April 1992 to visit a young Spanish friend. Whilst there he became ill and died on 28th April 1992. His estate was bequeathed to John Edwards.

1.2 Bacon's influences

Bacon was heavily influenced by Picasso in his early work, producing compositions including biomorphic forms similar to those seen in works such as *Baigneuse (La Plage de Dinard)*,1928. Some of his early sketches also seem to owe something to the surrealist movement which was prevalent in the 1930s. However, Bacon's work was judged not surreal enough to be included in an exhibition in London in 1936.
Bacon met Roy de Maistre in around 1930, who was undoubtedly influential in Bacon's initial use of oil paints (Johnson, 1995). De Maistre was deeply religious, unlike Bacon (a professed atheist), meaning their subject matter was wildly different in its purpose, though the early influence of de Maistre may have encouraged the association with Christian themes that appeared early in Bacon's work such as the Crucifixion and use of a triptych format, most usually associated with Altarpieces.

Bacon met Graham Sutherland in the early 1930s, possibly introduced by Roy de Maistre, and there appears to have been considerable artistic exchange between the two from the observed similarity between some of their work in the 1940s. It has even been suggested that the two artists may have shared materials, particularly during World War II, when Sutherland's position as official war artist would have made it easier for him to obtain materials (Hammer, 2005). Initially Bacon may have been influenced by Sutherland as the more established artist, but the position soon became reversed. Despite their friendship in the 1940s, they drifted apart in later years. Bacon, now the more successful artist, was scathing in his criticism of Sutherland's work, and in recent times Sutherland's reputation as an artist has suffered in comparison to Bacon.

Lucian Freud was another artist whom Bacon became friends with, and the two painted portraits of each other. These two were later described as foremost figures in the so-called 'School of London', other members including Frank Auerbach and R. B. Kitaj, a group of artists working in London in the postwar period in a figurative style. Bacon's work was highly influential on this group in his pursuit of figurative painting at a time when abstract expressionism was being promoted elsewhere.

Bacon had a circle of close friends in London, many artists among them, with whom he socialised in the bars and pubs of Soho. Isabel Lambert (later Rawsthorne) was a model for Bacon but was also an artist in her own right and her letters to mutual photographer friend Peter Rose Pulham reveal details of some of the discussions she had with Bacon about art (Jacobi, 2009).

The use of photographic images by Bacon became known as early as 1952 with the publication of photographs made by Sam Hunter of source material in Bacon's studio (Hunter, 1952). Bacon frequently stated that he 'looked at everything', therefore identifying all of his artistic and visual influences is an enormous task. An examination of the wide range of sources for artistic practice and subject matter, evidenced in part by the 'working documents', falls outside the scope of this study. As has been well documented, Bacon looked at the work of old masters such as Rembrandt and Velasquez, more modern masters van Gogh & Picasso, wildlife photography, action shots of sportsmen, diagrammatic images of the body in medical sources, Muybridge's sequences of human motion and film stills. He also appeared to use his own earlier works as sources, sometimes referring to much earlier compositions to produce drawn-out series of images on a common theme.

It is probable that the sources for all the different elements of his paintings are too numerous and too mixed up in the mind of the artist for us to identify them all.[3] The screaming nurse in the Odessa steps sequence of Eisenstein's *Battleship Potemkin*, combined with Velasquez's *Portrait of Pope Innocent X*, is perhaps one of the most

[3] For example, Bacon said he found it difficult to disentangle the influences of Michelangelo and Muybridge in the formation of his figures.

well-known examples. Interestingly, in an earlier sequence of this film, hanging carcases of meat are shown in close-up, crawling with flies, reminiscent of the sides of meat in works such as *Painting 1946,* a subject which also echoes the work of Rembrandt and Chaim Soutine.

It has been argued that this mixing of high art and commercial images in Bacon's art produced the first 'pop art' images (Alloway, 1962). The use of the still from Eisenstein's film, and of photographs from other mass-media sources became well-known, a scheme later taken up by members of the Independent Group.

1.3 Artists' use of modern paints

Over the twentieth century many new materials became available, opening up new possibilities for artists.[4] Oil paint has had a long history of use amongst artists, but since the 1920s a variety of different synthetic resins have been used as binding media in paint and have increasingly been used by artists (Learner, 2000). In addition to this, changing attitudes in art led to the adoption of a much wider range of materials, including those not traditionally associated with fine art. This subject is discussed at length elsewhere, with particular reference to the use of household gloss paints (Standeven, 2003).

Household paints were chosen by artists for the different qualities they could bring to their work, for example, the variation in gloss and appearance, the range of possible colours and working properties. Paints with a fluid consistency could be poured and dripped, leading to some highly important developments in twentieth century art, notably the 'drip paintings' of Jackson Pollock. The relative cheapness and ready availability of these paints compared to artists' paints may have been important for some artists, and may have encouraged artists to experiment with larger scale work. The use of commercial, easily accessible materials may also have had political implications for artists of moving art out of the realm of the specialist and bringing a certain democratisation.   This has resonance with the ideas of pop art itself, elevating the commercial and everyday to the status of high art. There also may be implications from the intended use of the paint itself. Picasso is reported to have used boat paints when working in Antibes in 1946, which he decided to apply to plywood, as wood would

[4] The main dates for the introduction of synthetic media are described in chapter 2.

be the usual support for this type of paint (Gilot & Lake, 1965). Richard Hamilton used car spray-paints to paint an image of a car in a literal translation of the paint’s intended use (Crook & Learner, 2000). Some of these materials may also have been initially used through expediency, especially during periods when more specialist materials might have been hard to come by, for example in wartime.

One of the first reported uses of non-artist paints appears to be the use of ‘Ripolin’ paints by Picasso in the 1910s (Stein, 2001). This was a French brand of household gloss paint, which at this time was still oil-based but was designed as a gloss paint for interiors and therefore had a quite different consistency from artists’ oil paints. The use of ‘Ripolin’ by Picasso became well-known, and appears to have encouraged other artists to experiment with similar materials. Gillian Ayres reports her use of it in the 1950s was influenced by the trust prompted by the association with Picasso’s name (Crook & Learner, 2000).

The use of commercial paints by artists may only be recorded where its use has a particular significance, and meaning is being attached to it. The use of household gloss and enamel paint by Jackson Pollock is well documented and may have been emphasised to draw attention to innovative practices and experimentation, as well as the implications of using a commercial mass-produced material rather than a specialised fine art one. Picasso’s use of Ripolin may also be linked to his role as an innovator, particularly as this appears to be one of the earliest uses of such a material in art. Alfred Wallis, working in St Ives in the 1930s reportedly used house and boat paints, something which seems to have been emphasised in accounts of his work, being associated with his image as an untrained ‘primitive’ painter (Standeven, 2003). The use of ship’s paints in particular could be associated with his life as a fisherman.

The impact of mass-produced ‘readymade’ colour on artists’ practice was explored in the exhibition *Color Chart: Reinventing Color, 1950 to Today* (Temkin & Fer, 2008). By using non-art paints from hardware stores, chosen from colour charts, artists rejected fine art tradition in favour of consumer culture. Paints which could be selected then applied straight from the tin further separated artists from the process of preparing their materials, leading to the individual hand of the artist becoming less important.

Artists’ paints containing synthetic media, particularly acrylics, have increased in popularity since their introduction. Magna acrylic solution paints were marketed as ‘the first new painting medium in 500 years’ and were popular with artists including Mark

Rothko, Barnett Newman and Kenneth Noland, who liked them for their intensity of colour, even when thinned (Crook & Learner, 2000). Acrylic emulsion paints appear to have been adopted by artists as soon as they entered the market in 1963. Peter Blake recalled trying many different brands of acrylic emulsion and found Rowney's Cryla his preferred brand. He used it in *The 1962 Beatles*, 1963 for its matt, flat characteristics (Crook & Learner, 2000). David Hockney also used acrylics in 1963 and found their speed of drying made it possible to work more efficiently.

1.4 Studies of artists' materials and techniques

Relatively few studies of the materials and techniques of later twentieth century artists have been carried out, although these are currently increasing in number, as concerns are raised over the longevity of modern works. Many developments in paint technology occurred over the course of the twentieth century, offering artists a much broader range of choices when selecting materials, making this a particularly interesting area for study.

The newly available paints led artists to experiment with materials to achieve a wide range of effects. The impact of modern paints on the work of twentieth century artists was explored in a series of interviews with contemporary artists, including Richard Hamilton, Patrick Caulfield and David Hockney, examining several works from the Tate collection (Crook & Learner, 2000). Interviews revealed information about the different ways in which paints were used, and the reasons behind their choice. Motives cited by the different artists were varied, ranging from a belief in the superior ageing properties of these materials, to their particular working properties or an aesthetic appreciation of their appearance.

Picasso's materials have been examined in several different studies. In particular his use of non-artist 'Ripolin' paints has been of interest, first used in 1912 (Koussiaki, 2002). This was a French brand of gloss housepaint used to produce glossy surfaces free of brushstrokes, which could be contrasted with areas of artists' oils. Other commercial paints, including marine paints and Triton house paints were also reportedly used. The early 'Ripolin' paints were oil-based, with alkyd media being introduced only after 1955. Distinguishing these paints from artists' paint using analysis has therefore relied on identification of the pigments and extenders present (Gautier *et al.*, 2009).

One study has focused on the paints used in the drip and poured paintings of Jackson Pollock, by examination of nine works dating from 1943-1950 (Lake *et al.*, 2004). A mixture of artists' and commercial paints were found, including oil and alkyd-based paints. The results were found to correlate to paint cans left in Pollock's studio, thought to have been used by him. A study of materials has also been carried out in an attempt to investigate a collection of questioned works (Newman & Derrick, 2007). The identification of several pigments which were not developed until well after Pollock's death seemed to disprove some of the works' authenticity, although this continues to be a contentious issue (Landau & Cernuschi, 2007).

Willem de Kooning is also reported to have used housepaints alongside artists' paints in works from the late 1940s and 50s, with added materials such as sand and plaster of Paris to impart texture. A study of his paintings from the 1960s and 70s however, showed a shift in materials in this period (Lake *et al.*, 1999). De Kooning experimented with media by adding slow-drying oils to retard drying rates and keep paints fluid for longer. Studio assistant John McMahon reported that safflower cooking oil was added to artists' oil paints, whipped up with water and solvent, and this was confirmed by analysis. The mixture appears to have contributed to the continued sticky condition of paint in some works from the 1960s, which may in turn have led to the artist's use of more conventional oil paints in the final two works examined, dated 1977.

The techniques and materials of French artist Jean Dubuffet (1901-85) have been investigated in a study focusing on 15 paintings produced from 1940 to 1950 (Bernicky, 2007). Dubuffet created the concept of 'Art Brut' or Raw Art in 1945 to describe art outside the fine art tradition, created spontaneously and without schooling, exemplified by the work of the inmates of insane asylums. The use of non-traditional materials and techniques fit within this ideal. The addition of sand, pebbles, pieces of glass and thread to the paint was noted in the study, used to create highly textured surfaces. Oil and natural resin glazes were identified, as well as areas of dry pigment. Dubuffet manipulated paint with spatulas and fingers, scratched through partly-dried paint layers and rubbed the surface with rags. Paint cross sections showed complex mixing of paint layers, and stratigraphy which varied greatly between different areas. The study compared works retaining their original surface with those which may have been altered by treatments such as varnishing or lining, with a view to removing non-original and inappropriate varnish layers.

Six paintings by British artist Robyn Denny (b.1930) made from 1958-64 were subjected to technical study, and discussed together with information from interviews with the artist (Gayler *et al.*, 2008). Denny described using Dulux and Carsons household paints, which were allowed to settle in the tin before the excess medium was poured off and the remaining paint mixed with artists' tube paints to achieve the desired consistency. PVAc, oil and alkyd media were identified in samples, as well as several organic red pigments. The water sensitivity of many paint passages was thought to result from the underbound, matt nature of the paint.

A study of the work of Canadian artist Jean-Paul Riopelle (1923-2002) was carried out with similar aims to the present study, to document materials, to assist in the care of his works and to identify genuine paintings (Corbeil *et al.*, 2004). While Riopelle's early works were painted in oil, from the 1970s acrylics were increasingly used, and in the 1980s mixtures included aerosol and craft paints. A variety of modern materials including synthetic organic pigments, fluorescent dyes and metal powders from metallic paints were identified. Several conservation concerns were noted, including the juxtaposition of areas of matt and glossy oil paint, resulting in powdery underbound areas and those with oily exudates.

Research has been carried out on the materials in the painting *Untitled* 1964-'65 by Jasper Johns (b.1930) to investigate the reasons for the water-sensitivity of the paint layers (Wijnberg *et al.*, 2007). All colours analysed were found to have an oil medium, with appreciable amounts of aluminium detected, thought to originate from aluminium stearate additives, used by paint manufacturers as dispersion aids. The aluminium stearate content was suggested as a cause of the observed water sensitivity.

Studies of this kind have been used to provide answers to questions of authenticity, to examine artistic practice and to address conservation issues. Materials are investigated to discover the reasons for particular sensitivities, and to discover more about the artist's intent and how this can be best served by conservation procedures. Many of the studies highlight concerns for the conservation of the paintings examined, often due to the way in which materials have been used. For example, removal of medium and excessive use of diluents to give matt underbound surfaces, layering or mixing of disparate materials and the use of cheaply-produced non-artist materials. Many modern oil paints have also proved to have problems with water sensitivity, even in cases where the paint does not have the appearance of being underbound (Burnstock *et al.*, 2008). These studies can therefore be used to identify the most prevalent conservation concerns with modern paintings. Together they also begin to build up a picture of how materials have helped to shape twentieth century art.

In the twentieth century, more than in any previous period, the physical materials used by artists have become entwined with the interpretation of the work. The changing nature of art meant a far wider variety of materials were used than ever before, the choice of material was no longer constrained by tradition, leading to the material itself having importance for the understanding of the art.

No technical studies appear to have been carried out on the work of artists who are closely linked to Bacon. However, the palette used by Graham Sutherland has been recorded as the following in a manual on painting technique:

> 'Zinc white, turquoise blue, cerulean blue, cobalt blue, French ultramarine, yellow ochre, Indian yellow, orange, lemon yellow (clair and fonce), peach black, lamp black, vermilion, lac carmine, crimson alizarin, erythrine, green alizarin, monastral green, violet, raw and burnt umber. Occasionally: golden ochre, flesh tint. Very occasionally: emerald green.' (Hiler, 1969)

The technique used for Sutherland's *Portrait of the Hon. Edward Sackville-West,* (City Art Gallery, Birmingham*)* 1954-9, (24 x 24“) has been briefly described, from Sutherland's answers to a questionnaire about the work. It is described as being painted on a canvas 'primed only with size, possibly with a thin layer of umber over it' which Sutherland stretched himself (Cobbe, 1976).

1.5 Previous research on Bacon's Materials

Very little has been published in the way of technical studies of Bacon's work. The *Three Studies for Figures at the Base of a Crucifixion*, 1944, owned by the Tate has been subjected to technical examination (Townsend, 1997) and the results discussed (as will be outlined in Chapter 6) (Hackney, 1999). However, this appears to be the only published technical examination of a painting by Bacon. Some unpublished analysis of several works on paper has also been carried out by Tate, to identify pigments (Townsend, 1999). Analysis of some pigments used in Painting 1946 has been carried out by MoMA, again unpublished (Ordonez, 1985). The aim of this last study was to identify the pigments used in the pink and purple areas of background, some of which appeared to have faded considerably. No further examples have yet been found of analyses of Bacon's works carried out by other institutions.

The most complete discussion of Bacon's method occurs in the catalogue for the 1985 retrospective of Bacon's work at the Tate Gallery in the 'Note on Technique' by Andrew Durham (1985). This discusses Bacon's choice of materials and methods of working, based on conversations with the artist conducted in 1984. The range of materials used is described as limited compared to other artists. His early use of Sundeala board is ascribed to reasons of economy, although Bacon found it 'held pastel well'. Primed canvas, which Bacon used when he was able to afford it, was less effective in this regard, but by turning the canvas and working on the unprimed side, it met his needs well. Artists' oil colour is used predominantly for the image, while emulsion housepaints are used for backgrounds. Additions of sand and dust are also mentioned, as is spray paint and Letraset.

Since Bacon's death and the subsequent donation of his studio at 7 Reece Mews to the Hugh Lane Gallery in Dublin, the contents of the studio have been available for study. Over 7000 items were found in the studio and were individually catalogued on acquisition. The materials found in the studio are discussed by Margarita Cappock, who describes the items found under several headings including 'photographs', 'canvases' and 'artists' materials' (Cappock, 2005). This gives an overview of the types of paint found, and the most common colours, as well as objects evidently used as tools, including cloths used to imprint texture and cut-out arrows used as templates. The huge amount of material in the studio awaits further investigation.

Joanna Shepard recently published an analysis of Bacon's technique focussing on his reported use of 'chance' in the creation of his work (Shepard, 2009). Cross-sections from several slashed canvases from Bacon's studio were examined and compared to look at Bacon's reworking of images and changes in procedure over time. Some of the canvases examined were the same works made available for the present study. It was argued that the idea of 'chance' was central to Bacon's enigmatic persona as an artist, but examination of techniques showed a much more calculated approach. More evidence of experimentation and rapid reworking was found in earlier works, but through practicing and refining his technique he was able to control his effects to produce much more predictable outcomes, with fewer paint layers. However, no analysis of materials was carried out in this work.

The series of interviews with Francis Bacon conducted by David Sylvester offer an insight into Bacon's working methods, including some reference to materials (Sylvester, 1993). The focus here is usually more on the ideas and influences behind the works than on the physical materials used. The transcripts of other interviews have been published, carried out by Hugh Davies (2009) and Michel Archimbaud (1993). Bacon's responses in many cases cover similar ground to those in the Sylvester interviews and Bacon appears to have had favourite anecdotes and phrases which were used repeatedly on these occasions.

Some of the Sylvester interviews were recorded or filmed for broadcast on radio and television (BBC, 1966). Television interviews were also carried out by Melvin Bragg (LWT, 1985), Daniel Farson (ITV, 1958) and David Jones (BBC, 1971). Bacon did not allow himself to be filmed painting, though we do see him squeezing paint out onto a plate, and mixing colours with his brush as though about to start work in the 1966 documentary. These appearances helped to create the public image of Bacon as charismatic artist-celebrity (Mellor, 2009).

Not a lot of documentary evidence survives, and Bacon does not appear to have been a great letter writer. Letters that do survive are generally short and usually deal with practical matters, often including requests for money. Further examination of Bacon's interviews and letters is carried out in Chapter 5.

Much of the existing information is thus reported and controlled by Bacon, and it has been seen that in many cases Bacon revealed only what he wanted to be known (Peppiatt, 2008). He was very aware of his image as an artist and appeared to use the new media culture to perpetuate his own myth. He was also reticent about his early life and work, even amongst his close friends (Farson, 1993). A re-examination is therefore needed, to examine the evidence away from Bacon's significant influence.

Writing about Bacon's work often emphasises material qualities of the image, such as the voluptuous quality of the thickly smeared paint and the variety of textures resulting from the use of textured cloths and sand, for example, in Sylvester's descriptions of Bacon's portraits (Sylvester, 1957). Bacon himself, in one of the very few examples of his published writing, described the importance of the physical paint in the work of Matthew Smith: 'Painting in this sense tends towards a complete interlocking of image and paint, so that the image is the paint and vice versa' (Bacon, 1953). Although describing the work of another artist, Bacon's words could equally be applied to his own work and philosophy. More recent descriptions have emphasised the sensory qualities of his works, conveyed through paint (Chare, 2009; Jarvis, 2009). The materials themselves are evidently very important to how Bacon's work is viewed and interpreted.

This study aims to re-examine the materials used by Francis Bacon in a more systematic manner than has been attempted before. Much of the information available up to now has been recounted through Bacon himself, and it has been seen that such information is not always entirely accurate or may have omissions. Analysis of the materials found in Bacon's paintings will enable the components actually used to be identified. By looking at paintings from a range of dates we can identify trends in the way materials have been used. We can also look at the extent to which modern materials were adopted by Bacon and the approximate dates at which they were first used. The studio contents also warrant further investigation as a source of information about the components of different types of paint. Materials here provide an additional resource for taking paint samples for analysis, and usually offer larger sample sizes than can be taken from the paintings themselves.

Chapter 2 Modern Paints

This chapter first outlines the development of materials used in modern paints, focussing in particular on synthetic binding media and the synthetic organic pigments introduced over the course of the twentieth century. In the second section, the analytical methods that have been used for the identification of synthetic organic pigments and synthetic binders are reviewed.

2.1 The Development of Modern Paints

2.1.1 New Paint Media

Over the course of the twentieth century many new types of paint were introduced, based on binders made from synthetic resins. These new materials were first used in paints for industrial and household settings, before being used in paints designed specifically for artists' use in some cases. The artists' paint industry has understandably been more cautious about adopting new materials in preference to tried and tested formulas.

The first synthetic resin to be introduced as a paint medium was nitrocellulose, produced by reaction of cellulose with nitric acid. Manufacture of a nitrocellulose-based lacquer was patented by DuPont in 1923 and introduced as automobile paint 'Duco' in the same year (Standeven, 2006). Ranges for interior use were also developed, with added alkyd resin, but were replaced by purely alkyd paints from the end of the 1940s (Crook & Learner, 2000). However, nitrocellulose continued to be used in spray-paints, and relatively recently was still to be found in some low-cost brands (Learner, 2000).

Alkyd paints were first developed in the 1920s, the first oil-modified alkyd paint becoming available in 1926 (Standeven, 2006). Further improvements led to them dominating the market, becoming the standard binders in oil-based gloss paints from the 1960s onwards, a position which they still hold today (Crook & Learner, 2000). Alkyds in the form of gloss house-paints were used by many artists, including Willem de Kooning and Jackson Pollock. The first range of artists' alkyd paints, Griffin alkyds made by Winsor and Newton, did not appear until 1976 (Winsor & Newton, 2003-2010). However, these were markedly different to the gloss house-paints as they were formulated as tube paints with similar working characteristics to oils, marketed as a quicker-drying alternative. Alkyds have also been widely used in artists' primers and in media intended to modify the working properties of oil paints.

Poly Vinyl Acetate (PVAc) resins were first developed in the 1920s (Seymour & Mark, 1990) but received little attention until they were prepared as aqueous emulsions, eventually introduced commercially in the early 1950s (Crook & Learner, 2000). They have been widely used in household emulsion paints, particularly in Europe, while in the USA acrylics are more commonly used for this purpose. PVAc polymers have not been widely used in artists' paints, but the unpigmented emulsion is a very commonly used adhesive and has also been marketed as a medium into which pigments can be mixed for the artist to create their own paint. Spectrum Oil Colours in the UK marketed these successfully by providing the pigments in aqueous dispersion, allowing them to be mixed more easily into the medium (Crook & Learner, 2000).

Acrylic resins were first developed in Germany and commercially introduced there by Rohm & Haas in 1927, then in the USA in the early 1930s (Seymour & Mark, 1990). Acrylic solution paints became the first synthetic paints to be widely used by artists. The first such brand was Magna, developed by Boccour & Golden in the late 1940s, which could be thinned with turpentine (Crook & Learner, 2000). These paints were produced in tubes as much faster-drying alternatives to oil paints, but had the disadvantage that they remained soluble in the application solvent, so paint layers would be disturbed by layering.[5]

Acrylic emulsions were first introduced into house-paints in 1953, followed by the first artists' acrylic emulsion paint in the USA, called Liquitex (Crook & Learner, 2000). Although initially rather thin in consistency, changes to the formulation in 1963 produced a paint with a similar texture to oil paint. This paint became much more popular and was soon followed by ranges from other brands, including Rowney's Cryla in the UK, also introduced in 1963. Acrylic emulsion paints have the advantage that they can be thinned using water, rather than organic solvents. Droplets of the acrylic polymer are suspended in water, which coalesce to form a solid film as the water evaporates. Because this is an emulsion, the film cannot be re-dissolved in water, allowing further paint layers to be worked on top.

[5] This property was exploited by some artists, for example in the poured paintings of Morris Louis.

2.1.2 Development of synthetic organic pigments

Of the new pigments developed over the course of the twentieth century, a very high proportion have been organic. Many of these are structurally similar and can be classified into several groups, each with a generic skeletal structure which can be modified by the introduction of different functional groups. With so many new pigments, naming becomes complicated, especially as many pigments have been marketed under different names by different manufacturers. The Colour Index system of nomenclature developed by the Society of Dyers and Colourists can be used to avoid confusion. In this system each pigment is given a Colour Index name, such as Pigment Red 1 (abbreviated to PR1) and a Colour Index number, usually of five digits. This number provides some information about chemical structure, as members of each different pigment class are given numbers within a certain range.

The succession of pigments discovered and introduced to the market can be useful for the dating of materials in paintings. However, identifying the first possible date at which a pigment could be used is not always straightforward, as the date of invention, patent, industrial production and eventual introduction into industrial or artists' paint can span a considerable time. An overview of important dates for many twentieth century pigments has been given by de Keijzer (2002).

2.1.2.1 Azo pigments

The synthetic dye industry originated with the synthesis of mauveine from aniline in 1856, known as Perkin's mauve. This accidental discovery led to increased research in dye chemistry, focussing on aniline (Herbst & Hunger, 2004). The first organic pigments were developed towards the end of the 19^{th} century, following the discovery of the diazo reaction by Peter Griess in 1859 (de Keijzer, 1999). In this reaction an aromatic amine is treated with a nitrosating agent to form an aryl diazonium ion. Azo coupling can then take place, by reaction of this compound with an electron rich aromatic (coupling component) to produce an azo compound. The resulting structure is highly conjugated, and therefore has a strong colour. This basic reaction is extremely versatile and has been used with many different diazo and coupling components to create a huge number of different pigment structures. The properties of the pigment, not only colour, but also thermal stability, light and solvent fastness, can be varied with the use of different substituents. Over the years, many new azo pigments have been introduced with increasingly desirable properties of stability, compared to the earliest examples, which gained a reputation for being fugitive and were referred to using the rather unappealing name ‘coal-tar colours’.

The beta-naphthol pigments were some of the first azo pigments to be developed, following the discovery of beta-naphthol in 1869 (de Keijzer, 1999). In 1885 Para red (PR1) was produced by coupling beta-naphthol with 4-nitroaniline, followed by Toluidine red (PR3) in 1904, Chlorinated Para red (PR4) and Parachlor red (PR6) in 1906, and Dinitroaniline orange (PO5) in 1907 (Herbst & Hunger, 2004). This group generally have poor light- and solvent-fastness, but PR3 and PR4 have nevertheless been used in ranges of artists’ paints including Winsor and Newton oil colours[6], and Daler-Rowney gouache colours.[7]

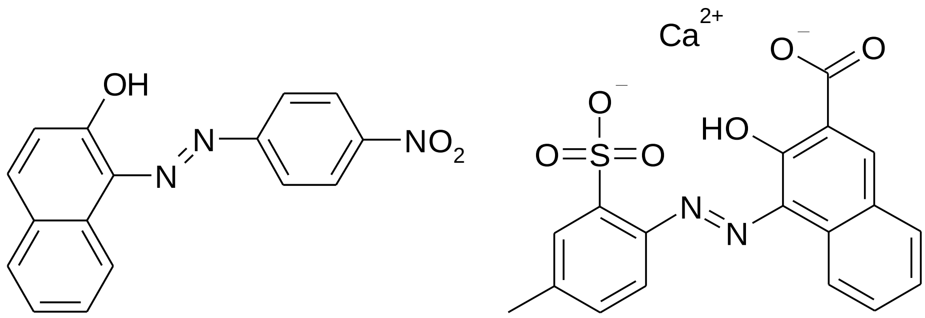


Figure 2.1 Examples of pigment structures. Left, beta-naphthol PR1. Right, BONA salt PR57:1

The beta-naphthol salts are closely related, using the same skeletal structure, but including a sulfonic acid group which can form a salt with a metal ion such as barium or calcium (see figure 2.1). These are also sometimes termed beta-naphthol pigment lakes, as they were originally precipitated onto an inorganic base like traditional lake pigments, but it was later found that this carrier was unnecessary (Herbst & Hunger, 2004). Lithol red (PR49) was the first such pigment introduced, discovered in 1899 (de Keijzer, 1999). BONA salts have similar structures, but use 2-hydroxy-3-naphthoic acid (beta-oxynaphthoic acid or BONA) as the coupling component. Lithol Rubine (PR57) was the first pigment of this type to be developed, patented in 1903 (de Keijzer, 1999).

[6] Toluidine red PR3 is listed as the pigment in Artists’ oil colour ‘Bright red’ in 1977, 1986 and 1990 catalogues.

[7] PR3 and PR4 are components in several colours in the Designers Gouache and Artists’ Oil colours ranges, including ‘Cadmium Red (Hue)’ and ‘Scarlet Alizarin’ (Daler-Rowney, 2010).

BONA has also been used to prepare another important group of azo pigments, the Naphthol Reds or Naphthol AS pigments. These use 2-hydroxy-3-naphthoic acid N-arylamides as the coupling component (see figure 2.2). This type of colorant was patented in Germany in 1911, where they were known as Grela reds, but they were initially neglected in favour of the beta-naphthols (Herbst & Hunger, 2004). The development of many important pigments followed in the 1920s and 30s in Germany, and in the 1940s in the United States. They are more lightfast and solventfast than the beta-naphthol class, and some have an additional amide group on the diazo component, leading to a further increase in lightfastness. Many of these pigments, including PR112, PR146, PR170 and PR188, have been used in artists' paints, for example PR188 was used in 'Winsor Red' oil paint until at least 1997 (Winsor & Newton, 1997).

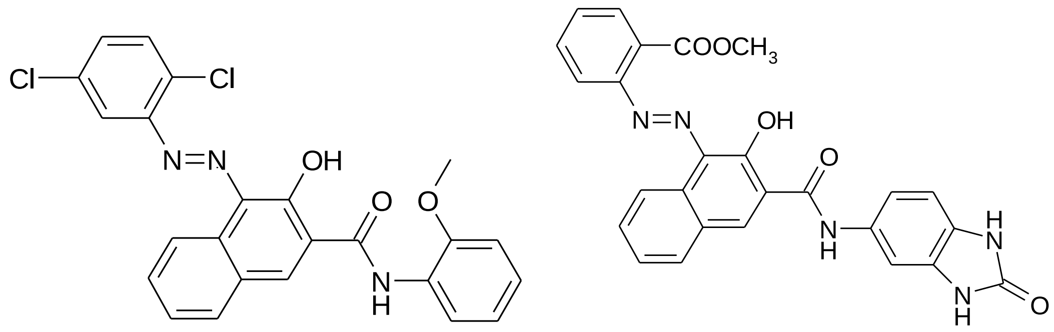


Figure 2.2 Examples of pigment structures. Left, naphthol AS PR9. Right, benzimidazolone PR175

Benzimidazolone pigments are a similar class developed in the 1960s, using 5-(2-hydroxy-3-naphthoyl)-aminobenzimidazolone as the coupling component, leading to further improvements in properties (Smith, 2002). An example used in artists' paints is PR176, found in Royal Talens 'Carmine' Oil colour (Royal Talens, 2010).

Disazo condensation pigments have a similar structure to the naphthol AS pigments, but here two naphthol-azo structures are linked by a central benzene ring. Pigments of this type were first manufactured in the early 1950s. Their greater solvent resistance resulting from enlargement of the pigment molecule and their greater expense compared to naphthol AS pigments has meant they tend to be used in higher quality products (Smith, 2002).

Disazopyrazolone pigments are another type of pigment containing two azo groups. They were first developed in the 1910s, but the first example PO13 was not made commercially available until the 1930s (Herbst & Hunger, 2004). Only a small number of such pigments continue to be manufactured, in red and orange shades. PO34 is an example currently used in artists' paints (Old Holland; Royal Talens; Daler-Rowney, 2010).

The first important synthetic organic yellow pigments to be produced were also azo pigments, using acetoaceticarylides as the coupling component (see figure 2.3). The first such Arylide or 'Hansa' yellow was discovered in 1909, Hansa Yellow G (PY1), soon followed by Hansa yellow 10G (PY3) in 1910. Many other pigments based on the same structure have been developed, but these first two yellow pigments have continued to be very important. They have been widely used in artists' paints, often sold under trade names such as 'Winsor Yellow' or 'Talens Yellow', and continue to be used today, although they are now increasingly being replaced by higher performance alternatives.[8]

Diarylide pigments consist of two arylide structures joined together. The first diarylide yellow was patented in 1911, but they were not introduced as pigments until the 1930s due to the dominance of the more lightfast arylide yellows (Lomax & Learner, 2006). They are widely used in printing inks, but have little use in paints (Herbst & Hunger, 2004).

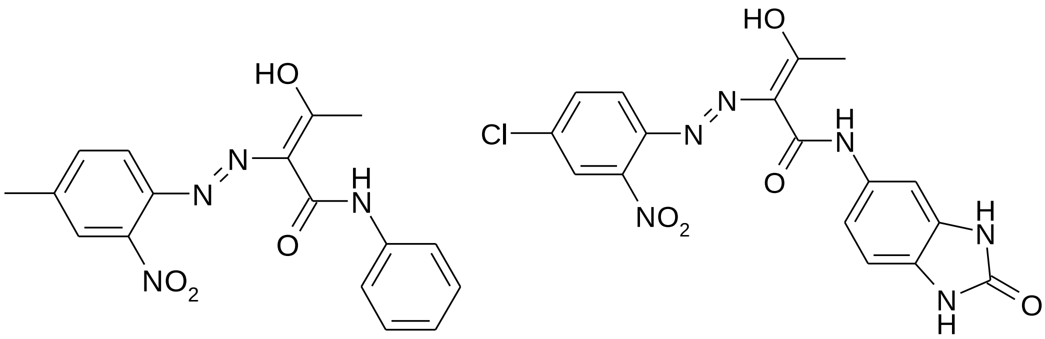


Figure 2.3 Examples of pigment structures. Left, Arylide PY1. Right, benzimidazolone PO36

Another type of benzimidazolone pigment has been developed based on the arylide yellow structure, using the coupling component 5-acetoacetylamino-benzimidazolone (figure 2.3). PY154, which entered the market in 1975 is the most popular example and

[8] PY1 was used in 'Winsor Yellow' oil paint until the mid-1990s, when it was replaced by another arylide pigment, PY74.

has been used in yellow oil paints, as well as in mixed formulations to give brilliant greens (Herbst & Hunger, 2004).

2.1.2.2 Non-azo pigments

Phthalocyanine pigments are some of the most successful organic pigments, and some of the first to be widely introduced to artists' paints, where they continue to hold an important position. Copper Phthalocyanine (PB15) was introduced in 1935, sold under the name Monastral Fast Blue BS by ICI. Chlorination of the phthalocyanine results in a green pigment (PG7), which has been available since 1936. These pigments were used in Winsor blue and Winsor green oil paints since at least 1948, and continue in use today. The yellower green copper polybromochloro-phthalocyanine PG36 was introduced in 1959.

Another important group are the quinacridone pigments, first introduced in the 1950s. They have polycyclic structures with extremely good resistance to light, solvents and heat. They cover a range of colours from gold, orange and red through to purple and magenta. The violet PV19 and magenta PR122 are two of the most important pigments of this class (see figure 2.4).

Perylene compounds first found use as pigments in 1950 (de Keijzer, 1999). They range in colour from red through brown to black and have high tinctorial strength and excellent lightfastness (Herbst & Hunger, 2004). Perinones were also introduced in the 1950s; only two commercial examples exist, which are isomers of each other, PO43 and PR194.

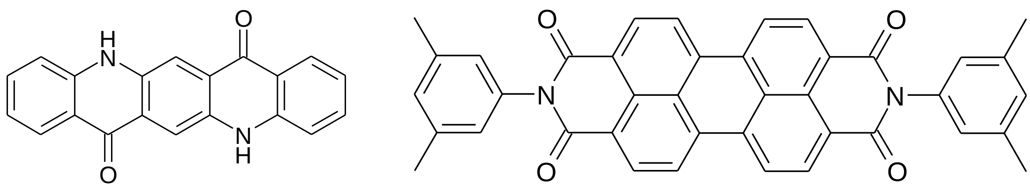


Figure 2.4 Examples of pigment structures. Left, quinacridone PV19. Right, perylene PR149

The isoindolinone pigments were not introduced until the mid-1960s, despite being first patented in the 1940s (Herbst & Hunger, 2004). They are mainly yellow to orange in shade and have very good fastness properties, but only two examples remain commercially available, PY139 and PY185 (Smith, 2002).

Pigments based on the dioxazine structure have been known since the 1920s (Herbst & Hunger, 2004). The most important pigment, Dioxazine violet PV23 was patented in 1952 (de Keijzer, 2002). This has very high tinting strength and has been used in architectural, automotive and artists' paints (Lomax & Learner, 2006).

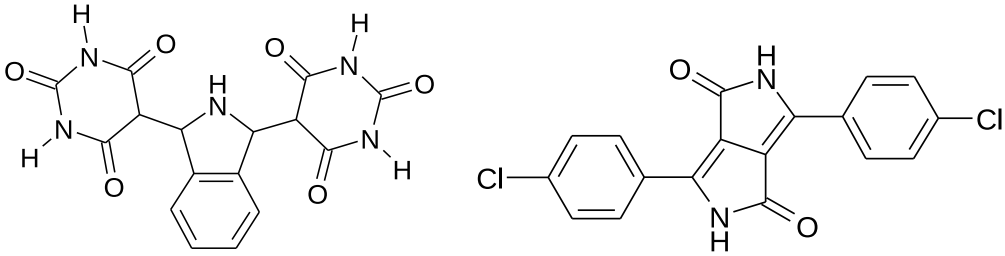


Figure 2.5 Examples of pigment structures. Left, isoindolinone PY139. Right, Diketopyrrolo-pyrrole PR254

Diketopyrrolo-pyrrole (DPP) pigments are the most recently developed class of pigments to have importance in artists' materials (see figure 2.5). The skeletal structure was first made accidentally in 1974, and the first pigment PR254 was introduced in 1986 (Smith, 2002). Three red pigments and one orange are now available, which have excellent lightfastness. Two examples, PR254 and R255, are now used in Winsor & Newton oil colours, replacing the PR188 used earlier in 'Winsor Red'.

2.2 Analysis of modern paints

2.2.1 Analysis of synthetic organic pigments

During the twentieth century the variety and number of pigments used in paints has vastly increased due to the development of synthetic organic pigments (Herbst & Hunger, 2004). While some early examples gained a reputation for poor lightfastness, many of those available today offer superior properties of stability, light and bleed resistance, as well as providing a much wider range of colour and finish than was possible with traditional pigments (Smith, 2002). These pigments are increasingly being used in artists' paints, but have also been extensively used in household and other paints which might be used by artists. The identification of these materials in works of art can increase our knowledge of an artists' technique and provide valuable information for the conservation and care of these works. The succession of new pigments developed throughout the twentieth century can also provide a useful timeline for the dating or authentication of works of art.

The analysis of synthetic organic pigments in works of art is affected by a number of factors which make effective identification more challenging than for more traditional pigments. Most commonly, polarised light microscopy (McCrone, 1981) and elemental analysis techniques such as SEM-EDX (Scanning Electron Microscopy with Energy Dispersive X-ray Analysis) (Ogilvie, 1965) are used to identify pigments in work of art, however these methods are not very effective for synthetic organic pigments. Modern production methods mean particle sizes are small, making microscopic features difficult to observe. In addition, the pigments do not usually contain distinctive elements enabling them to be identified by elemental analysis. In addition to carbon, hydrogen, nitrogen and oxygen, some contain sulphur or chlorine atoms, and a few include a metal ion, but in general the narrow elemental range, coupled with the large number of such pigments makes identification impossible by this method alone.

Identification is also hampered by the low concentration of pigments used, as many synthetic organic pigments exhibit high tinting strength. It is also true that, because of the large number of different examples and the fact that many are relatively new materials, the collection of reference data is often a necessary first step in any identification method. This necessitates the collection of reference samples which may not always be easy to obtain, especially in the case of pigments which are no longer being produced.

These difficulties have led to a wide range of different identification methods being explored in the literature, as will be described. Not all techniques are suitable for all pigment structures, therefore no single technique has emerged as the ideal identification method and many sources recommend using a combination of complimentary techniques. The methods chosen in individual labs will largely depend on the availability of equipment and on the experience of analysts.

The different classes of synthetic organic pigments have been described by Lomax & Learner (2006), including a discussion of methods for their identification. Other reviews exist which discuss the history, synthesis and uses of specific classes of pigments, and also include a section on methods of identification. Such papers have been published on the subject of azo pigments (Berrie & Lomax, 1997), phthalocyanine and quinacridone pigments (Lomax, 2005) and arylide yellows (Lake & Lomax, 2007).

In the following section the principal techniques that have been used for the identification of synthetic organic pigments are summarised, for application to samples from works of art. Each method is described in turn, with a brief description of its characteristics, major developments and applications of the technique. Emphasis is given to the characterisation of the synthetic organic colours that have been introduced over the past century, although the identification of natural organic dyes and pigments is also discussed where the techniques could be of relevance to synthetic colours.

2.2.1.1 Review of analytical techniques

Spectrophotometry

Spectrophotometry uses the most obvious feature of a pigment or dye for identification – its colour, by recording its absorption of electromagnetic radiation over a range of wavelengths, principally in the ultraviolet (UV) and visible regions of the spectrum. The technique necessitates having a collection of reference spectra of known pigments for comparison.

Spectrophotometry was one of the first methods to be applied to the identification of synthetic organic colorants, as described by Billmeyer *et al.* (1981). The authors also explored the use of solubility tests as a first step to classify pigments by chemical type, before absorbance curves were recorded. The technique was applied to the identification of pigments in a range of commercially available artists' paints. Although these experiments were successful, the quantities of material used in the analyses were greater than would be acceptable for the analysis of samples from works of art.

Another use of spectrophotometry was for the investigation of twenty-two synthetic organic pigments found in artists' paints (Talsky & Ristic-Solajic, 1987). Similar spectra were obtained for some pigments, a problem which was overcome by calculating the fourth-derivatives of the spectra to give absorbance curves with clearly defined maxima and minima for more effective comparison. In this way pigments that were similar in both colour and chemical structure could be distinguished. Samples of both pure pigments and oil and acrylic tube paints were analysed. The authors cited examples where the technique had been used successfully to study paint samples taken from artists' palettes.

A variation of the technique using fibre optics to enable *in-situ* analysis of painted surfaces without the need for sampling has also been explored (Talsky & Ristic-Solajic, 1989). Again, fourth-derivative spectra were recorded of commercial oil and acrylic paints. Although it was possible to distinguish the nine pigments tested, the authors recommended taking samples where permissible to carry out absorbance spectrophotometry, due to the complications caused by surface texture effects and pigment mixtures.

The use of fibre optics for *in-situ* analysis of paintings by reflectance spectroscopy was further described by Leona & Winter (2001). Colour measurements were taken directly from thin washes of colour on Japanese paintings, enabling the identification of both organic and inorganic pigments. The spectra of mixtures of pigments were calculated by the linear combination of spectral data from the individual pigments, enabling a mixture of indigo and Prussian blue to be identified.

A new setup using reflectance spectrophotometry for the microspectroscopic analysis of paint cross-sections was developed by van der Weerd *et al.* (2003). This allowed reflectance spectra to be recorded from different areas of a cross section in order to identify the pigments present in the individual layers. The method was applied to the analysis of a cross section from a work by Patrick Caulfield dating from 1985-6. Both the organic and inorganic pigments in the sample could be identified using this method, including two azo pigments, with findings being confirmed by other analytical methods. One red pigment however was not identified, due to a lack of reference spectral data. Some differences were seen in the spectra compared to reference samples, thought to arise from interference from neighbouring layers and optical effects from the cross-section surface.

Chemical tests

The use of chemical tests to identify organic colorants has been described in several papers by de Keijzer (1987; 1988; 1989; 1990). Concentrated sulphuric acid, nitric acid and alcoholic potassium hydroxide were applied to cross sections from paintings to observe the characteristic colour changes occurring in some pigments. In theory, this would allow the simultaneous identification of pigments in the different paint layers of the sample. Results are given for only a limited number of pigments however. It was also noted that the technique can only be used to identify one major pigment in a layer, and that mixtures can be problematic (de Keijzer, 1990). Micro-crystallisation is mentioned as another means of identification, in which certain pigments give a characteristic crystal growth, which can be observed under the microscope. Again, only a few pigments were mentioned as having been identified in this manner (de Keijzer, 1989).

Kalsbeek (2005) made a more extensive study along similar lines, again looking at the colour changes undergone by pigments when exposed to concentrated sulphuric and nitric acids, as well as with a mixture of these two, and with a solution of potassium iodate in concentrated sulphuric acid. From the colour reactions with these four reagents (observed under the microscope), flow charts were constructed for the identification of a pigment as a member of a group of chemically similar pigments. In some cases a precise identification can be made, but often further investigation would be needed. The paint binder was found not to affect the results in most cases, and fillers and extenders in the paint gave colourless solutions so did not affect the colours observed. However, mixtures of pigments could again pose a problem. The technique also requires several small samples of pigment, one for each of the different reagents.

Fourier Transform Infrared Spectroscopy

Fourier Transform Infrared Spectroscopy (FTIR) can provide information on the binding medium, organic and inorganic pigments in a sample in a single analysis. Using a diamond cell or diamond anvil attachment small samples can be analysed, which need no prior preparation and can be recovered for use with other types of analysis (Learner, 1996; 1998). Many organic pigments give spectra with a large number of sharp characteristic peaks in the fingerprint region, some of which have been published in spectral libraries (IRUG, 2000; Hummel, 2002). Although the spectra of the pure pigments are distinctive, peaks are often masked by the peaks from other components in the paint including binders, pigments and extenders. This is a particular problem where the pigment has a high tinting strength so is present at a low concentration.

Learner has listed the characteristic peaks observed for several organic pigments, and found it was possible to distinguish even quite chemically similar azo pigments by comparison with reference spectra (2004). In several test cases described, it was possible to identify the pigment, binder and extender present. However, this may not be possible in many cases, depending on the type and concentration of pigment, and the position of strong bands from extenders and binders.

Although FTIR spectra of organic pigments display sharp characteristic peaks, the practicality of identifying pigments by comparison to a wide range of possible candidates can present difficulties, especially when some bands are masked. Therefore recent work has attempted to identify some of the characteristic bands displayed by certain classes of pigments (Lomax *et al.*, 2007). Another work explored the use of statistical methods to classify pigments by type from their spectra (Schaening *et al.*, 2009). The results appeared promising, and were applied to the study of samples from paintings, but the class of pigment could not be unambiguously identified in all cases.

FTIR microscopy can be used to characterise layered paint samples, as described by Langley and Burnstock (1999). Thin sections were prepared from paint cross sections and FTIR was used in transmittance mode. The reference paints tested mainly contained inorganic pigments, but two azo yellows PY74 and PY83 and phthalocyanine blue PB15:1 were also included. The technique was applied to the analysis of four samples from modern paintings, but no organic pigments were positively identified. In one, a red lake was suspected, but only peaks from extenders were detected. One limitation of the technique was that the smallest resolution that could be obtained was 20 µm, making it difficult to target just one paint layer. The authors also commented that the preparation of thin sections might present problems for more aged or brittle paint samples.

In the forensic science literature, a series of papers have been published using FTIR for the identification of materials in automobile paints. Some of these have considered organic pigments which might also be found in artists' paints (Massonnet & Stoecklein, 1999b; Suzuki, 1999a; b). In some cases, a reference spectrum of the paint binder was subtracted from that of the mixed paint in order to clarify which peaks result from the pigment. However, this technique relies on knowledge of the likely binder and the availability of spectra of an equivalent unpigmented medium.

Raman spectroscopy

The potential of Raman spectroscopy for the analysis of modern synthetic pigments has been investigated in several papers. Like in FTIR, synthetic organic pigments generally give a series of distinctive peaks. Problems may be encountered however when signals are swamped by strong fluorescence from the paint binder or other components in the paint. Identification is through comparison to reference spectra.

One of the first applications to the identification of synthetic dyes and organic pigments was described by Guineau (1989) using Raman microanalysis. Several synthetic dyes and pigments were investigated to create reference samples, and the results were used to identify the materials present in samples of ink, pastel and paint. Methyl violet dye (CI 42535) was identified in a pastel drawing, and perylene red PR224 in a paint sample.

Davey *et al.* (1994) reported the use of Raman to identify a yellow ink from a print by Victor Pasmore. The ink was identified as arylide pigment PY1 by matching to a reference spectrum. Some problems with interfering fluorescence were encountered during this work, making it difficult to see the peaks clearly, but it was thought that this could be reduced with the use of a near-infrared laser source.

A number of organic red pigments found in automobile paints were analysed by Raman in another paper (Massonnet & Stoecklein, 1999c). In this study a near-infrared laser source was used and in most cases the pigments gave distinct spectra, without interfering fluorescence. The results were used to identify the pigments present in samples of automotive red paints. With these samples virtually all the bands seen resulted from the pigment rather than the binding medium. Another study examined green spray paints using both FTIR and Raman, with FTIR used primarily for discrimination of the binder and Raman for pigment identification (Buzzini & Massonnet, 2004). A similar protocol was used looking particularly at quinacridone pigments used in vehicle paints (Binant *et al.*, 1990). Many other examples can be found of Raman being used in forensic investigations for the identification of organic pigments (Buzzini *et al.*, 2006).

Vandenabeele *et al.* (2000) used Raman on a selection of 21 red and yellow azo pigments to build up a reference set of data. A flow chart was constructed to classify the pigments into a number of chemical types based on the Raman bands seen. With comparison to reference spectra it may also be possible to identify the exact type of pigment present, as was achieved for one unknown sample of paint examined as an example. Other authors have also attempted to build up reference sets of Raman spectra of artists' materials, including some organic pigments (Burgio & Clark, 2001).

Fibre optic FT-Raman spectroscopy has been described for the *in-situ* analysis of the painted surface without the need for sampling (Vandenabeele *et al.*, 2001). A painting dating from 1960 was examined by this method, allowing the two azo pigments PR4 and PY3 to be identified using the protocol developed in the earlier paper by some of the same authors (Vandenabeele *et al.*, 2000). In another case study, azo pigment PR49 was identified in a printing ink using Raman spectroscopy, by comparison with reference samples (Wise & Wise, 2004).

Raman micro-spectroscopy was applied to the analysis of coloured inks in four lithographic prints (Castro, 2004). This used a non-destructive method capable of taking spectra directly from the surface of the print, focussing on areas down to 1 µm in diameter. Identification of inorganic pigments by this method was straightforward, but only two organic pigments (indigo and phthalocyanine green PG7) could be positively identified, while several red and yellow organic pigments were not named. The failure to give a more precise identification was attributed to the lack of reference material available for synthetic organic pigments, and to problems with fluorescence. Other case studies have used Raman to identify azo colorants in lithographic inks on posters dating from 1890 to 1920 (Centeno *et al.*, 2006), and pigments in paintings by Max Beckmann and Georg Baselitz (Schulte *et al.*, 2008; Lutzenberger & Stege, 2009). Raman and FTIR have also been used as complimentary techniques to analyse paints used by American artist Sam Francis (Bouchard *et al.*, 2009).

Surface Enhanced Raman Spectroscopy (SERS) has been explored for the analysis of dyes and pigments (Chen *et al.*, 2007). This technique gives an enhanced Raman signal while simultaneously quenching interfering fluorescence through the use of a noble metal substrate, such as a gold or silver colloid. It can also be used without the need for extraction of the pigment from other components of the sample. The method was recently applied to the analysis of organic colorants in pastels and was said to be sensitive enough to identify a pigment from a single grain. (Brosseau *et al.*, 2009). However, the lack of reference data was again a limitation in successful identification of pigments.

Thin Layer Chromatography

Thin Layer Chromatography (TLC) was used by Milovanovic *et al.* (1982) on a reference collection of synthetic organic pigments. Different solvent systems were used to see if each pigment sample could be uniquely identified from their retention factors. Successive analyses using different solvent mixtures managed to achieve this, and the retention factors could then be used to identify the pigments in samples from artists' paints. The binder in the paint samples did not appear to interfere with the results except in the case of the phthalocyanine pigments, where the binder had to be first extracted using solvent. This technique has the advantage that it can be carried out without the need for expensive analytical equipment. TLC has also been described for distinguishing the pigments used in a collection of visually similar household paints (Home *et al.*, 1982).

The low solubility of some pigments in organic solvents can pose difficulties when carrying out TLC, therefore another method used trifluoroacetic acid to increase solubility (Massonnet & Stoecklein, 1999a). The authors used micro-spectrophotometry in combination with the TLC retention factors of the pigments to identify the colorants present in automotive paints. However, the use of acid did introduce new problems of pigment decomposition in some samples.

High Performance Liquid Chromatography

The use of High Performance Liquid Chromatography (HPLC) has been described in several papers, most frequently relating to the identification of natural dyes from textiles and in lake pigments. The low solubility of many synthetic organic pigments is one of the main limitations of this technique. Some of the more recently developed pigments have been designed specifically to have low solubility to increase their bleed resistance (Smith, 2002).

HPLC and Liquid Chromatography Mass Spectrometry (LCMS) have been reported for the analysis of natural anthraquinone dyes and pigments (Wouters, 1985; Wouters & Verhecken, 1989; White & Kirby, 2001; Surowiec *et al.*, 2007), flavonoid dyes (Ferreira *et al.*, 1999; 2001; 2002; 2003) and indigo (Puchalska, 2004). Negative ion Electrospray Ionisation Quadrupole Ion Trap Tandem Mass Spectroscopy (ESI-QIT-MS) was also used in some cases to characterise flavonoid dyes (Ferreira *et al.*, 1999; 2001; 2002; 2003). HPLC has also been applied to the identification of natural organic colorants in watercolour paints used by Winslow Homer (1835-1910) (Halpine, 1995). Little reference has been found to the use of HPLC for the identification of synthetic organic pigments from paint samples, but it has been used for the identification of synthetic dyes and pigments in cosmetics (Wegener, 1987; Rastogi *et al.*, 1997). Over 100 organic colorants permitted for use in cosmetics were analysed by this method, several of which have also been used in artists' paints (Rastogi *et al.*, 1997). A small number however could not be analysed, mainly due to low solubility in the solvents used.

HPLC has been reported for the identification of trace amounts of phthalocyanine pigments (Fischer, 1992). To overcome problems of insolubility, the pigment was first oxidised using potassium dichromate, to break down the phthalocyanine skeleton into more soluble fragments for HPLC analysis. However, with a pigment-specific method such as this, the presence of a phthalocyanine pigment must be suspected initially.

Pyrolysis Gas Chromatography Mass Spectrometry

Sonoda *et al.* (1993) first described Pyrolysis-Gas Chromatography (Py-GC) for the analysis of synthetic organic pigments. In this technique the paint sample is exposed to high temperatures in an oxygen-free environment, causing its molecules to fragment, before the volatile products are separated using gas chromatography (GC). Twenty-five synthetic organic pigments, including examples of azo, quinacridone and phthalocyanine pigments were subjected to this process. In the majority of cases the pigments gave distinctive pyrograms and could be distinguished. However, quinacridone and anthraquinone pigments did not undergo scission on pyrolysis to produce fragments volatile enough to pass through the GC column, therefore could not be identified.

A later paper by the same group focussing on azo and phthalocyanine pigments used Mass Spectrometry to identify the fragments emerging from the GC column (Py-GCMS). In this way they were able to identify many of the characteristic fragments produced by pyrolysis (Sonoda *et al.*, 1999). The results from pure pigment samples were compared to those from real paints, showing that both pigments and synthetic media could be identified in a single analysis. The pyrograms were dominated by peaks from the medium, but in most cases peaks from the most abundant pyrolysis products of the pigment were also seen, enabling them to be identified. Learner has also described Py-GCMS for the identification of azo pigments (2004), identifying the principal fragment ions seen in the pyrograms of some common red and yellow azo pigments. The fragments produced followed the same pattern among pigments of the same type, meaning products from other members of the class could be predicted to a certain extent.

Py-GCMS with simultaneous derivatisation of the sample was used for the identification of indigo by Chiavari *et al.* (2005). In this technique either a methylating or silylating reagent is mixed with the sample in the pyrolyser, causing the fragments produced to be derivatised *in-situ*, enhancing the detection of compounds with polar groups. After analysing a reference sample of pure indigo to identify the resulting products, a sample of blue oil paint from a 17th century painting was analysed, revealing peaks thought to be from indigo, as well as from the oil binder. The result was confirmed using Raman spectroscopy. Another paper investigated the detection of madder, saffron, curcuma and indigo using similar techniques (Casas-Catalan & Domenech-Carbo, 2005).

Direct Temperature Mass Spectrometry

In Direct Temperature Mass Spectrometry (DTMS), the sample is pyrolysed before being introduced directly into a mass spectrometer. The use of a temperature ramp during pyrolysis means different components of the sample can be separated according to their pyrolysis temperatures. The technique was described by Boon & Learner (2002) for the analysis of acrylic emulsion paints, for which both the medium and pigment can be identified. Examples were given of paint analyses in which organic pigments were identified from their mass spectra, including copper phthalocyanine blue PB15 and arylide yellows PY3 and PY73. The lack of a GC step means that certain pigments which could not be identified by Py-GCMS can be analysed by this method.

A pigment scraping from a painting by Patrick Caulfield dating from 1985-6 was analysed by DTMS. This identified the monomers of the acrylic medium and was also able to identify Naphthol red PR170 by comparison with reference spectra (Boon *et al.*, 2002).

DTMS of a wider range of pigments has been described more recently (Lomax *et al.*, 2007). Mass spectral data are reported for a range of different azo pigments, as well as some benzimidazolones, quinacridones, isoindolines and phthalocyanines.

DTMS has been successfully applied to the identification of organic pigments in acrylic paints used by American artist Sam Francis (Menke *et al.*, 2009). Reference samples of pigments and acrylic binding media were initially analysed, before the technique was used to identify materials found in Francis' studio. Different ionisation conditions were compared, which found that negative-ion chemical ionisation gave the best results.

Laser Desorption Mass Spectrometry

The technique of Laser Desorption (Ionisation) Mass Spectrometry (LDMS/LDI-MS) has been explored for the identification of both organic and inorganic pigments in several studies. This technique can be used on solid paint samples with no prior preparation steps necessary as it can selectively desorb and ionise many modern pigments without affecting the paint binder. A preliminary study using spatially resolved mass spectrometry for the identification of natural dyes was carried out by Wyplosz *et al.* (2001). This allows use of the technique on the surface of embedded paint cross sections to obtain mass spectra of the pigments. Tandem mass spectrometry was used to isolate the molecular ion and subject it to further fragmentation for structure determination. This method was applied to the analysis of a cross section from a painting by Patrick Caulfield in another paper involving some of the same researchers (Boon *et al.*, 2002). This showed ions from azo pigments PR170 and PY3.

A further study was carried out by Wyplosz (2003) on the use of LDMS on organic pigments, both natural and synthetic. Synthetic organic pigments were analysed using both LDI and MALDI (matrix-assisted laser desorption ionisation) with a time-of-flight-MS instrument. MALDI can be used to desorb non-volatile molecules without causing thermal decomposition, as the matrix absorbs some of the laser energy. Examples from most of the major classes of synthetic organic pigments were investigated, both as reference pigment samples and in acrylic emulsion and oil paints. LDMS analysis was found to produce a major peak from the intact pigment, with little or no fragmentation. Unidentified peaks were also seen in the spectra, thought to result from other components in the paint samples.

Grim & Allison (2003) have also investigated this technique. Samples of both organic and inorganic pigments suspended in oil or water were painted onto paper; and a UV laser was used to desorb the sample directly from the paper. The technique was found to be effective even when the pigment was present within a dried linseed oil film. The major MS peaks for some organic and inorganic pigments were identified, including phthalocyanine blue and carmine lake. LDMS was later applied to the identification of inks on several documents by the same group (Grim & Allison, 2004) and successfully identified both organic and inorganic colorants.

The use of MALDI-MS for the identification of carminic acid from cochineal was described by Maier *et al.* (2004). Here the sample was dissolved in cyano-4-hydroxycinnamic acid as the matrix before being subjected to laser desorption. A sample of carminic acid in linseed oil, covered with dammar resin was artificially aged to simulate a sample from a painting. Peaks from the dye molecule and fragment ions were detected, as well as some peaks thought to be from the linseed oil and dammar and from the matrix material, which might complicate interpretation in the case of unknown samples. Another study used tetrathiafulvalene as the matrix for the analysis of synthetic organic pigments PY93, PY180 and PG36 (Asakawa *et al.*, 2008).

In the forensics literature, LDMS has been described for the identification of organic pigments in automotive coatings (Stachura *et al.*, 2007). LDMS was carried out on a small set of reference pigments each mixed with polyester resin to form a solid paint chip, including quinacridones PV19 and PR122, benzimidazolone orange PO36 and phthalocyanine blue PB15. Samples of automotive paint were analysed by the same method. The authors note that a library of reference data could be built up, but that it is possible to interpret the mass spectra directly to identify the pigment. LDMS and MALDI MS have been described in several other forensic science articles for the analysis of dyestuffs and pigments found in ink (Siegel, 2005; Dunn & Allison, 2007; Papson *et al.*, 2008).

LDMS was used in a high-profile case to identify pigments in a set of paintings with a disputed attribution to Jackson Pollock (Kirby *et al.*, 2008). The analysis identified the pigments PR254, PR188 and PY74, which were not commercially available until after Pollock's death in 1956, adding weight to the argument that the works were not genuine, or at least had been substantially altered since his death. FTIR was used as a complimentary technique to confirm the findings.

X-ray Diffraction

X-ray diffraction (XRD) has been used fairly extensively for the identification of inorganic pigments, however organic pigments can pose some problems, as described by Curry *et al.* (1982). In general, they are poorer at scattering x-rays than inorganic pigments, and diffraction patterns can be weak due to the low concentration of pigments with high tinting-strength. Despite these difficulties, diffraction data were collected from over 70 organic pigments to build up a database for the identification of pigments in paint samples.

The use of XRD in forensic science is reviewed in another paper, for the identification of pigments in paints, amongst other materials (Rendle, 2003). An example is cited in which two visually similar red paints could be distinguished using this method, by identifying the azo red PR3 in one and a different red azo pigment, either PR48 or PR52 in the other.

Another study (Debnath & Vaidya, 2006) described the use of XRD by the paint industry for the identification and quality control of pigments. Both organic and inorganic pigments are analysed in this way, as pigment powders, including several azo reds and yellows, quinacridone and phthalocyanine pigments. Paint samples were also analysed, but it was found that for samples with multiple pigment components, minor components could not always be detected, and the use of complimentary techniques such as FTIR was recommended.

Other Techniques

Baumler *et al.* (2000) investigated a number of organic pigments used in tattoos with a variety of analytical methods, including FTIR, absorption spectroscopy, X-ray diffraction and transmission electron microscopy (TEM) to examine particle morphology. The techniques were able to identify several azo, quinacridone and phthalocyanine pigments. TEM was also able to detect differences between particles of the same pigment from different manufacturers.

The electrochemical analysis of natural organic dyes has been investigated as a means of identification in one paper (Grygar, 2003). Lake pigments were hydrolysed to extract the dye and the extract was applied to the surface of a paraffin-impregnated platinum electrode for voltammetry measurements. The resulting peak potentials can be compared to reference samples for the identification of the dye. The technique was not tested on paint samples, but it was thought that dyes could be extracted from lake pigments in paint samples using a similar method.

Nuclear magnetic resonance (NMR) has been used to characterise yellow azo pigment PY74, which is used as a pigment in tattoo inks (Cui *et al.*, 2004). Samples of the pigment were exposed to simulated sunlight in order to investigate whether harmful degradation products might be formed from the pigment within the skin. The photodecomposition products of the pigment were identified by NMR.

A method of identifying yellow arylide pigments using sublimation has been described, based on work carried out in an unpublished thesis, reported by Lake & Lomax (2007). The crystals formed by sublimation of the pigments at 190-200°C are examined using polarised light microscopy, from which the different crystal forms of the different pigments can be identified.

2.2.1.2 Conclusions

Many different techniques have been applied to the analysis of synthetic organic pigments. Reference data is needed for the identification of pigments for the majority of techniques, which is often a factor limiting successful identification. A certain investment of time is needed to collect and analyse samples of the many synthetic organic pigments which might be encountered. However, as techniques are explored further, reference data is increasingly becoming available in the literature, from the collections of synthetic organic pigments already gathered by some institutions.

Chemical tests can provide the simplest methods, requiring the least in terms of specialist equipment, but cannot identify every pigment uniquely. They also require several small samples of pigment. Different spectrophotometric methods have proved effective, but similar pigments are not always easy to distinguish with this technique.

FTIR can be a useful technique for the identification of materials in modern paints, but is often complicated by overlapping peaks from different paint components. However, it can be a useful first step to give an idea of paint composition, including the class of pigment present, before using other techniques which may be able to identify the components more precisely. Raman spectroscopy has been successfully applied to the identification of azo pigments, but was not always able to give a precise identification. Like many of the techniques, there is a lack of reference data for synthetic organic pigments compared to those used historically. Raman and FTIR have been used as complimentary techniques in several studies, e.g. (Buzzini & Massonnet, 2004; Bouchard *et al.*, 2009).

HPLC has most frequently been used for natural dyes and pigments, but results indicate that it could be applied to some synthetic colorants. When coupled to mass spectrometry systems it can be an effective tool for separating and identifying components. A suitable method for the extraction of synthetic colorants from a solid paint sample may need to be developed, and the technique may also be limited by the solubility of the organic pigments in suitable solvents.

Pyrolysis methods coupled to GCMS give encouraging results for azo pigments, but some other classes of synthetic organic pigments could not be identified using this technique. DTMS however, does not have this limitation. Both these techniques have the advantage that they can be used for the simultaneous identification of the binding medium, and require little sample preparation. LDMS and MALDI techniques have received attention in recent years and appear to offer an effective method of pigment identification.

It should also be noted that the information gained from each technique may not be enough to uniquely identify each pigment when used in isolation. For this reason it may be necessary to use a combination of methods. In particular, small sample sizes, low pigment concentration and pigment mixtures will increase the difficulty of making a successful identification whichever method is chosen.

2.2.2 Analysis of synthetic paint media

In general, the methods used for the analysis of modern media are better established than those used for modern organic pigments and there is less variety in approach. Some of the techniques used for the analysis of synthetic organic pigments are also able to identify the type of binding medium present so have already been discussed to some extent in the preceding section.

A review on the conservation concerns for acrylic emulsion paints included a brief review of their identification through analytical techniques (Jablonski *et al.*, 2003). This identified FTIR, Py-GCMS and DTMS as being the most commonly used methods. These methods also appear to be the most common for the identification of alkyds and PVAc, the other principal classes of synthetic media found in artists' paints. For the identification of modern paint media, much of the more recent work has been carried out by Learner, principally using these same techniques (Learner, 2004).

Methods for traditional media

Oil paint has had a long history of use amongst artists and consequently the methods employed for its analysis are well established. Analytical techniques can be used to discover not only whether oil is present but may also be able to tell us the type of oil, and in some cases how it has been prepared. Other components that may have been mixed with the paint, such as egg media or varnish, can also be identified. One of the simplest methods is to use staining tests on paint cross sections to identify the types of media present in the layers. Different stains can be used to identify the presence of oils, proteins or resins. However these tests are not always reliable and the pigments present in the layers may interfere with results. FTIR spectroscopy has been used for the analysis of traditional painting materials and can be a useful first step for the identification of the class of material present, for example oil, resin or protein, or a mixture of these. For more specific results another technique usually needs to be employed.

Further analysis can be performed using Gas Chromatography Mass Spectrometry (GCMS). This usually requires pre-treatment of the sample to produce derivatives that are volatile enough to enter the GC column. The solid oil paint sample must first be saponified to release the fatty acids from the oil matrix. The freed fatty acids are then esterified, usually to produce the methyl esters (Mills & White, 1994; Schilling & Khanjian, 1996; Pitthard *et al.*, 2005). The sample can then be separated and analysed by GCMS, resulting in peaks from the methyl esters of the fatty acids present.

The presence of a drying oil is confirmed by the presence of a large peak for dimethyl azelate, resulting from the reactions of the unsaturated fatty acids in the drying oil to form azelaic acid. The saturated palmitic and stearic acids are not consumed in the curing reactions of the drying oil so their proportion remains fairly constant over time, although care is needed in the interpretation of results (Tsakalof *et al.*, 2006). The ratio of these two acids can therefore be used to identify the type of drying oil present, for example linseed oil has a palmitate/stearate ratio of around 1.6, while poppyseed oil has a higher ratio of around 3.3 (Mills & White, 1994). Proteinaceous binders also need to be hydrolysed and derivatised prior to analysis to identify the amino acids present (Singer & McGuigan, 2007). The proportion of the different amino acids is characteristic of the type of protein present.

2.2.2.1 Review of analytical techniques

Gas Chromatography-Mass Spectrometry (GCMS) and Pyrolysis GCMS

GCMS has been used for the analysis of alkyd paints in a similar manner to that used for oils (Schilling *et al.*, 2004). To be able to quantitatively analyse both organic acid and polyol components, samples were divided in two and different derivatisation procedures applied to each half. Derivatisation with (m-trifluoromethylphenyl)-trimethylammonium hydroxide (a method used for the analysis of oils) was used to prepare methyl esters of the fatty acids and polybasic acids from the alkyd. To analyse the polyol components aminolysis with n-butylamine was carried out, followed by trimethylsilylation. The different components were successfully identified from both alkyd resins and commercial alkyd paints. In the same way as for oil media, the palmitate:stearate ratio can be used to identify the type of drying oil used in the alkyd.

GCMS is not well suited to the analysis of polymeric synthetic binding media, due to their high molecular weight and lack of characteristic extractable components. Therefore pyrolysis techniques have been used in which the solid polymer sample is broken down into volatile fragments by pyrolysis. This has been shown to be an effective method for all of the principal types of synthetic media (Learner, 2004). The sample is pyrolysed by heating it in the absence of air, causing it to fragment. The polymers form characteristic fragments which can be identified using GC, MS or a combination of the two, to identify the type of medium.

Acrylic polymers fragment to give peaks corresponding to the monomers, dimers and trimers of the acrylate species making up the copolymer. In this way the type of copolymer can be identified. For PVAc resins, acetic acid and benzene are major products from the pyrolysis, and often plasticisers can also be identified. Alkyds also give characteristic pyrograms, with a peak for phthalic anhydride appearing in all alkyds based on ortho-phthalic acid. Modifiers such as styrene, acrylic or silicone resins will also appear in the pyrogram. The fatty acids from the drying oil component can also be identified if a reagent is added to the sample for simultaneous derivatisation, such as tetramethylammonium hydroxide (TMAH). Py-GCMS with derivatisation can also be used to identify purely oil binders, but gives more complicated pyrograms and a less reliable palmitate:stearate ratio than the GCMS methods described above.

Pyrolysis techniques have a fairly long history of use for paint media identification in forensic science (Lehrle, 1997; Caddy, 2001). A paper from 1985 reviewed its use over the previous 10 years and compared Py-GC and Py-MS for their ability to characterise alkyd, acrylic and PVAc media (Wheals, 1985). Another paper reviewed the use of pyrolysis techniques for the identification of polymers and additives, including paint media, comparing Py-GC, Py-MS and Py-GCMS (Bart, 2001).

Py-GCMS is now the more commonly used method, as described by Learner (2001), for the effective separation and identification of components. Both reference paint samples and samples taken from works of art were used in the study, to identify acrylic, alkyd and PVAc media. Nitrocellulose paints were also investigated. Although the cellulose nitrate itself did not give characteristic peaks, the paints also contain alkyd and plasticiser components that could be taken as evidence for the presence of this binder. The use of Py-GCMS was also described in another paper for detection of alkyd modifiers (Burns & Doolan, 2000).

Pyrolysis-GCMS was used in another paper, along with several other techniques, for the characterisation of acrylic emulsion paints (Chiantore, Scalarone, & Learner, 2003). In this way the composition of the acrylic copolymer medium in two different brands of paint were identified. Both media were found to contain ethyl acrylate and methylmethacrylate monomers, with the addition of n-butyl acrylate monomers in one. Size exclusion chromatography was also used to characterise the molecular weight distribution of the media, and revealed the presence of a low molecular weight peak corresponding to polyethylene glycol surfactants.

Thermally assisted hydrolysis and methylation-GCMS (THM-GCMS) of alkyd resins was described by Challinor (1991). In this method the sample and methylation reagent (TMAH) are put together in the pyrolyser, so that the fragments formed by pyrolysis are simultaneously derivatised. The resulting fragments were separated by GC and analysed by mass spectrometry. Samples of pure alkyd resins, rather than paints, were used in this study. The methyl ethers of the polyol component of the alkyd could be identified in the pyrogram, as well as the methyl esters of the fatty acids and dimethyl phthalate. The proportions of the fatty acids can be used to identify different drying oils, and by comparison to phthalate content could give an indication of the oil length of the alkyd. Similarly, simultaneous silylation can be achieved, by using hexamethyldisilazane in the pyrolyser with the sample, as was investigated by another group analysing acrylics (Osete-Cortina & Domenech-Carbo, 2006).

The application of PyGCMS to the investigation of works of art has been reviewed (Chiavari & Prati, 2003), showing that it can simultaneously detect the presence of a wide range of different materials, including oil and protein media, natural and synthetic resins. Results were compared both with and without a methylating or silylating derivatisation reagent, showing that the derivatisation generally produces a clearer chromatogram. Another more extensive review focussed on the use of Thermally assisted hydrolysis and methylation with GC or GCMS, again using TMAH to derivatise the sample in the pyrolyser (Challinor, 2001). The application of the technique to a wide range organic materials including alkyd resins, was discussed.

THM-GCMS was applied to the analysis of samples from works of art in another paper (Cappitelli, 2004). Here samples from works by Jackson Pollock and Fiona Banner were analysed. In samples taken fron the Pollock work, an oil binder was identified in some colours, and an alkyd medium in others. The presence of pentaerythritol was detected in some of the alkyds, and the type of drying oil the alkyd was based on was estimated from the palmitate:stearate ratio. In the Banner samples an acrylic paint was detected based on butyl acrylate-methyl methacrylate. A peak was detected corresponding to n-methyl aniline, thought to be from the dye of a red ink used over the white acrylic ground. Apart from this no peaks corresponding to pigments were identified.

THM-GCMS, along with FTIR, has also been used for the analysis of samples from several works by Picasso (Cappitelli & Koussiaki, 2006). The presence of an alkyd medium was suggested in one sample, from the identification of a dimethyl phthalate peak in the pyrogram and from the carbonyl stretching frequency in the IR spectrum.

Direct Temperature Mass Spectrometry (DTMS)

DTMS is similar to PyGCMS, but instead of using a GC column, a temperature ramp is used to separate the components. The temperature is used to separate the pigments and media, allowing both to be analysed from one sample. The technique was used to analyse artists' acrylic emulsion paints (Boon & Learner, 2002). The pyrolysed material was ionised by either electron impact ionisation or by ammonia chemical ionisation. Monomers and dimers from the acrylic media were identified, allowing the type of acrylic copolymer to be characterised. The organic pigments present could also be identified. Using ammonia chemical ionisation a series of peaks from polyethylene glycols were also observed in one paint sample, thought to be added to the paint as emulsifiers.

The use of the technique for the analysis of alkyd and PVAc media has also been described (Learner, 2004). Again, acetic acid and benzene are produced as the major pyrolysis products for PVAc, and for alkyds based on ortho-phthalic acid, phthalic anhydride is detected. Styrene and vinyl-toluene alkyd modifiers are also readily detected.

Fourier Transform Infrared Spectrosopy (FTIR)

The use of FTIR for the identification of synthetic paint media has been described in several sources (Learner, 1995; 1996; Beveridge, Fung, & Macdougall, 2001). It has been shown that the main classes of paint binding media (oils, alkyds, acrylics and PVAcs) give sufficiently different FTIR spectra to enable them to be distinguished. For acrylics the type of copolymer can also sometimes be identified. Pigments and extenders will also absorb infrared and so contribute to the FTIR spectrum, which may complicate results.

Different sample introduction methods suitable for small paint samples are described by Beveridge *et al.* (2001). A diamond compression cell can be used to enable small samples to be used which are also easily recoverable for further analysis. It is also possible to perform FTIR on paint cross sections where a microscope attachment is available, either as transmission spectra for a thin section, or as reflectance spectra from the surface of the cross section.

FTIR was compared to THM-GCMS in another paper (Cappitelli, 2004). Here it was found that FTIR could identify the presence of nitrocellulose in a paint sample, which could not be identified by THM-GCMS. It was also shown that alkyds based on glycerol and those containing pentaerythritol could be distinguished using FTIR.

FTIR has been used in combination with size exclusion chromatography (SEC) to separate the components of acrylic emulsion paints prior to analysis, thus reducing the problem of overlapping and masking of bands from the different components (Scalarone & Chiantore, 2004). In this way separate FTIR spectra were obtained for the acrylic copolymer, an ethoxylated fatty alcohol surfactant and the pigment, allowing them to be identified more easily. The results were compared with those from Py-GCMS, which was suggested as a complimentary technique.

Another paper used FTIR for the analysis of a series of red spray paints with a variety of different binding media, including alkyds, acrylics, PVAc and nitrocellulose, often used in mixtures (Govaert & Bernard, 2004). As this paper is from the forensics literature the main emphasis was on distinguishing the different paints rather than specific identification of the components. The 51 paints tested could be distinguished into 17 different groups according to the type of binder present.

The FTIR spectra of synthetic resins used in art, including acrylic dispersions, alkyds and PVAcs were interpreted using linear discriminant analysis in another study (Peris-Vicente *et al.*, 2007). The principal peaks in different regions of the spectra were identified in order to provide a statistical framework for distinguishing the samples. Linear discriminant analysis proved to be an effective way of distinguishing the samples according to binder type. This study looked at resins only, so the effects of any overlapping peaks from pigments or extenders in paints were not examined.

Nuclear Magnetic Resonance

Nuclear magnetic resonance (NMR) techniques have been applied to the characterisation of alkyd paint binders. Pure alkyd resins were characterised in one paper using ^{13}C-NMR spectroscopy (Marshall & Lander, 1985). The resins, in solution form, were analysed and compared to NMR spectra of several drying oils commonly used in alkyds. Peaks were identified from the different components of the alkyds, for example the phthalate ester, glycerol and fatty acids. Modifiers such as silicones, epoxies and styrene could also be identified. However, this paper only examined the resin in its pure form, not as part of a paint, where one might expect analysis to be complicated by the presence of pigments, extenders and other additives.

A more recent paper applied NMR to the study of aged binding media used in paintings, namely linseed oil, egg and acrylic media (Spyros & Anglos, 2006). Sonication in deuterated acetone was used to extract organic material from the dried paint samples. The extracts were analysed by ^{1}H and ^{13}C-NMR spectroscopy. The acrylic medium gave significantly different results from the other two media, allowing acrylic to be readily distinguished. The constituents of the acrylic copolymer were identified as ethyl acrylate and methyl methacrylate, and polyethylene glycol was also found, used as a surfactant in acrylic paints. Finally suggestions were made of how the method could be scaled down so that a µg scale of sample would be needed, making the technique suitable for analysis of samples from works of art.

2.2.2.2 Conclusions

Many of the techniques discussed can be applied to the identification of media in all three main classes of synthetic paint: alkyds, acrylics and PVAcs. FTIR has been shown to be a useful method for the identification of binder type, and can also give information about other components of the paint. Pigments and extenders may complicate results however, when present in high concentrations.

Pyrolysis GC-MS appears to be the most commonly used method to obtain more detailed information, either with or without simultaneous derivatisation. For alkyds, GCMS methods similar to those used for oils can be effective, but for the other synthetic media the pyrolysis step is necessary for the breakdown of the high molecular weight polymers into analysable fragments.

2.3 Analytical methods used in this study

In this study, FTIR and PyGCMS are the principal techniques that will be used for the identification of modern paint components. Both methods can provide us with information about organic pigments and synthetic media simultaneously. By combining these techniques we are more likely to be able to identify materials with confidence. The main limitation with this approach however is that certain groups of pigments, for example quinacridones, cannot be identified using PyGCMS.

For the more traditional oil paint media and inorganic pigments, FTIR, GCMS, SEM-EDX and polarised light microscopy will be the analytical methods used.

Chapter 3 Experimental

The approach taken to carrying out the research is described in this chapter, along with experimental details.

3.1 Methodology

This research follows methodology fairly long established in conservation and technical art history. Many other studies have looked into artists' techniques and materials by examining and taking samples from a range of paintings by the artist in question, sometimes focusing on a particular period or theme in the artists' work and sometimes attempting to give an overview. The conservation treatment of one particular work will sometimes prompt a thorough investigation of just one painting. In other cases the gathering together of works and expertise from different institutions through the organization of exhibitions will provide the opportunity to study and compare related works. Several such studies have been carried out on the work of certain artists, focusing on different aspects of their career. Researchers often also use documentary sources such as contemporary letters, receipts or company records[9] to investigate materials and techniques, as well as surviving tools, palettes or paint-boxes used by the artist. Some artists' studios have been preserved along with their contents, which can be investigated and materials matched to paints in the paintings themselves (Eastaugh & Gorsia, 2007; Menke *et al.*, 2009).

In this study a sample of paintings spanning Bacon's career will be examined and sampled. From this a timeline of commonly used materials, including supports, pigments and media, will be constructed. Thus a framework will be built up against which undocumented works can be compared, to assist with dating or authentication. The timeline will also allow us to track changes in Bacon's practice which might be related to the development of his style. Changes in the use of materials might also be indicative of wider trends in contemporary art and the availability of new materials.

3.1.1 Sampling

Taking samples of paint from works of art in order to identify materials is a well-established method in conservation science. However, the sampling of works of art presents a number of problems. Firstly there is an ethical question of whether removing material from a work of art can be justified for the purposes of research. Non-destructive methods of analysis are increasingly being developed, but in many cases

[9] The Roberson Archive of Account Holders is one useful source often consulted in particular for 19th to early 20th century artists.

there is no alternative to removing a sample for analysis. Information gained from taking samples may be important for the study, interpretation and preservation of a work of art and comes at very little cost, as the sample taken is very small and its removal should not have any visual impact on the work of art.

The samples that can be taken from works of art will often be limited by ethical considerations. For example, it may only be acceptable to sample those areas which would not normally be visible, such as edges normally covered by the frame rebate, or drips onto the tacking margins at the sides. Junctions of cracks could also be possible sites, or areas of damage might be sampled, but the possibility of contamination by restoration materials might complicate analysis in this case. It would be difficult to justify taking anything but the tiniest scraping from undamaged paint in a more central area.

The size of sample taken relates to what we are able to do with it and how much information we can extract – with a tiny scraping of particles we may only be able to use SEM-EDX or polarized light microscopy to investigate (inorganic) pigments. A slightly larger scraping might allow us to carry out FTIR and GCMS or PyGCMS and also identify the binding medium. Whereas if we are able to take a chip of paint through several layers we can also prepare a cross-section and look at paint layering to investigate artist's technique.

Because of the availability of sample sites, the colours we are able to sample may be limited to what can be found around the edges. Paints used in backgrounds are likely to dominate our findings and faces and figures are unlikely to be reached. Another consideration is that the edges may not always be representative of the whole – the artist may have wiped his brush here, or the paint at the edge might have been damaged by the frame rebate and retouched. We cannot be sure if what we find here gives a realistic account of the rest of the painting. Inevitably we are taking a very small sample from a complex object, which is a tiny fraction of the whole and we cannot know how the area we have sampled relates to the rest of the object. Statistically speaking this is not a random sample, and to be sure of a statistically significant result we would need to take several samples from different areas and repeat our analyses (Reedy & Reedy, 1988). This is obviously not possible in a situation where taking even one sample needs careful justification.

3.1.2 Paintings sampled

The aim in this research was to sample a representative selection of Bacon's work spanning his whole career. However, although some paintings were specifically chosen to cover a certain date or phase in Bacon's output, in many cases the selection of paintings was primarily through their availability and the willingness of owners to participate. Canvases were sampled from four main sources:

- Paintings owned by the Estate of Francis Bacon (3)
- Privately owned paintings, many of which were brought to the Francis Bacon Authentication Committee meetings, from which samples were taken by kind permission of the owners. (7)
- Paintings from public collections in the UK. The galleries were contacted with a request for samples to be taken from one or more paintings, in return for a report on the materials found, to add to knowledge about the work for conservation and education. (11)
- Slashed canvases remaining in Bacon's studio, now in Dublin City Gallery The Hugh Lane. (17)

The slashed canvases remaining in Bacon's studio after his death have formed a large part of this study and these offer excellent opportunities to sample areas which it would be difficult and ethically questionable to access in an undamaged work. The paintings appear to cover a considerable period and are at varying stages of completion. Their inclusion helps us to overcome some of the problems addressed above, by allowing us to take samples from areas away from edges, and in many cases directly from paint used for figures. However, there are some problems associated with their use which should be considered, and might mean they should be discussed as a separate category from intact works.

Firstly, the slashed canvases were obviously found to be unsuccessful and were destroyed by Bacon, or under his instruction. Therefore they may represent experimental use of materials and techniques, which were abandoned in favour of more successful established methods. They may contain reworking in an attempt to salvage a composition, or in some way show features which are not typical of completed works. It is also sometimes difficult to tell how 'complete' the works were when destroyed. Secondly, in most cases we do not have much information about when the works were created, meaning their placing on a timeline of materials may be problematic. For some, dating is complicated because Bacon appears to have worked on the canvas over a period of time, making major areas of reworking or overpainting. We can usually only give approximate dates by comparing the surviving fragment with existing works. Most of the works sampled were those in which there were sufficient areas of surviving composition to allow them to be dated fairly precisely.[10] A few also had a date-stamp on the stretcher, providing an earliest possible date for these works.

The paintings that could be sampled from other sources were those with owners who were willing to allow sampling to be carried out, and which we could gain access to, given their location and planned programs of display and exhibition. This meant that the paintings forming the study were not necessarily chosen to allow the formation of a complete, regularly spaced timeline. In a study of this kind, attempting to give an overview of Bacon's whole career, and involving many individual works, the availability of samples will always be difficult. It is also worth noting that the number of complete works sampled here (21) represents only a small fraction of Bacon's overall output, believed to be over 600 works. One slight gap in the timeline exists in paintings from the later 1970s. There is also a shortage of completed works from the 1980s, as most of the works sampled from this decade are slashed canvases.

Reference materials

Methods for the identification of many of the materials likely to be found in twentieth century oil paintings are well established. Many materials have been used by artists over considerable periods, for example linseed oil and pigments such as lead white and vermilion, for which analysis techniques are well known and routinely carried out. However, materials that have been introduced more recently are less well studied, as discussed in chapter 2. For this reason, samples of modern synthetic organic pigments were collected to be analysed to build up a set of reference data. This work was carried out in preparation for the identification of these materials in the paint samples.

[10] Martin Harrison, who is currently working on the preparation of The Francis Bacon Catalogue Raisonné has provided valuable information on dating.

3.2 Methods

3.2.1 Samples

3.2.1.1 Reference samples of synthetic organic pigments

A set of synthetic organic pigments was collected to use as reference samples. A very large number of synthetic organic pigments exist, but a limited number of these have been regularly used in artists' paint. Pigments were selected by reference to catalogues of artists' materials and to the work of other researchers (Mayer & Sheehan, 1991; Berrie & Lomax, 1997; de Keijzer, 1999; Sonoda *et al.*, 1999; Kalsbeek, 2005; Winsor & Newton, 2007). All the pigments selected were mentioned in at least two of these sources as being used in artists' paints.

A number of organic pigment samples had already been collected from ICI, Winsor & Newton and a few from unknown sources. Further pigment samples were obtained from Kremer Pigmente and a set of samples was kindly donated by Clariant. Another set of pigments were gained from the Tate's own collection of modern organic pigments, originating from a variety of different sources. All pigment samples are listed in Appendix A.

3.2.1.2 Sampling of studio materials

The studio contained a vast number of different materials, tools and surfaces covered with paint accretions. It was obviously impossible to sample everything present, therefore an attempt was made to sample a range of different types of material, including tins of household paint, tubes of oil paint, cans of spray paint, pastels and dry pigments. Emphasis was given to materials which might be more difficult to identify, such as spray paints, or in which the contents would not necessarily be obvious from the packaging, such as household paints. Some materials sampled were those with apparent links to materials observed in paintings, for example the trays of bright orange pigment and corduroy cloths with pink and blue paint stains.

Three visits were made to the studio and a total of 100 samples were taken over the three occasions. The database of studio materials was examined to give an overview of the materials in the studio and to identify materials which might be of particular interest. Study of the database also allowed a more complete picture to be assembled of the range of colours used, and their relative abundance, see chapter 5.

The studio materials were studied in order to identify a wider range of materials than could be sampled from the paintings alone. It was also hoped that the identification of materials from the relatively large samples taken from studio materials would aid in the identification of similar components in micro samples from the works of art.

3.2.1.3 Examination of paintings and sampling procedure

Paintings were visually inspected and a report was written for each, detailing observations of the materials used for each component part – including support, ground and paint. A brief description of technique was also made. In some cases a binocular microscope was available for a closer examination of the surface.

Samples were taken from around the edges of the painting, or from areas of damage. For the slashed canvases, fragments of paint from along the cut edges were often collected. Sites were selected in an attempt to get samples representative of a range of colours. For some of the paintings examined, sampling decisions were made in consultation with gallery staff and subject to their approval. On average, about six samples were taken from each painting, but the number of samples that could be taken was sometimes restricted by the lack of suitable sites, either due to the very thin nature of the paint, or the lack of a range of colours at edges. A sample was also taken from the priming layer on the back of the canvas, where present.

Samples were taken using a clean sharp scalpel and transferred to a glass sample tube using a clean sable brush. The locations of sample sites were recorded by taking measurements and photographing the sampled area.

A list of the paintings sampled is given in table 3.1. The paintings were numbered according to the order in which they were examined, but here are rearranged into chronological order. The slashed canvases are numbered according to their entry in the Hugh Lane database, which has been abbreviated (e.g. full database number RM98F51 is shortened to F51).

Table 3.1 Paintings sampled listed in chronological order

No.	Title	Date	A&R [11]	Owner
FBA1	Untitled (Landscape)	c.1943[12]	-	Private
FBA2	Head (de Maistre)	c.1949	-	Private
FB01	Head	1949	A7	Private
FB07	Head II	1949	21	Ulster Museum
FB03	Untitled (Figure Crouching)	c.1950-1	-	Bacon Estate
FB10	Portrait of Lucian Freud	1951	33	Whitworth, Manchester
FB08	Untitled (Figure in a landscape)	c.1950-2[13]	-	Private
FB02	Figures in a landscape	c.1954[14]	A13	Private
FB17	Study for a Portrait of Van Gogh	1956	112	SCVA, Norwich
FB11	Study for Figure VI	1956-7	123	Hatton, Newcastle
FB06	Untitled (Pope)	1957-9	-	Private
FB16	Two figures in a room	1959	149	SCVA, Norwich
FB14	Head of a Woman	1960	171	SCVA, Norwich
FB13	Head of a Man	1960	174	SCVA, Norwich
F39	Untitled (Figures on carpet)	1959-63[15]	-	Hugh Lane, Dublin
F51	Untitled (Figure)		-	Hugh Lane, Dublin
F50	Untitled (Figure on blue couch)	c.1962	-	Hugh Lane, Dublin
F41	Untitled (figure study purple)	c.1962-3[16]	-	Hugh Lane, Dublin
FB09	Study for Self Portrait	1963	213	NMGW, Cardiff
F54	Untitled (yellow/green figure)	c.1964	-	Hugh Lane, Dublin
FB12	Portrait of Henrietta Moraes	1965	-	Manchester City Art Gallery
FB15	Three studies for a Portrait of Isabel Rawsthorne	1965	-	SCVA, Norwich
F48	Untitled (orange study)	c.1965	-	Hugh Lane, Dublin
F226:4	Untitled (green portrait)	c.1967	-	Hugh Lane, Dublin
FBA3	Self portrait	c.1968	-	Private
F65	Untitled (yellow figure study)	c.1971[17]	-	Hugh Lane, Dublin
FB04	Figure going through doorway	c.1972	-	Bacon Estate
F245:8	Untitled (portrait in blue shirt)	c.1973	-	Hugh Lane, Dublin
FB18	Three Figures & Portrait	1975	-	Tate (T02112)

[11] Catalogue number in Alley & Rothenstein Catalogue Raisonné

[12] This date was given to the work when it was sold at auction in 2008, but Martin Harrison suggests this should be revised to 1945 (personal communication).

[13] Dated 1952 by owner, but the suggested Buhler provenance would revise this date to before Bacon left Cromwell place in early 1951 (Martin Harrison, personal communication)

[14] This date is given in Alley & Rothenstein's Catalogue Raisonné, Martin Harrison suggests revising to 1955.

[15] Dated 1959-1963 by Martin Harrison, with a leaning towards the earlier date, taking account of 'Aubusson' rug

[16] Harrison places this at c.1962-3 from the style of the figure, but the lilac background is a feature of works from 1970 onwards – possibly revised at a later date.

[17] Harrison relates this to *Study for Portrait*, 1971.

Table 3.1 Paintings sampled listed in chronological order (continued)

FB05	Figure with cricket pads	c.1982	-	Bacon Estate
F133:9	Untitled (portrait in white t-shirt)	Post-85[18]		Hugh Lane, Dublin
F204	Untitled (black portrait)	Post-85	-	Hugh Lane, Dublin
F206	Untitled (blue portrait)	1980s	-	Hugh Lane, Dublin
F36	Study for portrait	1986	-	Hugh Lane, Dublin
F122	Untitled (black portrait)	c.1989-90[19]	-	Hugh Lane, Dublin
F98	Untitled (black portrait)	c.1989-90	-	Hugh Lane, Dublin
F85	Untitled (blue-green portrait)	70s/80s	-	Hugh Lane, Dublin
F242	Untitled (orange canvas)	1980s	-	Hugh Lane, Dublin

3.2.1.4 Analytical procedure

Different analytical techniques were chosen to analyse different components of the samples. Each sample was first examined under the microscope to decide how it should be analysed. Techniques were selected depending on the type of sample – scrapings thought to contain only one layer of a painting were analysed by Fourier Transform Infrared Spectroscopy (FTIR) to discover the medium present. FTIR was often used as a preliminary step to give an indication of the medium, which could then be confirmed and further analysed using Gas Chromatography Mass Spectrometry (GCMS) or Pyrolysis Gas Chromatography Mass Spectrometry (PyGCMS) as appropriate. PyGCMS was used where synthetic binding media or synthetic organic pigments were suspected from the FTIR analysis, and GCMS to identify traditional binding media. Some pigments and extenders could be identified using FTIR, including the presence of organic pigments in some cases.

Samples where several paint layers had been collected were mounted as cross sections to view the layers. Cross sections were often further analysed using Scanning Electron Microscopy with Energy Dispersive X-Ray Analysis (SEM-EDX) to identify inorganic pigments and extenders. Polarised light microscopy could often be carried out in addition to other techniques, as very little sample is needed, and was sometimes used as a complimentary technique to compare with the results of SEM-EDX.

[18] 1985 date stamp on stretcher of F133:9, F98, F122 and F204
[19] Date proposed by Martin Harrison for this and F98

3.2.2 Analytical Techniques

3.2.2.1 FTIR of paint and pigment samples

FTIR spectra were recorded on a Perkin-Elmer Spectrum RX I FTIR Spectrometer (PerkinElmer, Waltham, USA) with DuraScope diamond ATR accessory (Smiths Detection, Alcoa, USA). The sample was placed put directly on the diamond window, using enough material to cover the central area (if possible), a circle of approximately 0.2 mm^2. The spectra were recorded in the range from 4200 to 650 cm^{-1}, using 16 scans at 4 cm^{-1} resolution. For some layered samples, particularly the priming samples, the paint flake was flipped over to record a separate FTIR spectrum from the other side of the sample.[20]

Components in paint samples were identified by comparison to reference spectra of binders, pigments and extenders made on the same instrument, and to reference spectra from other sources (Derrick *et al.*, 1999; IRUG, 2000; Caddy, 2001; Castro, 2005).

3.2.2.2 PyGCMS of organic pigments and synthetic binding media

The method used for Pyrolysis Gas Chromatography Mass Spectrometry was based on that described by Learner (2001).

Instrumentation

Pyrolysis Gas Chromatography Mass Spectrometry was carried out on a Thermo Finnigan Focus GC Gas Chromatograph with Thermo Scientific TR-5MS SQC column (5% Phenyl Polysilphenylene-siloxane), 15 m x 0.25 mm, 0.25 µm internal diameter, fitted with a Pyrola 2000 platinum filament pyrolyser (PyroLab, Sweden). This was coupled to a DSQII Mass Spectrometer. The inlet temperature to the GC was kept at 250°C. The helium carrier gas flow rate was 1.5 ml/min with a split flow of 41 ml/min and split ratio of 27. The MS transfer line was held at 260°C and the ion source at 250°C. The pyrolysis chamber was heated to 175°C, and pyrolysis was carried out at 600°C for two seconds for the majority of samples. Pyrolysis was repeated at the higher temperature of 800°C for 2 seconds with a new sample for pigments which did not give clear results at the lower temperature.

[20] For priming samples this often enabled a protein-based size layer to be identified at the base of the sample.

Temperature program (15 m column)

Initial	40°C	2 mins
Ramp	10°C/min	21 mins
Final	250°C	5 mins
	Total run time	28 mins

During the project the column was changed to a 30 m DB-5 column, resulting in changes to the temperature program:

Initial	40°C	4 mins
Ramp	10°C/min	21 mins
Final	250°C	12 mins
	Total run time	37 mins

The change of column led to increased retention times for the products. The products resulting from the two different sets of run conditions could be related through the comparison of mass spectra and order of elution.

Run procedure

A small sample of pigment/paint was placed on the platinum filament of the pyrolyser, which was then replaced in the pyrolysis chamber. Isothermal pyrolysis was carried out for 2 seconds, which initiated GCMS acquisition after a delay of 0.01 minutes.

Pyrolysis with simultaneous derivatisation

0.5 µl of 25% TMAH (Tetramethylamonnium hydroxide) (Aldrich) in methanol was placed on the paint sample on the platinum ribbon prior to pyrolysis. The method was based on that used by Cappitelli (2004).

Examining results

Acquisition was carried out in a Total Ion Count mode, where all ions in the range 38-550 m/z were monitored. The data were examined and processed using Thermo Scientific Xcalibur software version1.4 SR1. Components were identified by searching through the NIST Mass Spectral Library. For the analysis of reference pigments, some components did not give a strong positive match, as the relevant compound was not present in the reference library. In many cases these compounds could be identified by interpretation of the mass spectrum and comparison with the known pigment structure. The mass spectra of all compounds identified from PyGCMS of reference pigments were compiled into a new library using AMDIS software (Automated Mass Spectral Deconvolution and Identification System). Subsequent analyses of paint samples were compared for matches with the assembled AMDIS library, as well as with the NIST Library.

3.2.2.3 GCMS of drying oil-based media

GCMS was carried out by first preparing the methyl esters of the fatty acids using (m-trifluoromethylphenyl)trimethylammonium hydroxide (TFTMAH) (Pitthard *et al.*, 2005).

Derivatisation

A small fragment of the sample was placed in a 1 ml Reactivial (Thermo Scientific) with 1-3 drops (15-40 µl) of Meth-Prep II reagent (0.2N methanolic solution of TFTMAH, Alltech Associates, Carnforth, Lancashire, UK), depending on sample size. The vial was heated in a heating block to 60°C for 5 hours.

Gas Chromatography Mass Spectrometry was performed using a Thermo Finnigan Focus GC Gas Chromatograph with 15 m Thermo Scientific TR-5MS SQC column coupled to a DSQII Mass Spectrometer. The inlet temperature to the GC was kept at 250°C. The helium carrier gas flow rate was 1.0 ml/min. The MS transfer line was held at 270 °C and the ion source at 250°C. Injection was splitless with an injection volume of 1 µl.

Temperature program for 15 m column (8 minute solvent delay)

Initial	54°C	1 min
Ramp	6°C/min	32.7 mins
Final	250°C	10 mins
	Total run time	43.7 mins

Temperature program for 30 m column (14 minute solvent delay)

Initial	54°C	1 min
Ramp	6°C/min	36 mins
Final	270°C	10 mins
	Total run time	47 mins

Acquisition was carried out in a Total Ion Count mode, where all ions in the range 50-650 m/z were monitored.

3.2.2.4 Polarised light microscopy

The sample was placed on a glass microscope slide and a drop of dichloromethane was introduced to facilitate breakdown of the medium and allow the particles to be dispersed. A cover slip was placed on top and gently pressed down to crush the sample and distribute the particles. Drops of Meltmount with refractive index of 1.66 (McCrone UK Ltd., Southampton, UK) were introduced along one side of the cover slip and the slide was placed on the hotplate to allow the Meltmount to be drawn under the cover slip by capillary action.

The prepared slides were examined using a James Swift polarised light microscope at 40x, 100x and 400x magnification, under plane polarised light and crossed polars to identify pigments (McCrone, 1981; Eastaugh, 2004).

3.2.2.5 Cross sections

The sample was examined under the microscope and then placed in a mould that had previously been half-filled with SamplKwik acrylic resin (Buehler GmbH, Düsseldorf, Germany). More of the resin was mixed and carefully poured on top of the sample. Some samples were prepared in a similar way using EasySections blocks and acrylic resin (VWFecit, London, UK). Once hardened, the block was ground down on a grinding wheel using successively finer-grade silicon carbide papers under running water to reveal the layers of the sample.

The cross sections were examined at 50x and 200x magnification using an Olympus BX51M microscope in both normal reflected light and ultraviolet. The sections were photographed using an Olympus DP70 digital camera attachment.

3.2.2.6 SEM-EDX

SEM-EDX was carried out using a Quanta 200 SEM (FEI, Hillsboro, USA) with INCA X-sight EDS system (Oxford Instruments, Abingdon, UK) in backscattered electron mode where available, otherwise using secondary electron imaging. Samples were not coated. Analysis was carried out both on the surface of cross-sections and on paint/pigment scrapings, which were introduced on an adhesive carbon disc adhered to a specimen stub (Agar Scientific, Stansted, UK). Different coloured areas and individual particles in the cross-sections were targeted for analysis by reference to a colour image of the cross-section taken in normal light. Results were processed using INCA software (Oxford Instruments, Abingdon, UK).

3.2.2.7 Photographic technical examination

Full photographic technical examination was carried out on only two paintings, due to the difficulty and expense of bringing paintings into the photographic studio in Burt Hall, Northumbria University.

The paintings were photographed in normal, raking light and ultraviolet light using a Canon EOS 30D digital camera. Infrared photography was carried out using a Fuji S3 UV-IR digital camera with B+W 093 filter.

X-radiography

X-radiography of two paintings was carried out using a Newton Victor x-ray unit, Several other works were x-rayed externally by Mobile X-radiography Services Ltd. (Teddington, UK).

Chapter 4 Analysis of Reference Pigments

In this chapter the results of the analysis of the collected synthetic organic pigments using FTIR and Py-GCMS are described.

4.1 FTIR results

The collection of synthetic organic reference pigments was analysed using infrared spectroscopy. The majority of the pigments gave a large number of sharp peaks in the fingerprint region, showing this to be an effective method for distinguishing them. The majority of the peaks are from complex group vibrations from the highly conjugated aromatic structures, making it difficult to assign bands to particular groups. Therefore the availability of reference spectra to compare with unknown samples is important if this technique is to be used successfully.

Because of the very large number of synthetic organic pigments that are available it can be difficult to identify an unknown pigment without some kind of searching tool. The matching of spectra is also made difficult because usually only the strongest peaks from the pigment will appear in the spectrum of a composite paint sample, and certain areas may be masked completely due to strong absorptions from other components in the paint such as extenders. We can see that there are some similarities in spectra among members of the same class of pigment, so a first step in identifying an unknown pigment might be to classify it as being of a particular type, even if the precise pigment structure cannot be identified. A further analytical technique such as Py-GCMS may be needed to provide more detailed structural information.

By comparing the spectra some general features can be identified. The strongest FTIR peaks for the different groups of pigments have been tabulated in order to compare results and look for common features. In the following tables, only the strongest peaks are listed, peaks of medium intensity are included only where these appear to correspond to stronger peaks in related pigments.

4.1.1 Red and orange pigments

Beta-naphthol pigments

The beta-naphthol pigments have a low to medium intensity band around 1620 cm^{-1} which is thought to be from the carbonyl resonance structure. There are also strong peaks at around 1190 and 750 cm^{-1}, and at 1330 & 835 cm^{-1} for PR1, PR4 & PO5, see table 4.1. All commercially available beta-naphthol pigments contain at least one nitro group (Herbst & Hunger, 2004), believed to give one or more sharp peaks at around 1500 cm^{-1}.

Table 4.1 Principal peaks in FTIR spectra of beta-naphthol pigments[21]

Region of spectrum/ cm^{-1}	***PR1***	***PR3***	***PR4***	***PR6***	***PO5***
1600-1700	1624m	1619m	1623m	1621m 1605m	1625m 1610s
1500-1600	1592s 1575s	1562s	1572s 1505vs	1562s	1592s 1582s
1400-1500	1496vs 1454s	1498s 1470s 1447s	1453m 1401m	1487s 1476vs 1448s	1493s 1478vs 1448s
1300-1400	1327vs	1321m 1302s	1333vs	1341s	1398s 1340vs 1307s
1200-1300	1258s 1225s	1255s	1261s 1230s	1289s	1258s
1100-1200	1199vs 1153s 1105vs	1189vs 1128s	1195vs 1158s 1127s	1186s 1136s 1106s	1179s 1127vs
1000-1100		1096s	1094s 1039s	1068m	1092s 1062s
900-1000	986s	986s	986s	986m	986m
800-900	859s 835vs	848s 812s	892s 835vs	894s 866s 833vs	842s 834s
700-800	746s	752vs 744s 722s	758s 742vs 709s	752vs 711s	760s 740vs 706s
650-700	685s		688s	686s	690s
Substituents	NO_2	NO_2, Me	NO_2, Cl	NO_2, Cl	2 NO_2

Beta-naphthol salts

The beta naphthol salts share many of the same absorptions as the beta naphthol pigments, with a medium peak at around 1620 cm^{-1}, strong peaks at around 1480, 1175-1200 and 750 cm^{-1}, see table 4.2. A pair of strong peaks at 1000-1040 cm^{-1} appear in most of the beta naphthol salts, not seen in the beta naphthols. Both groups are easily distinguished from the Naphthol AS pigments by the lack of a strong peak at around 1670 cm^{-1}.

[21] In this and following tables, peaks are given to the nearest whole wavenumber, with an indication of intensity: vs = very strong, s = strong, m= medium

Table 4.2 Principal peaks in FTIR spectra of Beta-naphthol salts

Region/ cm^{-1}	***PR48:2***	***PR49:1***	***PR52:1***	***PR52:2***	***PR53:1***	***PR57:1***	***PR58:4***	***PR60***	***PR60:1***	***PR63:1***	***PR63:2***
1600-1700	1618m	1616m	1622m	1618m	1620m	1620m	1621m	1617m	1616m	1625m	1616m
		1602m		1604m			1607m			1602m	1601m
1500-1600								1587m	1587m		
	1545s	1552m	1545s	1549m	1552m	1548s	1554s	1570m	1570m	1548s	1548s
1400-1500	1478s	1470s	1480s	1476s	1493s	1482s	1494s	1488s		1473s	1472s
	1449s	1448s	1448s	1446s	1478s	1450s	1479s		1487m	1448s	1448s
	1407s	1403s	1404s	1403s	1450s	1404s	1444s	1435vs	1435vs	1417s	1410s
1300-1400				1375s	1374s	1365s	1398s	1386s	1386s		1375m
	1323m		1322m	1324m		1326m	1357s	1336s	1335s		1325m
1200-1300						1291s				1278m	1284s
	1262vs	1256s	1261s	1262s	1255s	1248vs	1247s			1260s	1263s
	1238s	1232s	1236s		1229s		1232s	1236s	1236s	1241s	1240m
	1212vs	1203vs	1202vs	1213s	1212vs	1208vs				1205vs	1206vs
1100-1200	1181s	1171s	1175s	1178s	1185vs	1185s	1189vs	1192vs	1180vs	1177s	1180s
	1148s	1139s		1140s	1138s	1154s	1156vs				1142s
	1103s			1102s	1104s			1108s	1107s		
1000-1100		1096s	1098s			1088s	1068vs	1069s	1068s		1049s
	1036vs	1052s	1037vs	1039s	1034vs	1030s	1042s	1034s	1034s	1038s	1040s
	1014s		1011s	1014vs		1020vs	1016s	1000s	1000s	1019vs	1020s
800-900	872s	844s	825s	824s	868s					816s	815vs
		812s			846s	820s	824s				
700-800	765s	775m		763s		764s	762s		758s		
	753s	749s	753s	749s	752s	748vs	752s	748s	749s	753vs	754vs
	707s		711s	712s	716s		710s	713s	713s		712m
650-700		678s				698s		683s	684s	691s	692s
			666s	656s	660s		662s	666s	666s	668s	668s
Substituents	Cl, CO_2^-, Me, SO_3^-	SO_3^-	SO_3^-, Me, Cl, COO-	Me,COO^- Cl, SO_3^-	Me, Cl, SO_3^-	Me, SO_3^- COO^-	Cl, COO-, SO_3^-	COO-, $2SO_3^-$	COO-, $2SO_3^-$	COO-, SO_3^-	COO-, SO_3^-

Table 4.3 Principal peaks in FTIR spectra of Naphthol AS pigments (1)

Region/ cm^{-1}	***PR2***	***PR5***	***PR8***	***PR9***	***PR12***	***PR14***	***PR17***	***PR21***	***PR22***	***PR23***	***PR31***	***PR32***
1600-1700	1670s	1666s	1668s	1669s	1676m	1675s	1671s	1672s	1670s	1678s	1676s 1643s	1671s 1644s
1500-1600	1593s 1541s	1594s 1539s 1500s	1593s 1519vs	1598s 1538vs	1590s 1547s	1590s 1547s	1591s 1549s 1518vs	1594s 1532s	1595s 1540s 1518vs	1598s 1552s 1516vs	1597s 1526s 1504s	1596s 1552s 1530s
1400-1500	1491s 1479vs 1445s	1480s 1451s	1492vs 1446s	1493vs 1480vs 1448s	1486s 1447s	1461s 1437vs	1484s 1447s	1494s 1480s 1446vs	1483vs 1444s	1480s 1449s 1436s	1476vs 1445s	1476s 1444s
1300-1400	1383s 1362s 1323s	1394s 1339s	1346s 1328s		1325s	1324s	1346s 1325s	1333s	1347s 1324s	1344s	1325s	1387m 1326s
1200-1300	1257s 1236s 1202s	1262s	1266s 1247s 1201s	1262s 1240s 1206s	1282s 1252s 1202s	1278s 1203s	1268s 1251s 1204s	1286s 1269s	1284s 1267s 1247s 1204s	1279s 1259s 1237s 1204s	1245s 1222s 1202s	1244s 1222s 1201s
1100-1200	1155s	1198s 1156vs	1156vs 1128s	1159s	1158s 1149s	1156s 1135s 1111s	1154s 1129s	1193s 1144s	1156s 1129s	1171s 1156vs 1138s	1159s 1127s	1159s 1129s
1000-1100	1084s 1010s	1014s	1011s	1086s 1035s 1015s	1079s 1010vs	1006s	1013s	1040s 1014s	1036s 1010vs	1072s 1012s	1089s 1014s	1089s 1012s
900-1000					923s	966m						
800-900	891s 814s	806s	816s	805s	837s	890s 825s	894s 806s	872s 852s 816s	887m 815s	886s 824s 800s	824s	823s
700-800	787s 750s	775s 704vs	798s 760s 739s	758s 744s 727vs	741vs	746vs 731s 700s	741vs	753s	798s 751s 739s	762s 745s 736vs	799s 746s 755s	751vs
650-700	691s		699s		699s		698s	692s	691s 667s	680s 668s	688s	688s
Substituents	2Cl	$3OCH_3$, Cl, $SO_2N(C_2H_5)_2$	NO_2, Me, Cl	2Cl, OMe	NO_2, 2Me	NO_2, Me, Cl	NO_2, 2Me	Cl	NO_2, Me	$2NO_2$, MeO	OMe, NO_2, $CONHC_6H_5$,	OMe, $CONHC_6H_5$

Table 4.4 Principal peaks in FTIR spectra of Naphthol AS pigments (2)

Region/ cm^{-1}	***PR112***	***PR146***	***PR147***	***PR150***	***PR170***	***PR187***	***PR188***	***PR210***	***PO38***
1700-1800							1708m		
1600-1700	1673s	1666s 1642s	1673s 1642s 1609s	1661s 1644s	1678m 1658s	1683m 1652s 1603s	1674s 1656s	1682m 1655s	1659vs 1606m
1500-1600	1592s 1552s 1539s	1596s 1551s 1531s	1586s 1527s 1505s	1597s 1556s 1532s 1506s	1599s 1551s 1539s	1588s 1532s 1519s 1503s	1578s 1553s 1520s	1597s 1538s	1569s 1548s 1515vs
1400-1500	1480s 1456s	1494s 1475vs 1447s 1401s	1477vs 1442s 1409s	1479vs 1447vs	1495s 1486s 1453s	1483s 1451s 1404s	1491s 1469s 1449vs 1407s	1492s 1482s 1449s	1497vs 1484vs 1450s 1404s
1300-1400	1391s 1324s	1325s	1326s	1396s 1325s	1386s 1363m	1374s 1328s	1389m 1325m	1385s 1362s	1363s 1326s 1312s
1200-1300	1282s 1252s 1204s	1246s 1214s	1242s 1224s 1200s	1263s 1244s 1219s	1260s 1205m	1225s 1207vs	1260s 1240s 1204m	1285s 1263s 1227s	1243s 1206s
1100-1200	1158s 1120s	1173s 1149s	1160s 1127s	1171s 1130s	1149s	1196s 1157s	1154s 1107s	1191s 1149s 1117s	1188s 1159vs 1110s
1000-1100	1062s 1014s	1044s 1014s	1089s 1013vs	1091s 1004s	1015s	1037s 1016s	1072s 1011s	1013s	1042s 1009vs
900-1000				943s					
800-900		821s	824s	821s	802s	850s 832s	825s 800s	800s	891s 836s 816vs
700-800	760s 745vs 702s	754s 746s	792s 745vs	754s	738vs	772s 758vs	752s 740vs	738vs 702s	751vs
650-700		690s	688s	689s					696s
Substituents	3Cl, Me	3OMe, Cl, CONH-C_6H_5	OMe, Me, Cl, CONH-C_6H_5	CONH-C_6H_5	OEt, $CONH_2$	3OMe, Cl CONH-C_6H_4-$CONH_2$	OMe, COOMe, $CONHC_6H_4Cl_2$	$CONH_2$, OEt/ OMe	$CONH_2$, Cl, NHCOMe

Naphthol AS

The Napthol AS pigments have strong peaks at 1660-1675 and 1540-50 cm^{-1} from the amide I and II stretches (Lomax *et al.*, 2007). A strong pair of peaks at 1470-90 and 1440-50 cm^{-1} are found, but are also seen in other azo pigments. Other strong peaks are at around 1600, 1150 and 750 cm^{-1}, see tables 4.3 and 4.4. The peak at around 1324 cm^{-1} is reported to be from the aromatic hydroxyl of the naphthol (Lomax *et al.*, 2007).

Disazo condensation

The same main peaks are seen as in the naphthol AS pigments, making it difficult to distinguish these groups, see table 4.5.

Table 4.5 Principal peaks in FTIR spectra of Disazo condensation pigments

Region of spectrum/ cm^{-1}	***PR144***	***PR166***	***PR214***	***PR221***	***PBr23***	***PBr41***
1700-1800				1712s		
1600-1700	1665s 1607m	1664s 1606m	1665s 1608m	1670s 1611m	1683s 1603s	1688s 1607s
1500-1600	1544s	1549s	1567m 1542s	1552s 1540s	1549s	1577s 1549s
1400-1500	1478vs 1446s 1401s	1493s 1478vs 1447s 1408s	1490s 1479vs 1447s	1489s 1444s	1470s 1447s	1482s 1450s 1431s
1300-1400	1384s 1323s	1385m 1323s	1381s 1324s	1381s	1399s 1367s 1314s	1383s 1366s 1326s
1200-1300	1258s 1235s	1257s 1238s	1258s 1236s	1259s 1228s	1281s	1271s 1202s
1100-1200	1199s 1153s	1184s 1154s	1191s 1156s	1197s 1154s	1198s 1156s 1133s	1154s
1000-1100	1083s 1040s 1013s	1085s 1044m 1011s	1078s 1015s	1074s 1018s	1003s	1041s 1017s
800-900	810s	814s	826s		885s 813vs	807s
700-800	779s 745s	776s 750s	746s 702s	760s 744s	755s 734s	765s 746vs
650-700	693s	697s		699s	695s	680s
Substituents	5Cl	4Cl	6Cl	2Me, 2Cl, 2($CO_2C_3H_7$)	3Cl, $2NO_2$	4Cl

Naphthol AS Benzimidazolones

Benzimidazolone pigments have a strong peak at 1700-1715 cm^{-1} from the carbonyl of the benzimidazolone. A second carbonyl peak might be expected in PR175 and PR208 which have an additional ester group. This was not observed in PR175, but a slight shoulder was seen below 1710 cm^{-1} in PR208. Like the naphthol AS pigments, members of this group have strong peaks at around 1480, 1450, 1180 and 1015 cm^{-1}, see table 4.6.

Disazopyrazolone

The disazopyrazolone pigments have a strong peak at 1650-65 cm^{-1}. PR38 has an additional intense peak at 1733 cm^{-1} from the ester carbonyl attached to the pyrazolone ring. Other strong peaks are at 1535-50, 1490-1510, 1325-44, 1235-65 & 1135-57 cm^{-1}, see table 4.7.

Table 4.6 Principal peaks in FTIR spectra of Naphthol AS Benzimidazolone pigments

Region of spectrum/ cm^{-1}	***PR175***	***PR176***	***PR185***	***PR208***	***PBr25***	***PV32***
1700-1800	1711s	1709s	1699vs	1710s	1716s	1699vs
1600-1700	1657s	1644s	1657s	1660m 1624m	1658s 1626s	1656s
1500-1600	1582m 1552s	 1552m 1503s	 1555s 1505s	1589s 1552s 1506s	1583s 1552s	1582m 1554s
1400-1500	1477s 1443vs	1480vs 1448s	1480s 1451s	1493s 1467s 1443vs	1482vs 1448s 1418s	1498s 1480vs 1450s 1408s
1300-1400	1389m 1325m	 1326s	 1320s	 1328m	 1325s	 1325s
1200-1300	1292s 1276s	1293m 1224s	1250s 1225s	1251s 1224s	1254s 1230s	1248s 1216s
1100-1200	1179s 1144s	1180s	1185s 1122vs 1100s	1181s 1156s	1180s 1155s	1150s 1122vs
1000-1100	 1011s	 1014vs	 1014s	 1016s	1085s 1011s	1038s 1014vs
800-900				815m	816s	820s
700-800	749vs 710s 687s	752s 708s 691s	 702s	748s 692m	792s 752s 699s	 702s
Substituents	CO_2Me	$CONHC_6H_5$	OMe, Me, SO_2NHMe	CO_2Bu	2Cl	SO_2NHMe, 2OMe

Table 4.7 Principal peaks in FTIR spectra of Disazopyrazolone pigments

Region of spectrum / cm^{-1}	***PR38***	***PR41***	***PO13***	***PO34***
1700-1800	1733s			
1600-1700	1662s	1654s	1652s	1658s
1500-1600	1540s	1534vs	1548vs 1516s	1567s 1547vs 1509vs
1400-1500	1493vs 1450s	1499s 1475s 1458s	1496vs 1456s	1456s
1300-1400	1326s	1343s	1335s	1338s
1200-1300	1254vs	1263vs 1248vs	1235vs	1247vs
1100-1200	1135s 1114s	1157vs 1131s	1146vs 1133vs	1151vs
1000-1100	1035s 1010s	1024s 1001s	1048s	1050s 1001s
900-1000	912s	914s	999s 909s	912s
800-900	812s			811s
700-800	756s	780s 750s	753vs	774vs 701s
650-700	689s 666s	689s 677s	687s 670vs	667s
Substituents	2 Cl, $2CO_2Et$	2 OMe	2 Cl, 2Me	2 Cl, 4Me

Quinacridones

The quinacridone pigments have several medium intensity peaks in the region 3000 to 3300 cm^{-1}, and strong peaks at approx 1575 and/or 1600, 1450-70 and 1330-40 cm^{-1}, see table 4.8. Quinacridone quinone pigments PR206, PO48 and PO49 have some additional peaks, a strong peak at around 1680 cm^{-1}, from the quinone carbonyl, and peaks at around 1520 and 1444 cm^{-1}.

Perylene

The perylene pigments have a strong peak at around 1655 cm^{-1} and 1590 cm^{-1}. Most also have a peak near 1700, 1577, 1358 and 795 cm^{-1}, see table 4.9. They can be distinguished from other red pigments by the lack of peaks at 1450 and 1470-90 cm^{-1}. The structure of PR224 is different to that of the other perylene pigments, as it contains oxygen instead of nitrogen in the polycyclic structure. This leads to several differences in the FTIR spectrum, for example the lack of strong peaks in the 1600-1700 and 1300-1400 cm^{-1} regions.

Table 4.8 Principal peaks in FTIR spectra of Quinacridone pigments

Region of spectrum/ cm^{-1}	***PR122***	***PR202***	***PR206^{q}***	***PR209***	***PO48^{q}***	***PO49^{q}***	***PV19***
3000-3400	3364m 3229m 3167m	3258s 3233m 3159m	3152m 3104m 3061m	3270m 3154m 3099m	3160m 3104m 3065m	3104m 3053m	3264m 3229m 3164m
1600-1700	1636m 1605s	1625m	1682s 1622s 1606s		1679s 1622s 1606s	1678s 1622s 1603vs	1625m 1601s
1500-1600	1576vs 1555s	1599s 1575vs 1546vs	1576s 1553s 1523s	1596vs 1552s	1577s 1520vs	1519vs	1577vs 1556s
1400-1500	1474s	1465vs	1465vs 1444s	1455s	1469vs 1443s	1469vs 1442s	1498s 1468s
1300-1400	1339vs	1334vs	1339vs 1312s	1338vs	1360s 1338vs	1359s 1336vs	1334vs 1311s
1200-1300	1298m 1261m 1202s	1289s 1254s		1282m			1260s
1100-1200	1145m 1120m	1143s 1131s	1139s				1134s
1000-1100		1070m		1076s	1070s	1069s	
900-1000			962s	928s			961s
800-900	872m 808s	894s 804vs	896s	800s			893s
700-800	792s	748s 705s	748vs 708s	773s 703s	756vs	761vs	740s 708s
650-700		682s	691s		693s	691s	692s
Substituents	2Me	2Cl	Mixture: 2Cl / C=O	2Cl	Mixture: C=O / none	Mixture: C=O / none	None

q. Quinacridone quinone pigment

Table 4.9 Principal peaks in FTIR spectra of Perylene pigments

Region of spectrum/ cm^{-1}	***PR123***	***PR149***	***PR178***	***PR179***	***PR190***	***PR224***	***PV29***
1700-1800			1702s			1768s 1749s 1730s	
1600-1700	1699s 1657vs	1699vs 1654vs	1658vs	1689s 1652vs	1695s 1659vs		1671vs
1500-1600	1593s 1577s 1512s	1593vs 1578s	1592s 1577s 1500s	1592vs 1576s	1592vs 1576s 1512vs	1591vs 1507s	1587vs 1574vs 1509s
1400-1500		1405s	1404s	1436s	1405s	1406s	1434s
1300-1400	1358vs	1359s	1356vs 1343s	1399s 1357s 1348s 1325s	1356s 1347s 1303s		1399s 1361s 1346s 1324s
1200-1300	1251vs	1250vs	1253s	1281s	1250vs	1297vs 1234s	1274vs
1100-1200	1193s 1178vs	1198s 1181s	1192s 1176s	1182s	1192v 1175vs	1144s 1119s	1184s 1117s
1000-1100	1045s			1051s 1021s	1030s	1014vs	1072s
900-1000	922s	968s	970s		957s	938s	950s
800-900	852s 809s	869s 853s 811s	852s 809s	849s 808s	827s 808s	858s 807s	879s 850s 809vs
700-800	796vs 744vs	798vs 746vs 722s	799vs 764s 744vs	792s 741vs	794vs 743vs	793s 758s 730vs	794s 738vs 724s
650-700		682s	683vs 668s	655			658vs

Diketopyrrolopyrroles

Diketopyrrolopyrrole pigments have a pair of very strong characteristic peaks at around 1635 and 1600 cm^{-1}. Strong peaks are also found at around 1450, 1330, 1145 and 815 cm^{-1}, see table 4.10.

Perinone

The two perinone pigments are isomers, and have very similar FTIR spectra, see table 4.11. Peaks at around 1695, 1350 and 757 cm^{-1} are the most intense in both spectra. The relative intensity of some peaks varies between the two, with the main difference in the strongest peaks in the 850-950 cm^{-1} region, with a strong peak at 860 cm^{-1} in PR194, and at 901 cm^{-1} in PO43. However the difference in colour between these two pigments should make it fairly easy to distinguish them, as PO43 is a bright red-orange and PR194 a dark red.

Table 4.10 Principal peaks in FTIR spectra of Diketopyrrolopyrrole pigments

Region/ cm^{-1}	***PR254***	***PR255***	***PR264***	***PO73(RA)***	***PO73(RTR)***
2900-3500	3132m	3049m 2978m	3031m 2964m	2957m	2977m
1600-1700	1635s	1636vs 1608vs	1640vs 1603vs	1639vs 1605vs	1639vs 1606vs
1500-1600	1598vs	1568s 1500s		1554s 1517s	1567s
1400-1500	1495s 1444s 1400s	1454s 1418s	1486s 1437s 1405s	1442s 1407s	1496s 1454s 1428s
1300-1400	1325s	1330m	1321s	1364s 1334s	1328s
1200-1300		1202s	1203s	1269s	1203s
1100-1200	1192s 1141s	1144s	1143s	1199s 1145s 1110s	1146s
1000-1100	1090s 1034m 1013s	1098m 1044m	1046m 1005m	1038s	1093s 1013s
900-1000		916m			
800-900	842s 822s	812s	844s 821s	844s 814s	813vs
700-800	750vs 711s	765s 736vs	767s 733vs	760s 714s	731s 715s
650-700	621s	673s 661vs	694s 633s	632s	677s 661s
Substituents	2Cl	2H	2C_6H_5	2 ^{t}Bu	2 ^{t}Bu

Table 4.11 Principal peaks in FTIR spectra of Perinone pigments

Region/ cm^{-1}	***PR194***	***PO43***
1600-1700	1696vs	1694vs
1500-1600	1542m	1552s
1400-1500	1447m	1447s
1300-1400	1383s 1353s 1304m	1381s 1350vs 1338s 1312s
1200-1300	1289m 1226m	1286s 1232vs
1100-1200	1178m 1134m 1102m	1132s 1102m
1000-1100	1010m	1010s
900-1000	992m 902m	990s 901s
800-900	878s 860s	874s
700-800	757vs	757vs 747s 734s

Miscellaneous red/orange pigments

Several additional red pigments were analysed which were not structurally similar to any others, see table 4.12.

Table 4.12 Principal peaks in FTIR spectra of miscellaneous red & orange pigments

Region of spectrum/ cm^{-1}	***PR81:2***	***PR83***	***PR88***	***PR168***	***PR177***	***PO51***	***PO59***	***PO67***
3000-3400				3076	3399s			
1700-1800	1717m							
1600-1700	1649m 1604vs	1636m	1654vs	1651vs	1634s	1648vs	1671m	1694s 1601s
1500-1600	1529s	1590m 1527m	1563s	1594s 1567vs 1550s	1592vs 1534vs	1597vs 1572s	1597s 1523s	1552s 1531s
1400-1500	1497vs 1435s	1466s 1456s	1448s	1496s 1415vs		1498s 1471s	1462s 1431s	1489vs 1464vs 1410s
1300-1400	1365m	1361m 1348m	1355m	1378vs 1311vs	1367s	1373s 1316s	1374s	1339s 1320vs
1200-1300	1299vs 1243s	1287s 1267vs	1295m 1230vs	1278s	1284s 1249vs	1294s 1271vs	1294s 1252s	1293s 1270s 1211s
1100-1200	1185s 1130s	1187m	1178s 1132s	1197s 1171s	1182s 1170s	1148s	1125s 1115vs	1185vs 1167s 1150s 1116s
1000-1100	1083s 1020s	1039vs 1021vs	1065vs	1081s 1067s	1008m	1027s	1044s 1028s	1064s 1029s
900-1000	987m 941s	904m	913s	942s 904s		951s	920s	
800-900	893vs	838s	872s 822vs	883s 826s	881s 842s 801s	888s 808s		892 858
700-800	784vs 736s	770s 718s 670s	778s 656s	772vs 756vs 714s 663s	792s 732vs 703s	771vs 731s 704s 679vs	769s 745vs 723s	775vs 754s 725s 688s 667s

The strongest peaks for the different classes of pigments are tabulated below (table 4.13). From this we can see that many of the azo pigments have strong peaks in the same regions. This table is based only on the pigments analysed here, so may not hold for all members of each group.

Table 4.13 Regions of principal peaks in FTIR spectra of different classes of red/orange pigments

Region of spectrum/ cm^{-1}	**Beta-naphthol**	**Beta-naphthol salt**	**Naphthol AS**	**Disazo condensation**	**Benzimid-azolone**	**Disazo-pyrazolone**	**Quinacridone**	**Perylene**	**Diketo-pyrrolopyrrole**
1700-1800				1712 (PR221)	1699-1716vs	1733 (PR38)		1749 (PR224)	
1600-1700	1619-25 m	1616-22m	1666-83s	1664-88s	1644-60s	1652-62s	1679-82 (q)* 1622-36	1689-1702s	1635-40vs 1598-1608vs
1500-1600	1562-82s	1545-70s	1590-1609s	1540-9s	1552-5s	1534-48s	1596-1606vs 1519-23s (q)	1587-93s	
1400-1500	1487-1505vs 1447-54s	1470-88vs 1435-50s	1461-92vs 1437-50vs	1470-89vs 1444-50s	1477-93vs 1443-51s	1493-1509s 1450-8s	1455-74s 1442-4s		1437-54s
1300-1400	1321-41s				1320-8m	1326-43s	1334-9vs	1356-61s	1321-34s
1200-1300						1235-54vs			
1100-1200	1179-99s	1175-1200vs	1191-1207s 1149-71s	1184-1202s 1153-6s	1179-85s	1135-57s		1175-85vs	1141-6s
1000-1100	1092-1106s	1030-42s	1004-15s	1003-18s	1011-6vs	999-1010s			
900-1000						909-14s			
800-900	835-48s								812-22s
700-800	740-752s	748-54s	740-60 s	744-55vs	692-710s			730-46vs	

* q = only in quinacridone quinone pigments

4.1.2 Yellow pigments

Arylide yellows

All of the arylide pigments analysed had a medium to strong intensity carbonyl peak at around 1670 cm^{-1}, see table 4.14. A peak near 1500 cm^{-1} is usually the most intense in the spectrum, often split into two peaks of around 1505 and 1490 cm^{-1}. Other strong peaks are seen at 1280-95 cm^{-1} and 1160-80 cm^{-1}. Peaks at around 1479 and 1337 cm^{-1} are reported to be due to the aromatic nitro group (Lomax *et al.*, 2007), which is present in all pigments tested except PY97.

Diarylide yellows

The diarylide pigments give similar spectra to the arylide pigments, again with a carbonyl peak at 1660-1675 cm^{-1}, see table 4.15. The most intense band is generally at 1480-1520 cm^{-1}, sometimes split into two or three peaks. Other strong peaks occur at around 1250, 1180 and 950 cm^{-1}. The peak at around 1360 cm^{-1} is seen in diarylide but not arylide pigments, while a peak at around 1140 cm^{-1} is found in arylides only.

Arylide benzimidazolones

Like the red benzimidazolone pigment, a strong peak at 1700-15 cm^{-1} results from the benzimidazolone carbonyl. The two pigments including an ester group, PY120 and PY175, have a second strong carbonyl absorbance in the same region. In other respects the spectra appear similar to those of other arylide pigments, see table 4.16. Peaks are seen at 1640-70, 1560-80 1475-99 and 1000-22 cm^{-1}, and a strong peak near 1200 cm^{-1}.

Table 4.14 Principal peaks in FTIR spectra of Arylide pigments

Region of spectrum/ cm^{-1}	***PY1***	***PY2***	***PY3***	***PY6***	***PY65***	***PY73***	***PY74***	***PY75***	***PY97***	***PY62:1***	***PY168***
1600-1700	1666s	1674s	1670s	1666s	1670s	1674s	1675m	1672s	1668m	1684s	1689s
	1600s			1600s				1609s		1615s	1617s
1500-1600	1560s	1596s	1584m	1559s	1597m	1599m	1593m	1561s	1588m	1592s	1596s
		1553s	1533s		1576m	1528s	1554m			1562s	1533s
	1506vs	1504s	1501vs	1506vs	1543s	1503vs	1516vs	1505vs	1516vs	1520s	1520s
1400-1500	1490vs	1478vs	1478vs	1489vs	1493vs	1485vs	1461m	1474vs	1464s	1483s	1483s
	1450m	1442s	1442s	1450s	1459s	1459vs			1451m	1462s	1446s
1300-1400								1389s	1399s	1344s	1343s
	1342s	1340s	1336vs	1338s	1325s	1339s	1338s	1341s	1306s		1307m
1200-1300	1292vs	1281s	1280vs	1281vs	1295s	1280vs	1288s	1284s		1285m	1286s
	1270vs	1258s	1260s		1274s					1259s	1262s
	1255m			1254s	1247s	1258s	1252s	1244vs			
		1225s			1220s	1221s	1224s		1210s	1224s	1223s
1100-1200	1175vs	1171vs	1176vs	1172vs	1182s	1168vs	1180s	1166vs	1161s	1197vs	1197vs
	1138s	1137s	1138s	1141s	1134s	1137s		1138vs	1140s	1135vs	1134vs
1000-1100							1088s	1050s		1059vs	1059vs
			1036s		1028vs	1027s	1021s		1035s		1036s
900-1000	951m	954m		952s	950m	953m	954m	955m			
800-900								894s			
	804s	829s	812s		817m			820vs			
650-800		781s	793s	795s	791s	796s	780s	790s			788s
	770vs			768vs							
	758s	756s	749vs	757s	760vs	755vs	757s	758s		757s	749vs
				692s			739s		703s	745s	
	692s					692m		694m	654s	671vs	671vs
Substituents	Me, NO_2	Cl, NO_2, 2Me	2Cl, NO_2	Cl, NO_2	NO_2, 2OMe	Cl, NO_2, OMe	NO_2, 2OMe	Cl, NO_2, OEt	4OMe, Cl, SO_2	SO_3^-, NO_2, Me	SO_3^-, NO_2, Cl

Table 4.15 Principal peaks in FTIR spectra of Diarylide pigments

Region of spectrum/ cm^{-1}	***PY12***	***PY13***	***PY14***	***PY16***	***PY17***	***PY55***	***PY81***	***PY83***	***PY87***	***PY126***	***PY127***
1600-1700	1673m 1659s	1670s	1672s 1609s	1667s	1665s	1666s 1604s	1676s	1659s	1661s 1601m	1661s	1660s
1500-1600	1594s 1552s 1506vs	1599s 1551s 1522vs	1588s 1552s 1517vs	1587s 1513vs	1599s 1546s 1505vs	1529vs 1508vs	1596s 1547s 1519vs	1539m	1545m 1505vs	1595s 1553s 1506vs	1595s 1552s 1507vs
1400-1500	1487vs 1446s	1489vs 1446s	1488s 1458s	1480vs	1459vs 1436s	1485vs	1493vs 1469vs	1496vs 1450s	1426s	1488vs 1446s	1488vs 1446s
1300-1400	1358s 1311s	1358s 1311m	1362s 1320m	1357s 1305s	1358s 1305m	1359s 1314s	1361s	1399s 1362s 1323s	1362s 1322s	1358s 1312s	1359s 1312s
1200-1300	1283s 1241vs 1213s	1282s 1248s 1213s	1283s 1246vs 1215s	1278s 1244s 1212s	1285s 1248s 1222s	1282s 1244s 1212s	1286s 1251s 1225s	1292s 1261s 1209vs	1299s 1259s 1213s	1285s 1245vs 1213s	1284s 1243s 1214s
1100-1200	1177vs	1179s	1176vs	1181s	1177vs	1176vs	1180vs	1180s	1178s	1177s	1178s
1000-1100	1051s	1049s	1050s	1098s	1048m 1025s	1050s	1057s	1065m 1032s	1043s 1024s	1052s	1052s
900-1000	949s	951s	954s	950s	951	950s	953s	951s	951s	948s	949s
800-900		828s				815vs	882s 827s				
650-800	750s 685s	775vs 702s	784s 758vs	778s	785s 751s	779vs 750s	774s 742s	792s 740s	790s 707s	751s 686s	750s 686s
Substituents	2Cl	4Me, 2Cl	2Me, 2Cl	2Me, 4Cl	2OMe, 2Cl	2Me, 2Cl	4Cl, 4Me	4Cl, 4OMe	2Cl, 4 OMe	2Cl, OMe	2Cl, 2Me, OMe

Table 4.16 Principal peaks in FTIR spectra of Arylide benzimidazolone pigments

Region of spectrum/ cm^{-1}	***PY120***	***PY151***	***PY154***	***PY175***	***PY180***	***PY194***	***PO36***	***PO62***
3000-3500	3385m	3177s	3408m	3324m		3146m	3376m	3388m
1700-1800	1713vs			1713vs	1715s	1707s		1711s
1600-1700	1694vs 1661s 1620m	1685s 1652s	1694vs 1667s	1696vs 1671s	1636s	1677s 1644s 1623s	1696vs 1657s 1619s	1670s
1500-1600	1565s 1524s	1565s	1581s 1534s	1563s	1568s 1512s	1562s 1509s	1566s	1580s 1530s
1400-1500	1499vs 1435s	1481vs 1453s	1496s 1463s	1498vs 1474s 1436s	1498vs 1483s	1488vs 1425s	1475vs	1493vs
1300-1400	1360s	1362s 1311s	1363s 1310s	1361m 1315s	1378s 1311s	1362s 1318s 1305s	1356s 1337s	1333s 1305s
1200-1300	1298s 1268s 1245vs 1211vs	1248vs 1206s	1263s 1218s	1287s 1242s	1262s 1209s	1251s 1211s	1282s	1288s 1258s 1216vs 1201s
1100-1200	1118s	1147s	1166s 1107vs	1198s 1118m	1155s 1109s	1152s 1110s	1190vs 1139s	1166s 1112s
1000-1100	1005s	1022s	1035s 1000s	1011s	1014s	1018s 1002s	1004s	1005s
900-1000		952s 936s	950s	964m 948m	950s	968s 953s	948s	953s
800-900		833s 816s	816s	811s	827s	839s 812s	863s 807vs	864s 801vs
650-800	795s 752vs 725s 700s	753s 692vs 659s	759s 748vs 731s 702s	758vs 705s	739s 709s	782s 733vs 708vs	751s 734s 704s	780s 738s 707s
Functional groups	$2CO_2Me$	COOH	CF_3	2 CO_2Me	-OEtO-	OMe	Cl, NO_2	NO_2

Isoindolinone

The isoindolinone pigments have a strong carbonyl stretch at around 1730 cm^{-1}, higher than for most other pigments, see table 4.17. However, this may be masked by the carbonyl of the binder, when these pigments are analysed as part of a paint sample. Strong peaks are found at 1650-60, 1360-90, 1299-1308 and 1180-1200 cm^{-1}.

Table 4.17 Principal peaks in FTIR spectra of Isoindolinone pigments

Region of spectrum/ cm^{-1}	***PY109***	***PY110***	***PY139***	***PY173***	***PO61***	***PO69***
3000-3500	3250m	3220m	3044m	3180m	3220m	3107m
1700-1800	1742s 1730vs	1725vs	1730s	1728s	1731vs	1747m
1600-1700	1659s	1652vs	1675s 1650vs	1660s	1660s	1699s 1660s 1640s
1500-1600	1565s		1581m 1506vs		1588s	1597s 1567s
1400-1500			1433s	1485s 1472s		1494vs 1429s
1300-1400	1374s 1333s 1306s	1376s 1346s 1308vs	1389vs 1352s	1360s 1306s	1378s 1308s	1392s
1200-1300	1268s 1242s	1268s	1299s 1256vs 1235vs	1223m	1270s	1284s 1219s
1100-1200	1181s	1181s	1198s 1178s 1136s	1188s	1184s	1194s 1138s
1000-1100	1053s	1085s	1074s	1090s 1052s	1084s	
	938s	936s	958m 905s			922m
800-900		853s	832s	825s	852s	853m 808s
700-800	799s 747s 700s	742s 717s	776s 768s 741vs	770s	734s 721s	770s 748s 704s
650-700	659s	677s 650s	678s	698vs	660s	680s 624s
Functional groups	8Cl, Me	8Cl		2Cl	8Cl, Me	Cl, Me

Miscellaneous yellow pigments

Several yellow pigments do not have particularly similar structures to any other examples analysed, see table 4.18.

Table 4.18 Principal peaks in FTIR spectra of miscellaneous yellow pigments

Region of spectrum/ cm^{-1}	***PY128***	***PY100***	***PY24***	***PY108***	***PY129***	***PY138***	***PY150***
3000-3400							3339m 3231m
1700-1800				1740m		1786s 1726s	1710s
1600-1700	1665s		1660vs	1670s	1601s	1639s 1619vs	
1500-1600	1561s 1508vs	1558m	1592s 1554s	1589s 1512s	1578s 1535s 1506s	1593s 1530s	1582s 1543s
1400-1500	1485vs 1436s 1401s	1479m	1446s	1478m	1476s 1455s	1484s 1411s	1458s 1403s
1300-1400	1334vs		1317s 1304vs	1310s	1399s 1386s 1355s 1338s 1301s	1380s 1368s 1352s 1301vs	1307m
1200-1300	1250s 1218s		1269s	1271s	1286s 1265s	1227s	1269s
1100-1200	1173s 1158s 1124vs	1124m	1157s		1175s 1163s	1138s 1114s	1172s 1054s
1000-1100	1099s	1032s 1006s	1094s		1090s	1048s	
900-1000			946s			964s	
800-900			856s		826vs	852s	
700-800	748s		786s 724s	774s 705vs	732vs	741s 727s	776s
650-700	670s		686vs		651s	679s	

The strongest peaks in different regions of the spectra for the different classes of yellow pigments are tabulated in table 4.19. The most intense peaks for arylide and diarylide pigments are very similar, the main differences being in the 1357-62 and 1134-40 cm^{-1} regions.

Table 4.19 Regions of principal peaks in FTIR spectra of different classes of yellow pigments

Region/ cm^{-1}	***Arylide***	***Diarylide***	***Benzimidazolone***	***Isoindolinone***
1700-1800			1685-1715	1725-47s
1600-1700	1666-89s	1659-73s	1636-70s	1650-60s
1500-1600	1584-1609s	1587-1609s	1530-68s	
1400-1500	1483-1516vs 1442-62s	1470-1520vs 1435-69s	1475-99vs	
1300-1400		1357-62s	1356-78s	1360-92s
1200-1300	1247-62s	1241-61s 1209-25s	1242-63s	1284-1308s
1100-1200	1168-97s 1134-40s	1175-81vs	1190-1218vs	1181-98
1000-1100			1004-15s	
900-1000		948-54s	948-53s	
800-900				
700-800	749-760s	748-54s	733-58s 692-709vs	

4.1.3 Blue and green pigments

Phthalocyanines

All phthalocyanine pigments had strong peaks around 1280 and 1090 cm^{-1}, table 4.20.

Table 4.20 Principal peaks in FTIR spectra of phthalocyanine pigments

Region/ cm^{-1}	***PB15:3***	***PB15:6***	***PG16***	***PG7***	***PG36***
1500-1600	1505s	1506s	1500s	1558m	1538m
1400-1500	1464m 1419s	1464m 1419s	1437s	1497m	1487m
1300-1400	1332s	1331s	1334s 1319s 1302s	1390s 1319s 1304vs	1360s 1316s
1200-1300	1287s	1286s	1276s	1275s 1208s	1277s 1263s
1100-1200	1165s 1118s	1162s 1117s	1187s 1159s 1117s	1150vs	1173s 1125vs
1000-1100	1088vs 1067s	1092vs 1067s	1092s	1093vs	1085s
900-1000	900s	900s	999vs 946s	947s	916s
800-900	877s	880m	871s		
700-800	780s 754s 727vs	774s 754s 725vs	764s 727s 710s	768s 747s	798s 765s 745s 733s
650-700	690s	692s	684s		699s

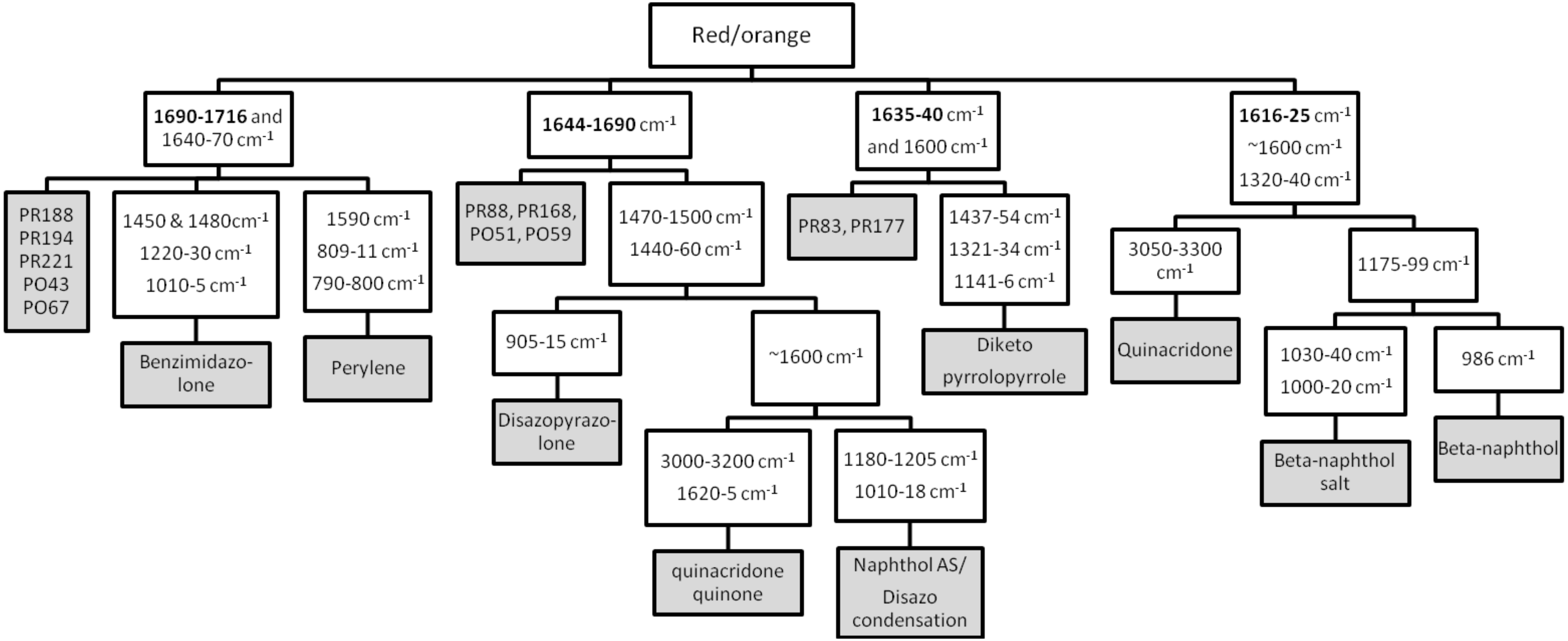
The two different phthalocyanine blue pigments PB15:3 and PB15:6 are different crystal modifications of this pigment, resulting in slightly different shades, however these could not be distinguished using FTIR.

4.1.4 Discussion

Simple flow charts can be constructed from the results of FTIR analysis to enable pigments to be classified as belonging to a particular group. The strongest peaks are used as indicators, however in practice these may not all be visible due to overlapping peaks from other paint components. The main peaks in the region from 1600-1750 cm^{-1} have been used as a first step in distinguishing many of the pigment types. Peaks from the pigment will generally be sharp and well-defined compared to the carbonyl stretches from paint binders, but if these actually overlap identification will be difficult, and other peaks will have to be examined.

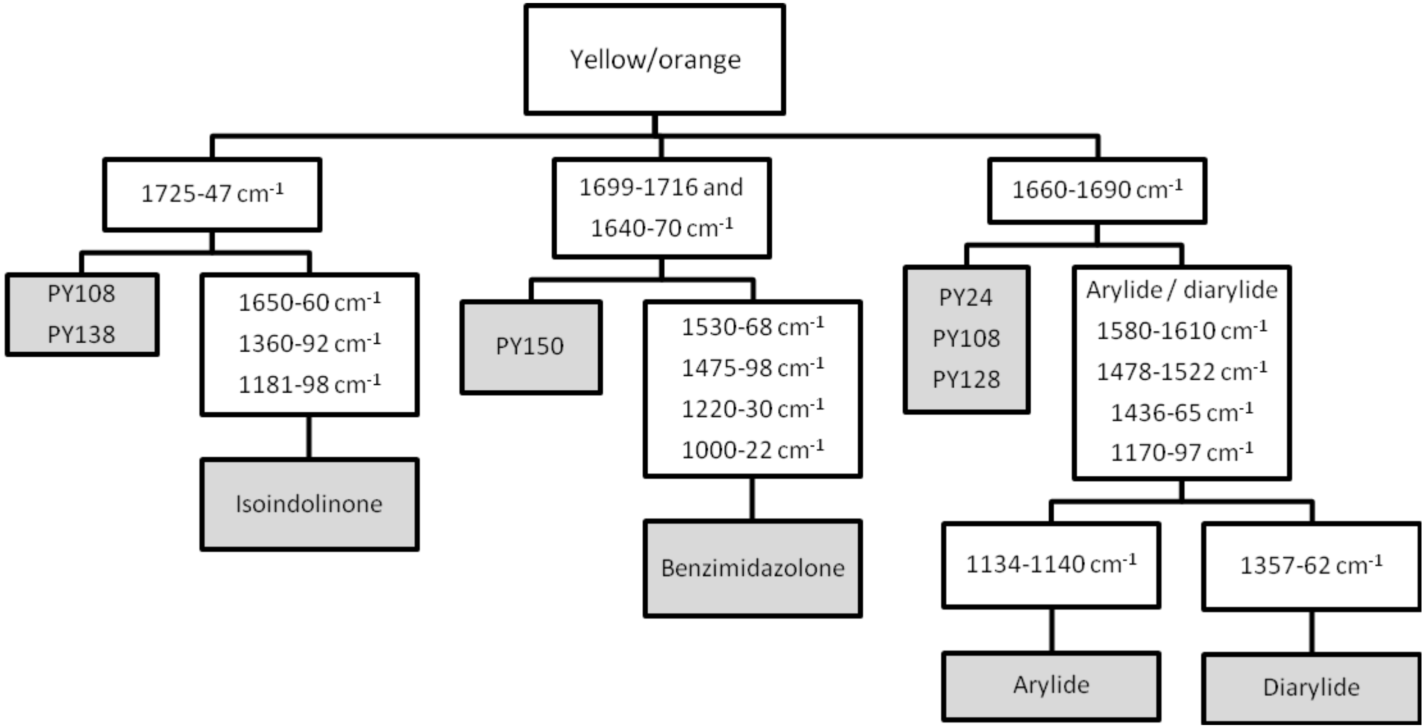
Many of the pigments give strong peaks in similar areas, for example from the aromatic rings and amide groups, however there are small differences which can be used to distinguish most of the different classes. To distinguish between pigments of the same class and identify the exact pigment type may not be possible using this method, especially where only the strongest peaks are visible.

Figure 4.1 Flow Chart showing principal peaks of red/orange pigments



The chart is used by comparing the peaks in the spectrum with those in the boxes, initially looking at the strongest peak in the 1600-1720 cm^{-1} region, then finding which group of peaks in the subsequent boxes most closely match those of the unknown. The spectra themselves can then be compared for a more precise identification.

Figure 4.2 Flow Chart showing principal peaks of yellow /orange pigments



4.2 Pyrolysis-GCMS results

Pyrolysis GCMS can give specific structural information to enable a pigment to be identified, thus it is not always necessary to have results from a reference sample to be able to make an identification.

4.2.1 Azo Pigments

Beta-naphthol

Pyrolysis products from three pigments of this type have been reported previously: PR3, PR4 and PO5 (Sonoda *et al.*, 1999). Results obtained here were similar, with beta-naphthol being produced, as well as the benzene and aniline from the coupling component frequently appearing (see figure 4.3). In some cases the pigment molecule did not readily fragment, and a peak from the intact molecule was the most abundant peak seen in the pyrogram (PR1, PR3 and PR4). In addition, cyclisation appeared to occur in PR6, where a nitro group is adjacent to the azo bond, giving a benzofurazan product. The results are summarised in table 4.21.

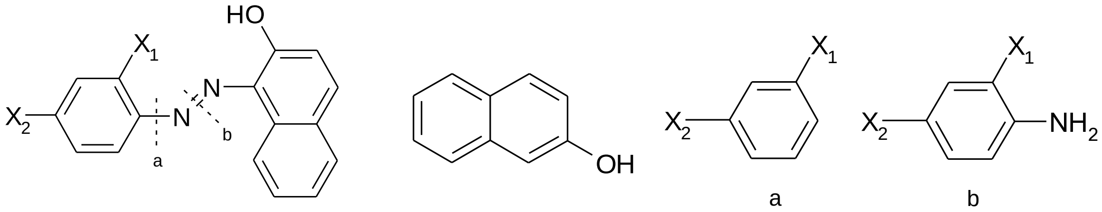


Figure 4.3. Structure of beta-naphthol pigment, left, with fragments produced by pyrolysis, right

*Table 4.21** Products from Py-GCMS of beta-naphthol pigments

C.I. Name		*beta-naphthol*	*Intact molecule*	*Product a*	*Product b*	*Other products*
PR1	X_1= H, X_2=NO_2	+ 144, 115	+++ 143, 293, 115			
PR3	X_1= NO_2, X_2=CH_3	+ 144, 115	+++ 143, 275, 115, 307	+ 65, 137, 91	++ 152, 106, 77	unidentified product 260, 231, 202: ++
PR4	X_1= Cl, X_2=NO_2	+ 144, 115	+++ 143, 327, 115	+ 111, 157, 75	+++ 172, 90, 63	
PR6	X_1= NO_2, X_2=Cl			++ 111, 157, 75	+++ 172, 126, 99	Benzofurazan 154, 124, 156: + unidentified product 279, 254: ++
PO5	X_1= NO_2, X_2=NO_2	++ (144, 115)		++ 168, 76, 122	+++ 183, 153, 91	unidentified product 291, 189, 217: ++

*In this and all following tables, the number of +'s show the relative amount of each product, classified according to the percentage abundance of the peak in relation to the most intense peak in the pyrogram: +++ = 60-100% abundance, ++ = 15-60%, + = less than 15% but at least 3 times the height of the noise, (+) = product not always seen. The following numbers give the m/z values of the most abundant MS ions.

Naphthol AS

Results of pyrolysis have been reported for several pigments: PR7, PR9, PR12, PR112, PR146, PR170, PR188 (Sonoda *et al.*, 1999) and PR5, PR9, PR112, PR170, PR171 (Learner, 2004). Sonoda reported that beta-naphthol was produced, with two products (a substituted benzene and aniline) from the diazo component, and the aniline and occasionally isocyanate from the coupling component. Not all of the products were described by Learner, but it was reported that an aniline fragment from the breaking of the azo bond was seen in most cases.

In this study, the beta-naphthol product was not normally seen, or was detected only as a very minor product. The pigments of this type generally produced up to four products, in varying proportions, as summarised in figure 4.4. Additional products were identified in some cases, with a commonly observed m/z value corresponding to a dimerisation of two fragments. Those pigments with an additional phenyl ring often broke down to give further products from the diazo functionalised component. The results are summarised in table 4.22.

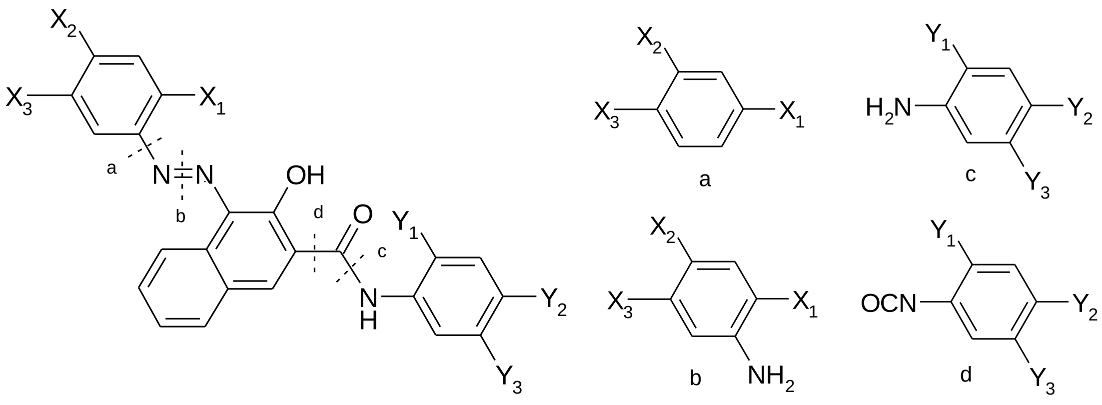


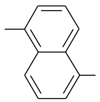
Figure 4.4. Structure of naphthol AS pigment, left, with fragments produced by pyrolysis, right

Table 4.22 Products from Py-GCMS of Naphthol AS pigments

C.I. name	*Substituents*						*Products*				
	X_1	*X_2*	*X_3*	*Y_1*	*Y_2*	*Y_3*	*a*	*b*	*c*	*d*	*Other products*
PR2	Cl	H	Cl	H	H	H	++ 146, 148, 111	+++ 161, 163, 63	+ 93, 66	+ 119, 91	Dimer of a/b : + 235, 270, 305
PR5	OCH_3	H	$SO_2N(C_2H_5)_2$	OCH_3	OCH_3	Cl	+++ 171, 228, 107	+++ 122, 258, 186	+ 172,187,144	+ 213, 198, 170	
PR8	CH_3	H	NO_2	H	Cl	H	++ 65, 137, 91	++ 152, 106, 77	+++ 127, 129, 65	++ 153, 125, 155	
PR9	Cl	H	Cl	OCH_3	H	H	++ 146, 148, 111	+++ 161, 163, 99	+ 108, 123, 80	++ 149, 134, 120	Dimer of a/b : + 235, 270, 305
PR12	CH_3	NO_2	H	CH_3	H	H	++ 91, 137, 65	++ 152, 122, 77	+++ 106, 107, 77	++ 133, 104, 78	
PR14	NO_2	Cl	H	CH_3	H	H	++ 111, 157, 75	++ 172, 126, 174	+++ 106, 107, 77	+++ 133, 104, 78	
PR17	CH_3	H	NO_2	CH_3	H	H	++ 65, 137, 91	+++ 152, 77, 79	++ 106, 107, 77	+++ 133, 104, 78	
PR21	Cl	H	H	H	H	H			+++ 93, 66, 65	++ 119, 91, 64	Product b from PR22? 152, 106, 77 : +
PR22	CH_3	H	NO_2	H	H	H	++ 91, 137, 65	+++ 152, 106, 77	+++ 93, 66, 65	++ 119, 91, 64	
PR23	OCH_3	H	NO_2	H	H	NO_2	+ 153, 122, 92	+++ 168, 153, 122	++ 65, 138, 92	+ 164, 134, 90	
PR31	OCH_3	H	$CONHC_6H_5$	H	H	NO_2	++ 135, 227, 92	+++ 150, 242, 122	++ 65, 138, 92		Aniline: + (93, 66, 65) Isocyanatobenzene: + 119, 91, 64
PR112	Cl	Cl	Cl	CH_3	H	H	++ 182, 180, 145	+++ 195, 197, 124	+ 106, 107, 77	++ 104, 133, 105	d with 2-naphthol: + 277, 107, 171 dimer of a/b: + 340, 305, 368

PR147	OCH_3	H	$CONHC_6H_5$	CH_3	H	Cl	+ 135, 227, 92	++ 150, 242, 122	+++ 141,106,143	++ 167, 138,132	
PR170	H	$CONH_2$	H	OC_2H_5	H	H			+++ 137, 108, 80	++ 135, 163, 79	d with 2-naphthol: ++ 137, 171, 307
PR188	CO_2CH_3	H	$CONHC_6H_{3-}Cl_2$	OCH_3	H	H	++ 163, 288, 135	+++ 178, 303, 338	++ 108, 123, 80	++ 149,106, 134	Dichloroaniline from X ring: ++ 161, 163, 99

Table 4.23. Products from Py-GCMS of Disazo condensation pigments

C.I. Name	*Substituents*						*Products*			
	X_1	X_2	X_3	X_4	Y_1	Y_2	*a*	*b*	*Y ring*	*Other*
PR144	Cl	H	H	Cl	Cl	H	++ 146, 148, 111	+++ 161, 163, 90	(+)	Dimer of a: + 292, 294, 220 Mixed dimer of a & b: + 235, 270, 307
PR166	Cl	H	H	Cl	H	H	++ 146, 148, 111	+++ 161, 163, 90		Dimer of a: + 292, 294, 220 Mixed dimer of a & b: + 235, 270, 307
PR214	Cl	H	H	Cl	Cl	Cl	++ 146, 148, 111	+++ 161, 163, 90	(+)	Dimer of a: + 292, 294, 220 Mixed dimer of a & b: ++ 235, 270, 307
PR221	Cl	H	H	$CO_{2-}C_3H_7$	Cl	Cl	++ 176, 178, 141	+++ 151, 106, 193	++ 176, 178,141	
PBr23	NO_2	H	Cl	H	Cl	H	++ 111, 57, 75	+++ 172, 126, 99	+ 105, 168,142	Chloro-benzofurazan: + 154, 124, 156
PBr41	Cl	Cl	H	H			++ 146, 148, 111	+++ 161, 163, 126	+ 210,154, 127	Mixed dimer of a & b: + 235, 270, 307

Disazo condensation

These pigments have a similar structure to the Naphthol AS pigments, but here two naphthol-azo structures are linked by a central benzene ring. As with Naphthol AS pigments, pyrolysis produces substituted benzenes and anilines from the X-substituted rings (see figure 4.5). In a few cases products were also detected from the central aromatic group – a diamine, diisocyanate or amine-isocyanate substituted Y-ring. The results are summarised in table 4.23.

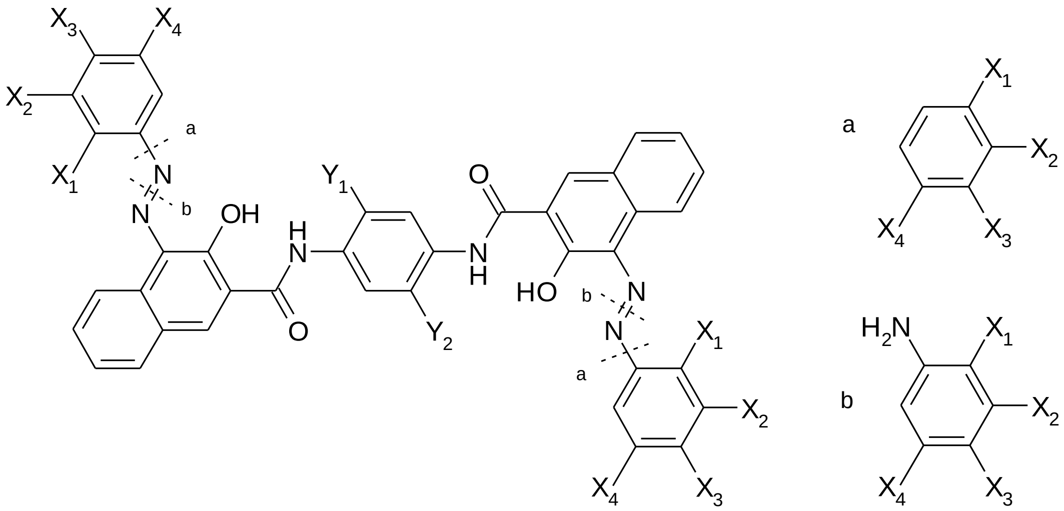


Figure 4.5. Structure of Disazo condensation pigment, left, with fragments produced by pyrolysis, right

PR144, PR166 and PR214 are structurally very similar, differing only in the substituents on the central Y ring, so give identical a and b products. Therefore these cannot be distinguished using Py-GCMS alone, as the products from the Y ring were very minor and not seen in all cases. PBr41 also gives similar a and b products, differing only in the positions of the substituents. Different isomers such as these were not usually unambiguously identified by MS.

Benzimidazolone (naphthol AS)

The benzimidazolone pigments based around the naphthol AS structure fragment in a similar way to the naphthol AS pigments, but only products from the diazo end of the molecule were identified. These consistently gave the two products shown in figure 4.6. The results are summarised in table 4.24.

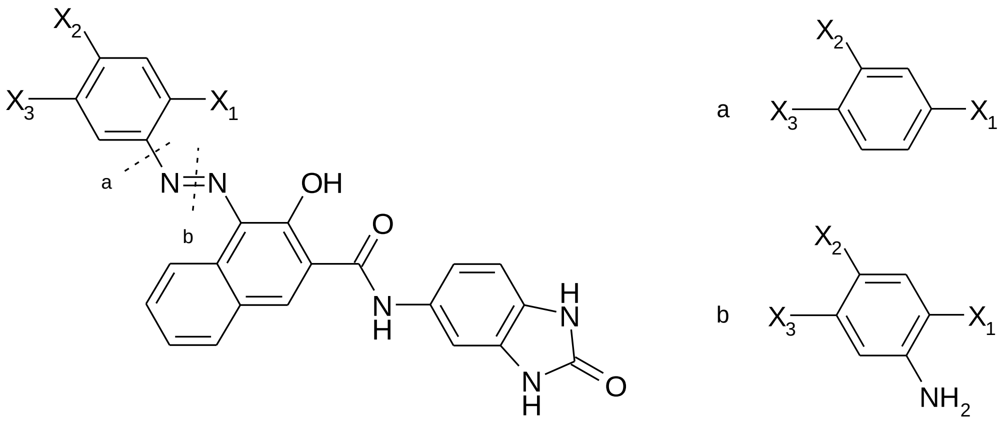


Figure 4.6. Structure of Benzimidazolone pigment, left, with fragments produced by pyrolysis, right

Table 4.24. Products from Py-GCMS of Benzimidazolone (naphthol AS) pigments

C.I. name	*Substituents*			*Products*		
	X_1	*X_2*	*X_3*	*a*	*b*	*Other*
PR175	CO_2CH_3	H	H	++ 105, 77, 136	+++ 119, 151, 92	
PR176	OCH_3	H	CO- NHC_6H_5	++ 135, 227, 92	+++ 150, 242, 122	Aniline: +++ 93, 66 Isocyanatobenzene: +++ 119, 91, 64
PR185	OCH_3	SO_2- $NHCH_3$	CH_3	++ 120, 215,121	+++ 135, 230, 136	
PR208	$CO_2C_4H_9$	H	H	++ 105, 123, 77	+++ 119, 193, 137	
PBr25	Cl	H	Cl	++ 146, 148,111	+++ 161, 163, 126	Dimer of a and b: + 235, 270, 307

Arylide pigments

The arylide yellow pigments fragment in a similar way to the Naphthol AS pigments, producing aniline and isocyanate products from the coupling component and in some cases anilines from the diazo component, see figure 4.7 and table 4.25. In addition these pigments produce acetyl cyanide, which emerges very early on in the pyrogram. An apparent cyclisation to form a benzofurazan product was reported by Sonoda for PO1 (not tested here) (Sonoda *et al.*, 1999). A similar benzofurazan product was identified here from pigments having a nitro group in the X_1 position.

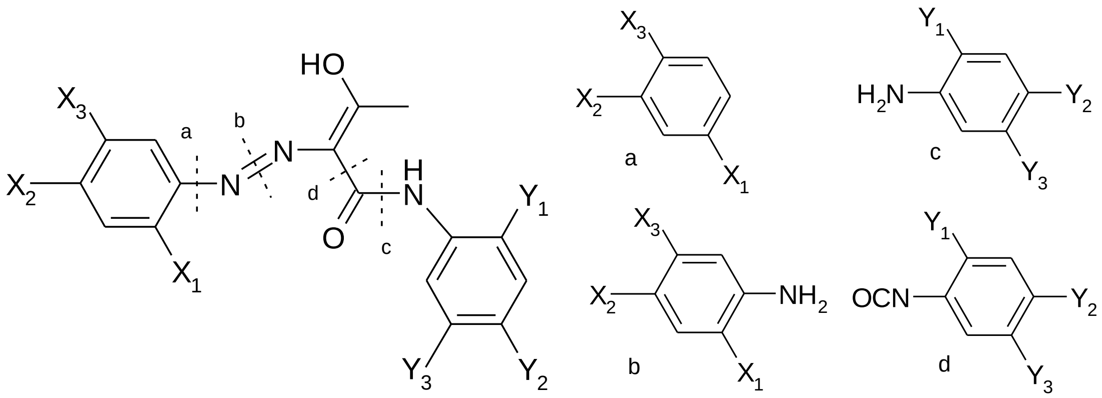


Figure 4.7. Structure of Arylide pigment, left, with fragments produced by pyrolysis, right

Benzimidazolone (arylide)

As with the benzimidazolone (naphthol AS) pigments, only products from the diazo end of the molecule were identified, see figure 4.8. Most also formed a product with an isocyanate group, and several also gave a major unidentified product. The results are summarised in table 4.26.

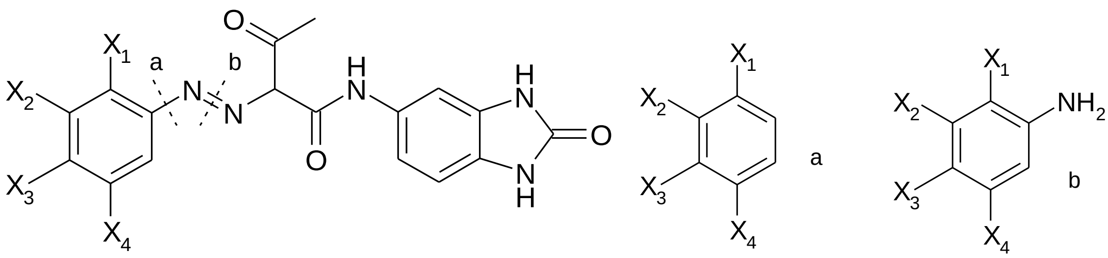


Figure 4.8. Structure of Benzimidazolone (arylide) pigment, left, with fragments produced by pyrolysis, right

Table 4.25. Products from Py-GCMS of Arylide pigments. [a]Acetyl cyanide

C.I. Name	*Substituents*						*Products*					
	X_1	X_2	X_3	Y_1	Y_2	Y_3	*Ac*[a]	*a*	*b*	*c*	*d*	*Other*
PY1	NO_2	CH_3	H	H	H	H	+ 43, 69, 54	+ 91,137 ,65		++ 93, 66	+++ 119, 91, 64	Benzofurazan from X ring: + 134, 77, 105
PY2	NO_2	Cl	H	CH_3	CH_3	H	+			+++ (overlap) 121,120106	147,132,118	Benzofurazan from X ring: + 124, 154, 126
PY3	NO_2	Cl	H	Cl	H	H	+			+++ 127, 129, 65	++ 153,155125	Benzofurazan from X ring: + 124, 154, 126 c & methyl group: + 140, 141, 77
PY6	NO_2	Cl	H	H	H	H	++		+ 172, 126, 63	++ 93, 66	++ 119, 91, 64	Benzofurazan from X ring: + 124, 154, 156
PY65	NO_2	OCH_3	H	OCH_3	H	H	++	++ 153, 107	+ 168,153,122	+++ 108, 123, 80	++ 149,106120	Benzofurazan from X ring: ++ 150, 120, 77
PY73	NO_2	Cl	H	OCH_3	H	H	+		+ 172, 126, 99	+++ 108, 80, 65	++ 149,106134	Benzofurazan from X ring: ++ 124, 154, 156
PY74	OCH_3	NO_2	H	OCH_3	H	H	++		+ 168,153,122	+++ 108, 123, 80	++ 149,134106	a & NCO group: +++ 194, 164, 77
PY75	NO_2	Cl	H	H	OC_2H_5	H	++	++ 111,157, 75	++ 172, 126, 99	+++ 108,109137	++ 135, 163, 79	Benzofurazan from X ring: ++ 154, 124, 156 c & methyl group: ++ 122, 151, 94
PY97	OCH_3	$SO_2NHC_6H_5$	OCH_3	OCH_3	Cl	OCH_3	++		++ 168,308,122	+++ 172,187, 144	+++ 198,213, 200	a & NCO group: ++ 239, 334, 148

Table 4.26. Products from Py-GCMS of Benzimidazolone (arylide) pigments. [a]Acetyl cyanide

C.I. name	*Substituents*				*Products*			
	X_1	X_2	X_3	X_4	*Ac*[a]	*a*	*b*	*Other*
PY120	H	CO_2CH_3	H	CO_2CH_3	+ 43, 69, 54	++ 163,194,135	+++ 209,178150	a with isocyanate group: + 204, 235, 161 unidentified product: ++ 234, 203, 276
PY151	COOH	H	H	H	+++			Benzene: ++ 78, 77 Aniline: ++ 93, 66, 65 isocyanatobenzene : + 119, 64, 91 2 unidentified products: + 118, 160, 91 160, 145, 118
PY154	CF_3	H	H	H	+	++ 146, 145, 127	++ 114,161141	a with isocyanate group: +++ 187, 168, 145 unidentified product: +++ 186, 166, 228
PY175	CO_2CH_3	H	H	CO_2CH_3	+	+ 163, 194, 135	++ 209,177150	a with isocyanate group: ++ 204, 235, 144 unidentified product: +++ 234, 203, 245
PY194	OCH_3	H	H	H	+	++ 108, 65, 78	++ 108, 123, 80	a with isocyanate group: +++ 149, 106, 120
PO36	NO_2	H	Cl	H	++	++ 111, 75, 157	+++ 172, 126, 99	Benzofurazan from X ring: ++ 124, 154, 126 unidentified product: + 241, 170
PO62	H	H	NO_2	H	++	+ 77, 123, 51	++ 138, 65, 108	a with isocyanate group: + 134, 164 unidentified product: +++ 163, 133, 205

Diarylide

On pyrolysis of the diarylide pigments, the fragmentation of the coupling component is similar to that of the arylide yellows, and most also produce a series of minor biphenyl products from the central diazo component, see figure 4.9 and table 4.27.

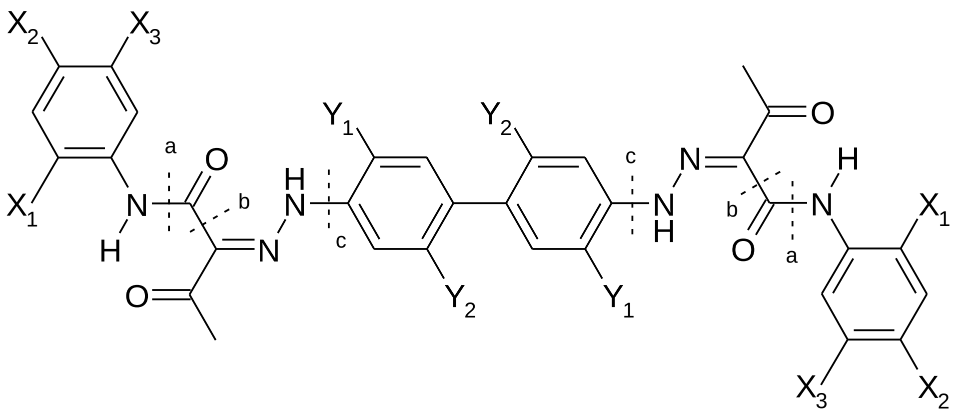


Figure 4.9. Structure of Diarylide pigment showing fragmentation pattern

Table 4.27. Products from Py-GCMS of Diarylide pigments.

C.I.	*Substituents*					*Products*							
Name	X_1	X_2	X_3	Y_1	Y_2	*Ac*[a]	*a*	*b*	*c*	*c +NCO*	*c +NH_2*	*c + di-NCO*	*c + NCO +NH_2*
PY12	H	H	H	Cl	H	+ 43, 69, 54	+++ 93, 66, 65	++ 119, 91, 64		+ 263,265,200	+ 237,239,167		+ 278, 280,215
PY13	CH_3	CH_3	H	Cl	H	++	+++ (overlap) 121,120,106	147,118,132		+ 263,265, 200	+ 237, 239,167		
PY14	CH_3	H	H	Cl	H	+++	+++ 106, 107, 77	++ 104, 133,105		+ 263,265, 200		+ 304,306,241	+ 278, 280,215
PY17	OCH_3	H	H	Cl	H	+	+++ 108, 123, 80	++ 149, 106,134		+ 263, 265,200	+ 237, 239,167		+ 278, 280,215
PY55	H	CH_3	H	Cl	H	++	+++ 106, 107, 77	++ 133, 104,132	(+) 222, 224, 152	+ 263, 265,200			+ 278, 280,215
PY81	CH_3	CH_3	H	Cl	Cl	++	+++ 120, 121,106	++ 147, 132,118		+ 333, 331,261	+ 307, 305,235	+ 374, 372,302	+ 348, 346,276
PY83	OCH_3	Cl	OCH_3	Cl	H	++	+++ 172, 187,144	++ 198, 213,200				+ 304, 306,241	+ 278, 280,215
PY87	OCH_3	H	OCH_3	Cl	H	++	+++ 138, 153,110	++ 164, 179,136		+ 263, 265,200	+ 237, 239,167		
PY126	H H	H OCH_3	H H	Cl	H	++	+++ 93, 66, 65	++ 119, 91, 64		++ 263, 265,200	+ 237, 239,167	++ 304, 306,241	+ 278, 280,215
PY127[b]	CH_3 OCH_3	CH_3 H	H H	Cl	H	+++				+ 263, 265,200		++ 304, 306,241	+ 278, 280,215
PO16	H	H	H	OCH_3	H	++	+++ 93, 66, 65	+++ 119, 91, 64		+ 255, 212		++ 296, 253,210	

[a]Acetyl cyanide. [b]PY127 gave the same a & b products as PY126

PY126 and PY127 both consist of a mixture of two different structures. However, only one set of a & b products was detected in each case. In the case of PY127, only the unsubstituted aniline and isocyanatobenzene were produced.

Disazopyrazolone pigments

As with other azo pigments, aniline and isocyanatobenzene products were usually seen. In two cases, product c including the pyrazolone ring was detected (see figure 4.10 and table 4.28). Biphenyl products from the centre of the molecule were major products in all cases. The main products from PR38 and PO13 were identical, as these differ only in the X_2 group, which was not present in any of the detected products.

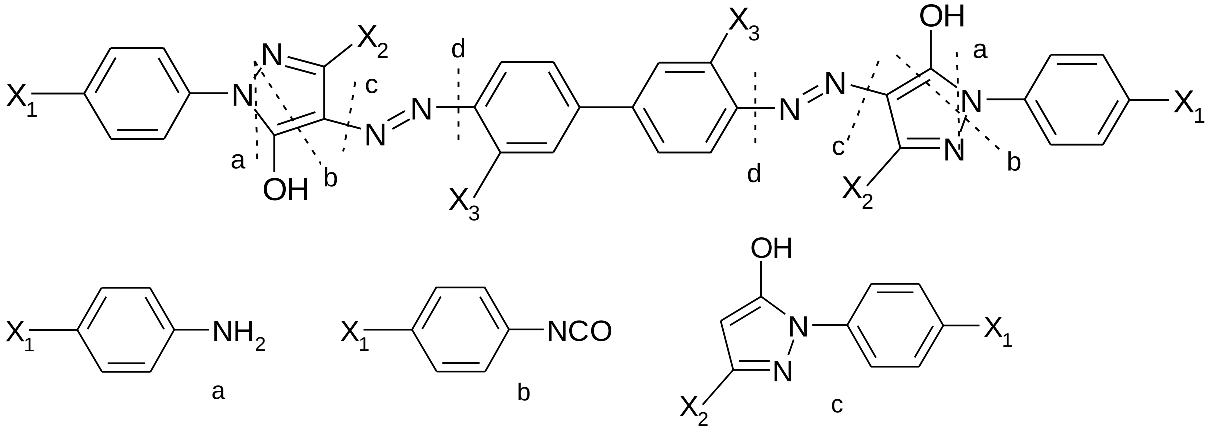


Figure 4.10. Structure of Disazopyrazolone pigment showing fragmentation pattern

Table 4.28. Products from Py-GCMS of Disazopyrazolone pigments.

C.I.	*Substituents*			*Products*					*Other*
name	*X_1*	*X_2*	*X_3*	*a*	*b*	*c*	*d*	*d + NH_2*	
PR38	H	$CO_2C_2H_5$	Cl		+++ 119, 91, 64		++ 222, 224,152	++ 237, 239, 167	Benzene: ++
PR41	H	CH_3	OCH_3	+ 93, 66	++ 119, 91, 64	+++ 174, 105,91	+++ 214, 171	++ 229, 214, 186	
PO13	H	CH_3	Cl		+++ 119, 91, 64		++ 222, 224,152	++ 237, 239, 167	Acetonitrile:++ 41, 40 Benzene: ++
PO34	CH_3	CH_3	Cl	+ 106, 107	++ 133, 104	+ 188, 105,91	++ 222, 224,152	+++ 237, 239, 167	Acetonitrile:+ 41,40 Toluene: +

4.2.2 Non-Azo Pigments

Diketopyrrolopyrrole

Py-GCMS of diketopyrrolopyrrole pigments has not previously been reported. Pyrolysis products could only be identified from these pigments if the pyrolysis was carried out at the higher temperature of 800˚C. The pigments produced substituted benzenes and benzonitriles, see figure 4.11 and table 4.29.

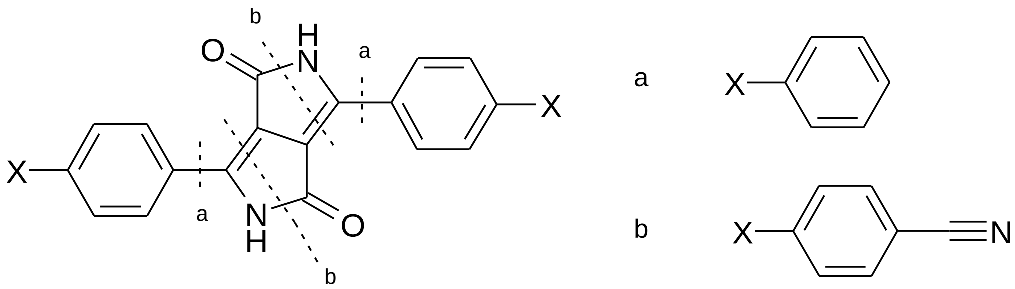


Figure 4.11. Structure of Diketopyrrolo-pyrrole pigment, left, with fragments produced by pyrolysis, right

Table 4.29. Products from Py-GCMS of Diketopyrrolo-pyrrole pigments

C.I. Name	*X*	*Product a*	*Product b*	*Other products*
PR254	-Cl	++ 112, 114, 77	+++ 139, 137, 102	? (mw-43): ++ 313, 315, 250
PR255	-H	++ 78, 77	+++ 103, 76, 50	? (mw-43): ++ 245, 216, 189
PR264	$-C_6H_5$	++ 154, 153, 76	+++ 179, 178, 151	Benzene: ++ 78, 77
PO73	$-C(CH_3)_3$	++ 119, 91, 134	+++ 133, 148, 105	

Phthalocyanines

Py-GCMS of the phthalocyanine pigments did not give such consistently good results as for the azo pigments. Products were only seen when pyrolysis was carried out at 800˚C. In all cases a product is seen from the benzene ring plus two nitrile groups, see figure 4.12. In PB15 this was the only identified product, but gave only a small peak. The halogenated phthalocyanines PG7 and PG36 gave much more intense peaks for the equivalent products, see figures 4.13 and 4.14. In addition the variation in substitution pattern for PG36 leads to a series of products with different numbers of chlorine and bromine atoms (table 4.30).

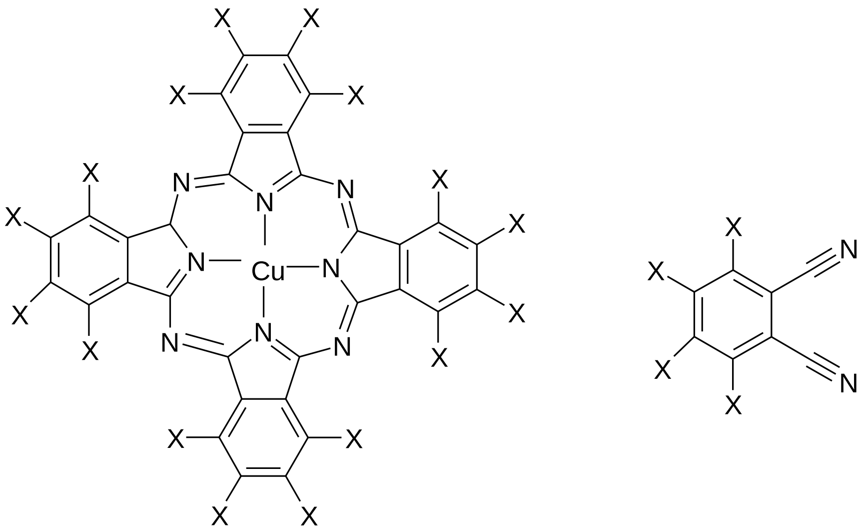


Figure 4.12. Structure of Phthalocyanine pigment, left, with fragment produced by pyrolysis, right

Table 4.30. Products from Py-GCMS of Phthalocyanine pigments

C.I. name	*X*	*Product a*	*Other products*
PB15:6	H	+ 128, 101, 75	
PG7	14-15 Cl	+++ (4 Cl): 266, 264, 229	Product a with 1 CN group substituted by Cl : + 275, 277, 240
PG36	4-9 Br, 8-2 Cl	+++ (4 Br): 444, 442, 284 +++ (3 Br, 1 Cl): 400, 398, 240 ++ (2 Br, 2 Cl): 354, 356, 276	Chlorobenzene ++ 112, 114, 77 Bromobenzene ++ 156, 158, 77

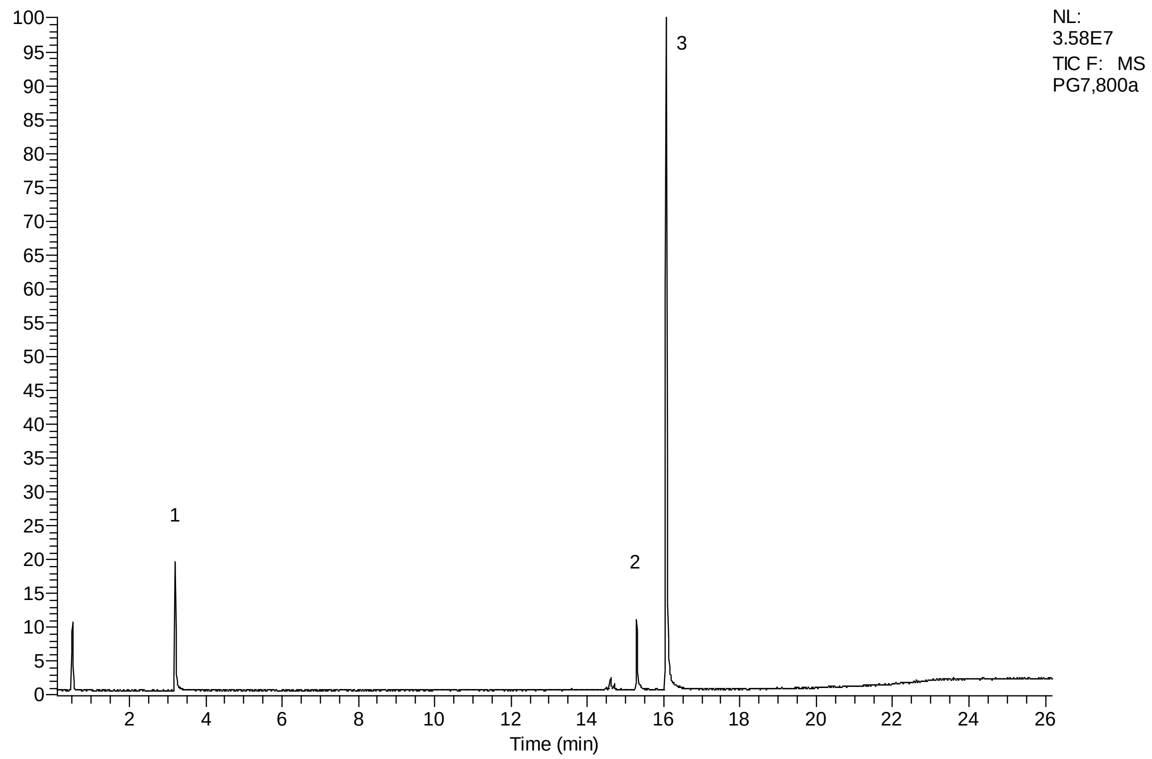


Figure 4.13. Pyrogram of PG7 Phthalocyanine green, Kremer. Pyrolysis temperature of 800°C. (1 = chlorobenzene, 2 = $C_6(CN)Cl_5$, 3 = $C_6(CN)_2Cl_4$)

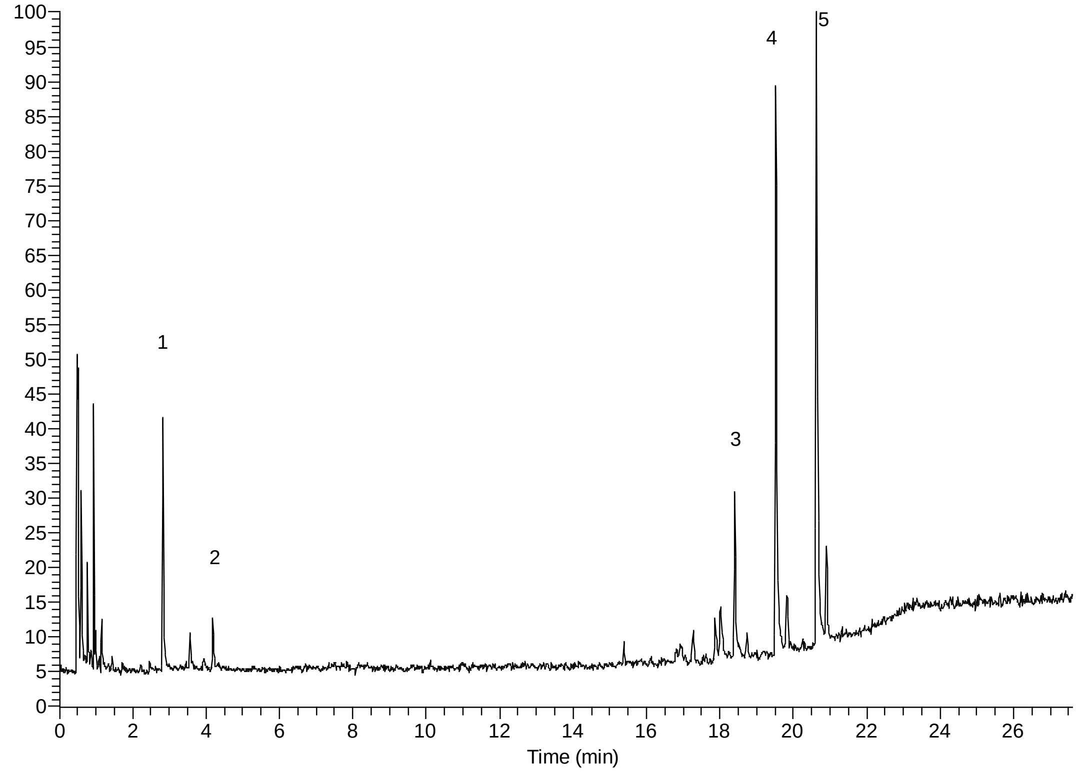


Figure 4.14. Pyrogram of PG36 Phthalocyanine green, yellowish, Kremer. Pyrolysis temperature of 800°C. (1 = chlorobenzene, 2 = bromobenzene, 3 = $C_6(CN)_2Br_2Cl_2$, 4 = $C_6(CN)_2Br_3Cl$, 5 = $C_6(CN)_2Br_4$)

Isoindolinone

The isoindolinone pigments all include the isoindoline ring, but show variation in the structure of the central linking ring(s). Pyrolysis gives X-substituted benzenes, sometimes including a nitrile group, from the isoindolinone groups, and in some cases also benzenes from the central aromatic group, see figure 4.15 and table 4.31.

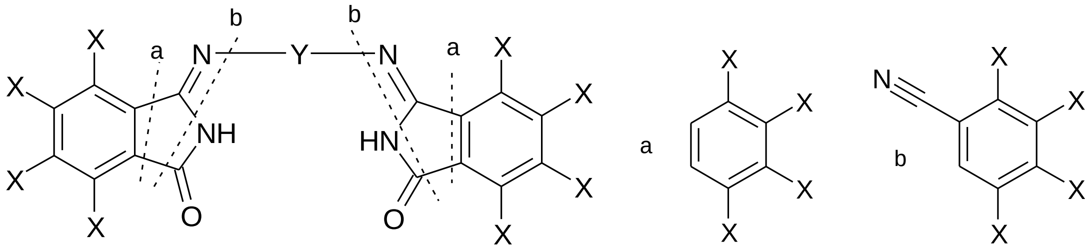
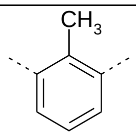
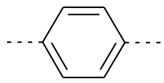
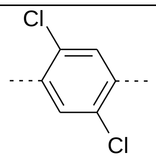
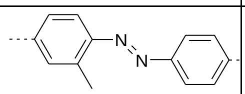


Figure 4.15. Structure of Isoindolinone pigment, left, with fragments produced by pyrolysis, right

Table 4.31. Products from Py-GCMS of Isoindolinone pigments

C.I. name	*X*	*Y*	*Benzene a*	*Benzo-nitrile b*	*Central group*	*Other products*
PY109	Cl		+ 216, 214, 143	+ 241, 239, 204		Dichlorobenzene: +++ 146, 148, 111
PY110	Cl		++ 216, 214, 143	+++ 241, 239, 204		Hexachlorobenzene: + 284, 286, 249
PY173	H				+++ 146, 148, 111	Dimer of Y ring: + 322, 281, 320
PO61	Cl		++ 216, 214, 143	+++ 241, 239, 204		Dichlorobenzene: +++ 146, 148, 111

Perylene pigments

Perylene pigments again needed a pyrolysis temperature of 800˚C to give good results. Products result only from the outer X substituents, not from the central polycyclic structure (figure 4.16). PR179, where X is a methyl group, did not give any identifiable pyrolysis products (Table 4.32).

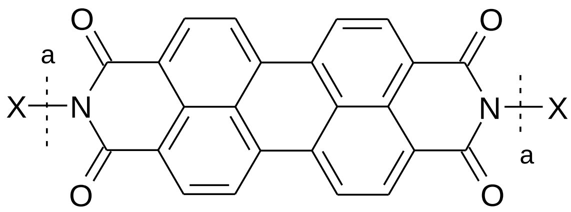
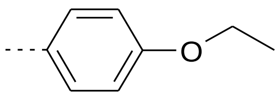
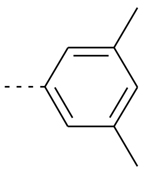
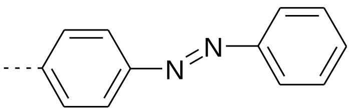
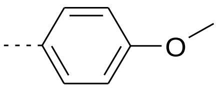


Figure 4.16. Structure of Perylene pigment

Table 4.32. Products from Py-GCMS of Perylene pigments

C.I. name	*-X*	*Product a*	*Other products*
PR123		++ 94, 122, 66	Phenol +++ 94, 66
PR149		++ 106, 91, 105	
PR178			Benzene +++ 78, 77 Aniline +++ 93, 66, 65 Biphenyl ++ 154, 153, 152 4-amino-1,1'-biphenyl (?) ++ 169, 168, 77
PR179	---CH_3		
PR190		+++ 108, 65, 78	Benzene + 78, 77 Phenol ++ 94, 66

Alizarin crimson

Pyrolysis at 600 and 800˚C did not produce any identifiable products. However, when carried out with *in-situ* methylation using TMAH, several products were detected, see table 4.33. A major unidentified product was obtained with a base peak at m/z 129 which appears to be characteristic of alizarin, so could used to identify it in a paint sample. Another minor product was sometimes seen, apparently from methylation of the hydroxyl-anthraquinone structure.

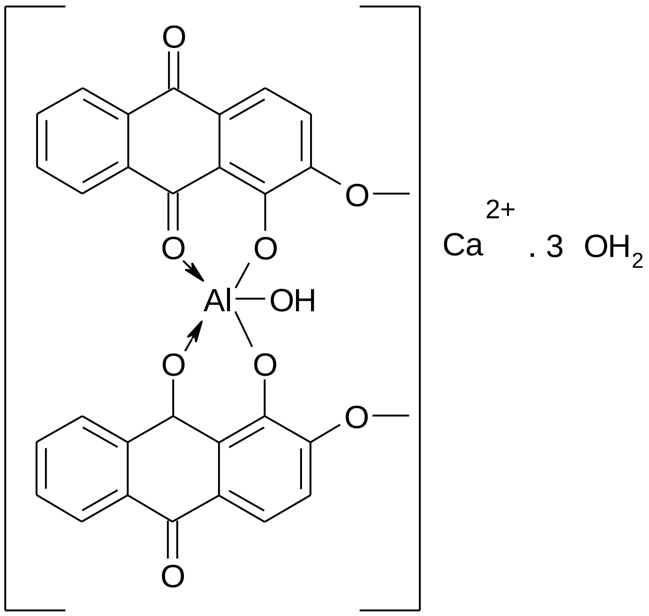
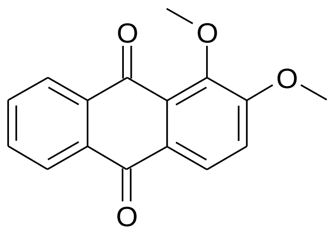


Figure 4.17. Structure of Alizarin crimson pigment

Table 4.33. Products from THM-GCMS of Alizarin crimson

Peaks m/z (% abundance)	*Product*	*Amount*
67, 155(95), 81(70), 95(60), 294(35)	Not identified	++
129, 97(50), 241(10), 201(15), 55(45)	Not identified	+++
268, 239(30), 126(20), 225(20)		+

4.2.3 Discussion

The fragmentation of the pigments generally followed a predictable pattern among members of each group. In the majority of cases at least two main products were identified, which could be used to identify the pigment. However, some products are produced from a large number of different pigments, for example aniline and isocyanatobenzene were found as a pair of products in more than 15 red, orange and yellow pigments tested. Often these were the most abundant products, therefore in such cases it becomes important to identify the minor products to narrow the field. A few pigments cannot be easily distinguished by this method, for example PR144, PR166 and PR214 which all gave the same principal products.

In several cases some of the predicted products did not appear, or were present only in very small quantities. In the case of PY127 only the unsubstituted aniline and isocyanatobenzene were produced, which were not the expected products but might result from contamination of the pigment with another similar diarylide. This pigment is reported as being a mixture of two compounds, and it is possible that another compound might have been added to adjust the hue, or the pigment could even have been mislabelled. Analysis using other methods might help to identify if this has occurred.

For the diketopyrrolo-pyrrole, perylene and phthalocyanine pigments, it was necessary to use a pyrolysis temperature of 800˚C to be able to identify pyrolysis products. For the remaining pigments both pyrolysis temperatures generally gave similar results, with the same products being identified, though often in slightly different proportions. The higher temperature tended to produce a greater proportion of higher molecular weight products.

Pyrolysis-GCMS does have limitations, as not all organic pigments will pyrolyse to give characteristic fragments. In particular, quinacridones and some other polycyclic pigments cannot be pyrolysed to give identifiable fragments, meaning alternative methods will need to be used.

4.3 Conclusions from the analysis of reference pigments

For both of the analytical techniques used, pigments within each group followed a similar pattern of results, due to their structural similarities.

FTIR spectra had a large number of sharp characteristic peaks, which could be matched to an unknown pigment. General features of the spectra could be identified for similar pigments, making it possible to identify the class of pigment, if not the precise structure. However these similarities can also make it difficult to distinguish related pigments using FTIR alone. Py-GCMS can provide more specific structural information for the identification of synthetic organic pigments. As demonstrated here, pigments of the same type will behave similarly when subjected to pyrolysis, so products can be predicted to a large extent for other members of the same group. Therefore pigments could be identified without the need for reference samples. For analysis using FTIR it is more important to have reference spectra of all the possible candidate pigments.

The two techniques provide different information which, if combined, would give us greater confidence in our identification of a particular pigment. If FTIR is used alone it can be difficult to pick out the peaks from the pigment in the spectrum of a paint sample and match them with spectra from the large number of possible candidates. There is also the disadvantage that unless we have reference spectra of all possible pigments we don't know if our closest match is the correct one. A large number of synthetic organic pigments were analysed here, but many more are or have been available. With PyGCMS, many fragments are produced by more than one pigment, but the combination of products should allow most pigments to be identified uniquely. However, in paint samples, only the most abundant product(s) might be picked up in the analysis, due to the low concentration of pigment in comparison to binding media and extenders, meaning that there may be several possible candidates. Mixtures of pigments can also complicate identification, as the products could combine in several different ways to give a number of different pigments. By combining the information from both techniques we are more likely to be able to identify the pigment.

For both techniques, low pigment concentration and small sample size will make it more difficult to see clear signals from the pigments, rather than from other paint components. The very large number of synthetic organic pigments that may have been used in artist and household paints also complicates identification. Therefore it will often be necessary to piece together information from both techniques to identify an unknown pigment from a paint sample.

Chapter 5 Documents and Studio

This chapter gathers the evidence about Bacon's materials using information other than that taken directly from the paintings examined. In the first part, information is gathered from any documentary sources which mention materials and techniques. This has been grouped according to different aspects of the painting process – supports, paints, procedure and technique. The second section looks at the contents of the studio to see which materials are represented here. This can be interpreted to identify the colours most favoured by Bacon, and the types of media most often used. Some objects used as tools in the painting process are also identified. This is incorporated with the results of analysis of selected materials from the studio.

5.1 Evidence from documentary sources

There are relatively few sources of documentary evidence about the materials and techniques used by Bacon. The interviews carried out by David Sylvester, Hugh Davies and others provide some of the most detailed information on technique, but these occasions are of course largely dictated by the artist (Durham, 1985; Sylvester, 1993; Archimbaud, 1993; Davies, 2009). It is apparent that some contradictory information appears in interviews, so this cannot all necessarily be taken at face value. For example, Bacon said he never drew as a child (Bacon, 1985), but his sister Ianthe Knott recalled him making many drawings of '1920 ladies' (Low, 2005).

Not many letters written by Bacon survive. A number were written to Erica Brausen of the Hanover Gallery, mainly when Bacon was travelling abroad, which form part of the Gallery records acquired by the Tate Gallery Archive (Bacon, 1948-58). Some letters written to fellow artist Graham Sutherland mention materials, which are transcribed in Hammer (2005). A few receipts for materials bought from the Chelsea Art Store were kept by Valerie Beston at Bacon's gallery, Marlborough Fine Art, dating from the late 1970s. In addition to these, a few colours are mentioned in notes written by Bacon on scraps of paper or inside books found in the studio.

Bacon did not allow himself to be filmed in the act of painting and few people were allowed to be in his studio while he was at work. After some of his early attempts at portraits, Bacon found he was better able to work from photographs without the presence of a sitter. The sittings recorded by Cecil Beaton in his diaries in 1960 form one of the very few accounts of Bacon at work (Beaton, 1976). Other sitters in early portraits include Lucian Freud, who found most of his portrait (*Portrait of Lucian Freud*, 1951) had been completed before he arrived, based on a photograph of Kafka (Alley & Rothenstein, 1964), and David Sylvester, who was disconcerted to find Bacon referring continuously to a photograph of a rhinoceros while attempting his portrait (Sylvester, 2000).

Supports

An overview of the types of supports used by Bacon (at least in the earlier part of his career) can be seen by looking at the list of works recorded in Alley & Rothenstein's Catalogue Raisonné from 1964 (Alley & Rothenstein, 1964). A small number of works surviving from the 1930s are on paper, in pastel, gouache or ink. A couple of early works use Sundeala board, a soft fibreboard which was used for the 1944 *Studies for Three Figures at the Base of a Crucifixion*. A similar board was also used for *Head I*. Other early works use primed canvas, such as the 1945 *Figure in a Landscape* and *Painting 1946*. One of the first works to use unprimed canvas was *Head II*. The choice of unprimed canvas is described by Bacon as having come about by accident:

> 'This thing of using unprimed canvas came about when I was living in Monte Carlo in the late 1940s. I had no money – probably I had lost it in the casino – but I had some canvases there which I had already used, so I turned them and discovered that the unprimed side was much easier to work on. And since then I have always worked on the unprimed side of the canvas.' (Sylvester, 1993, p.196)

Bacon was not unique in this choice however, as his friend at the time Graham Sutherland also used raw canvas (Durham, 1985), and it has been implied that this story was recounted as evidence of 'chance' used in Bacon's work, while it might have actually come about in a more considered way (Shepard, 2009).

Bacon used a wider range of canvas sizes in his early work than were used later on in his career. In 1963 a canvas measuring 78 by 58 inches is first used and this becomes the standard large canvas size for all subsequent works. After this date the two standard canvas sizes 78 x 58 inches and 14 x 12 inches are used for virtually all works. Interestingly, this timing appears to coincide with Bacon finding his mature style. However, prior to 1963 a variety of canvas sizes are used.

Starting with *Painting* 1946, Bacon consistently used canvases with a height of 78 inches, but the width increases several times over the years (see figure 5.1). For *Painting* 1946 and one other work from 1950, the width is 52 inches. However a slightly wider canvas, 54 inches across, is adopted from 1950 to 1957, used in at least 25 works. For canvases used from 1956 to 62 the width increases again, to 56 inches (at least 27 works). In 9 works from 1962-3 a canvas measuring 78 x 57 inches is used, before the 78 x 58 canvas is introduced and remains for the rest of Bacon's career. Smaller canvases measuring 24 x 20 inches are used from 1952 to 61 in at least 21 works, including the William Blake series and several other portraits. Over a similar period (1953 to 61) a canvas measuring 60 x 46.5 inches is used in at least 51 works, including the 1953 series of Popes, and several of the *Man in Blue* series. These are the sizes most commonly used, but a range of other dimensions are also found in a small number of works in the 1950s to early 1960s.

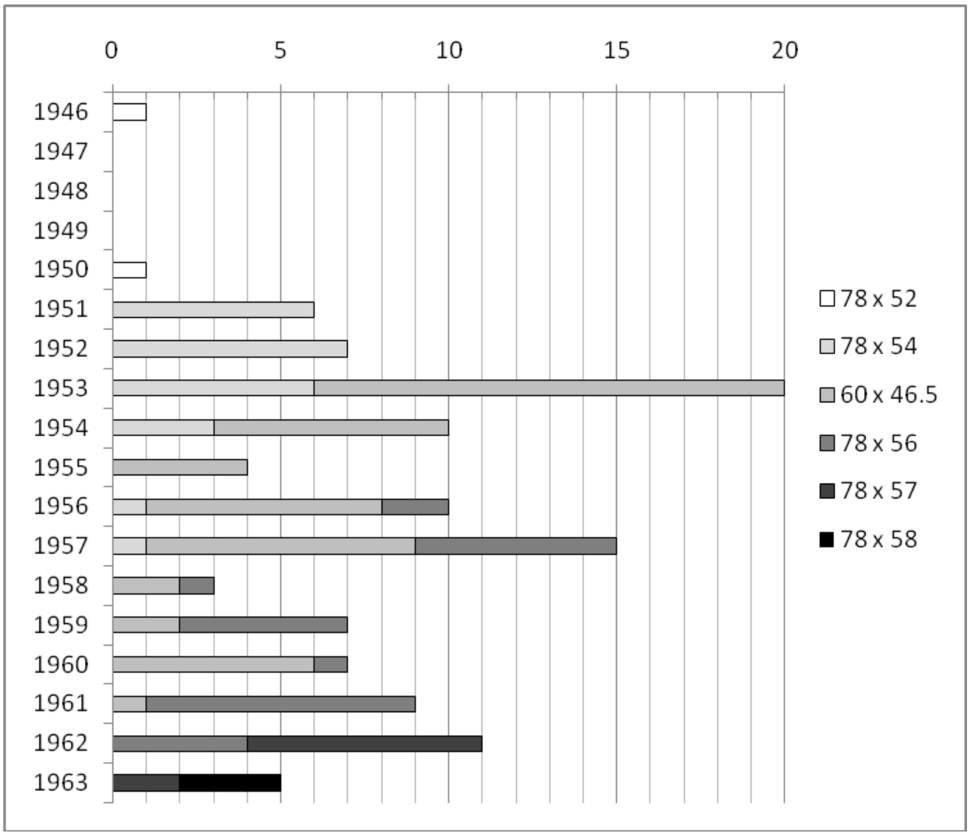


Figure 5.1 Chart showing numbers of works on large standard canvas sizes, 1946-63 (data from Alley & Rothenstein, 1964)

The variety of sizes may result in part from Bacon changing the dimensions of his work, which he appeared happy to do at least during the 1950s. In one letter to Graham Sutherland, (apparently from Monte Carlo) he writes:

> '...I have not been able to get the stretcher made yet as the people who make them are closed for a holiday. I am just hanging the piece of canvas on the wall and it seems quite pleasant to not to have the tyranny of the stretcher and be able to alter the dimensions as one wants.'[22]

Cecil Beaton also reports being shown an enormous canvas by Bacon, when he went to have his portrait painted, who said 'he hoped I wouldn't be alarmed by the size of it but that the portrait would be cut down, if necessary, when he had finished it' (Beaton, 1976). Another example of a painting being cut-down was witnessed by Robert and Lisa Sainsbury, early patrons of Bacon (Alley & Rothenstein, 1964). On visiting Bacon's studio they were distressed to find that Bacon intended to destroy a work, whereupon Bacon cut out the central part of the composition with a razor blade and presented it to them with the paint still wet.[23]

By the early 1960s however, Bacon appears to have decided on the ideal size of canvas and remained faithful to it. There are a few cases of a figure being cut from one canvas and stuck to a new one, e.g. *Reclining Woman* 1961 and *Turning Figure* 1963, presumably if something had gone wrong with the background, but the canvas sizes remain remarkably consistent after 1963. His frequent use of a triptych format also began around this time and we can imagine that the use of only two canvas sizes would certainly have made life easier from a practical point of view, for example where it was necessary to re-paint one panel using a new canvas.[24]

A few receipts survive from materials bought from the Chelsea Art Store, which show the canvases bought by Bacon from June 1976 to September 1980. Bacon appears to have bought his supplies from this store for a considerable period, as shown by a label attached to the back of *Man with Microphones* (1946-8).[25] An interesting inconsistency is in the three canvases of a slightly different size bought in 1979. These dimensions in

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[22] Letter from Bacon to Sutherland, undated, reproduced in Hammer, 2005, p.235

[23] The painting in question is *Study (Imaginary Portrait of Pope Pius XII)*, 1955. Other works cut down from larger canvases are *Figure with Meat*, 1954 and *Head*, 1962 (Alley & Rothenstein, 1964).

[24] It is also reported that Bacon's framer Alfred Hecht had an influence in his use of standard canvas sizes, because of high insurance costs while framing Bacon's work (Sinclair, 1993, p.248).

[25] A paper label is recorded on the back of the stretcher in the Hugh Lane database entry for this work (RM98F47), as 'The Chelsea ******ores (Frank Pearce) Artists Colourmen L**don'

fact match those of the *Three Studies for Self-portrait, 1979* owned by the Metropolitan Museum, New York. No other paintings of these dimensions have been noted among those reproduced in catalogues, although it has been observed that dimensions are not always quoted accurately in reproductions.[26]

In 1978, 16 stretchers of both sizes were sent to be re-covered with new primed canvases. These were presumably from paintings which Bacon had attempted, then destroyed. It might be interesting to speculate over whether 1977-78 was a period in which Bacon had particular difficulty with his work, or whether these canvases had simply accumulated over a longer period of time. It is likely that these are not the only materials bought over this period. Bacon bought an apartment in Paris in 1974 and used this as a studio from autumn of this year until the mid-1980s (Peppiatt, 1996). From Peppiatt's report, this was similar in appearance to his Reece Mews studio:

> 'equipped with an easel, a stack of large, stretched canvases and a painting table on which a coagulated heap of half-used paint tubes, brushes and rollers, sponges and rags grew with each working session'. (Peppiatt, 1996, p.259)

Bacon may well have used local suppliers to provide him with canvases and paint while in Paris, which might have meant different materials were used in the paintings completed here. A few apparently French materials were found in the London studio, including cans of orange spray paint and several small bottles of retouching varnish.

Table 5.1 Numbers of canvases bought from Chelsea Art Store from 1976 to 1980, from receipts

Year	Date	78 x 58"	14 x 12"	14¾ x 12½"
1976	21st June		12	
	1st Oct	4		
1977	3rd Mar		12	
	23rd Mar		12	
	28th June	3		
	27th Oct	4		
1978[27]	9th June	3		
	8th Sept	3	10	
1979	23rd May	6	12	3
1980	18th July		12	
	23rd Sept	4		

[26] If these are the same canvases used in the Metropolitan work, it might suggest that this triptych was produced without any re-painting of panels, as this would have meant Bacon would need to buy new canvases of the slightly larger size.
[27] The invoices specify 'Recover stretchers with 118 rev' for all canvases bought in this year

All the canvases on the Chelsea Art Store receipts were specified to have '118' on the reverse, a particular type of priming produced by Roberson & Co artist suppliers. It is uncertain why this was specified, as one might expect that the type of priming would not be important, given that Bacon did not actually paint on it. This might have been due to the quality of canvas associated with this priming type. We might also imagine that Bacon could equally have used an entirely unprimed canvas, but it's probable that the stiffness and opacity leant to the canvas by the presence of the priming layer was important to its appearance and feel. The presence of the priming also offers a degree of protection to the back of the canvas from environmental pollutants, meaning the canvases are better preserved than would be the case for a wholly unprimed canvas. It is possible that Bacon was aware of this, but it is more likely that its use arose from his early reversal of ready-primed canvases, which then became a habit. Initially Bacon appears to have bought ready-primed canvases which he re-stretched himself back-to-front, before getting his suppliers to prepare canvases in this way for him.

Further information about Bacon's supports was collected from staff at Chelsea Art Store shortly before it closed in the early 1990s (Winner, 2009). It was reported that Bacon was using Roberson canvases from the mid to late 1950s, bought from the Chelsea Art Store. In the early 1960s he was said to have become unhappy with changes made to the canvas and switched to a Winsor & Newton oil-primed canvas called Herga.[28] In later years he changed again to an acrylic-primed Daler Rowney canvas called Herston. However this information does not wholly tie up with the receipts, which show Roberson canvases were still being bought regularly in the 1970s.

Paints

A few specific materials are named in letters written by Bacon. A letter addressed to Graham Sutherland's wife, Kathy, on 22nd Jan 1947 asked:

> 'If you could get it could you possibly bring me some white (zinc white) paint and 3 tubes of marble medium, Holland nearly always has it, and some *lamp* black if it is not too much of a bother.'[29]

The Sutherlands were due to join Bacon in Monte Carlo, bringing these materials with them. The medium mentioned is believed to be Parris Marble medium, a product made

[28] In the 1951 Winsor & Newton Catalogue this is described as ' A single primed, pure flax canvas with a very fine grain but with adequate tooth'

[29] Letter from Bacon to Kathy Sutherland, 22 Jan 1947, reproduced in Hammer, 2005.

by Roberson, designed to be added to paint to give a flat or dead surface.[30] The product still exists and is said to be a mixture of refined beeswax, turpentine and synthetic copal resin.[31] Walter P. Holland was the proprietor of Chelsea Art Store.[32]

Many notes were found in the studio, scribbled on scraps of paper or card, loose sheets of notepaper, or the endpapers of books. Most describe ideas for paintings in a few words, and colours are sometimes mentioned. One note, part of a list of ideas written on the endpapers of Eadweard Muybridge's *The Human Figure in Motion*, says: '3 versions of the Landscape with dark background / alizarin crimson & windsor [sic] green'[33]

Another note written on a piece of card with red patches of spray paint is simply a list of colours: 'Alizarin Crimson / Windsor Green / Jaune Brillant'[34] a note on a piece of notepaper appears to say 'Matt orange acrylic paint'.[35] Another note on a loose paper dated December 1957 says 'The series of nudes / against a dark background made of/ alizarin crimson and Winsor green...' (Bacon, 1957). These are among the few examples of specific colours being mentioned.

Other notes might indicate changes of mind over colour. One written on a fragment of paper torn from an exhibition pamphlet has the words 'Possible white instead of orange'[36] and another note on a brown envelope: 'For white (crossed out) <u>orange</u> Tryptich [sic] 1986'[37]

In the Sylvester interviews, Bacon describes the background of *Triptych May-June 1973* being 'a very thinly painted mixture of Prussian blue and black' (Sylvester, 1993, p.94), while the background of *Landscape,* 1978 is made with cobalt blue (p.162).

Oil and acrylic paint

It is reported that Bacon used artists' oil paints predominantly for the image, without the addition of extra oil or varnish media, although turpentine may be added to create very

[30] One tube of this was found in the studio, right at the back on the shelf below the mirror, in an area probably undisturbed for many years.
[31] Described on Roberson website: http://www.robco.co.uk/html/subitem.asp?group=Oil Painting&sub_subgroup=Roberson Oil Mediums Solvents [accessed 09/03/10]
[32] Recorded on a label found on the back of *Portrait of Lucian Freud*, 1951
[33] Dublin City Gallery The Hugh Lane Archive, RM98F198:2
[34] Dublin City Gallery The Hugh Lane Archive, RM98F114:7
[35] Dublin City Gallery The Hugh Lane Archive, RM98F105:125
[36] Dublin City Gallery The Hugh Lane Archive, RM98F8:135
[37] Dublin City Gallery The Hugh Lane Archive, RM98F104:81A

thin washes of colour (Durham, 1985). Oil paints are also described by Bacon in the Sylvester interviews and appear to be important to the idea of chance effects in his work:

> 'You see, I don't think that generally people really understand how mysterious, in a way, the actual manipulation of oil paint is. Because moving – even unconsciously moving – the brush one way rather than the other will completely alter the implications of the image.... I mean, it's in the way that one end of the brush may be filled with another colour and the pressing of the brush, by accident, makes a mark which gives a resonance to the other marks; and this leads on to a further development of the image.' (Sylvester, 1993, p.121)

In the Sylvester interviews dated 1971-3 Bacon stated: 'I do use acrylic sometimes for the background' (1993, p.93). He contrasts this with oils, saying of oil paint: '...you never quite know how it will go on. I think you probably know more with acrylic paint, which all the new painters use.' A distinction is made between the figure and the background, reflected by this choice of material: 'I would like the intimacy of the image against a very stark background.' (Sylvester, 1993, p.120). Durham also reports the use of acrylics in backgrounds, and of emulsion housepaints, used to create large expanses of colour (1985).

The receipts kept by Marlborough Fine Art, dating from 1976-80, list the paint types and colours bought from Chelsea Art Store, as well as the details of canvases mentioned earlier. The number of tubes of each colour purchased in each invoice are listed in table 5.2.

The colours on the receipts have the abbreviation A.O.C. (artists' oil colour). The brand is only specified in a few cases – Rowney titanium white appears to have been bought fairly often, while Winsor & Newton is specified for a few other colours. The numbers no.14 and no.40 are usually mentioned, which are used by Winsor & Newton to denote 37 ml and 122ml tubes respectively. These numbers are also used where Rowney is specified – it is unknown whether the same numbering system was used by this company. The colours are usually bought in multiples of 3 as they are supplied by Winsor & Newton in boxes containing three tubes.[38]

All tubes are artists' oil colour, apart from the three tubes of 'Cadmium yellow pale acrylic' bought in November 1977. If acrylic paint was frequently used in backgrounds

[38] Numerous such empty boxes and plastic inserts were found in the studio.

at this date, as reported, it is likely that this was more often a household acrylic paint, which would have been purchased elsewhere, from a hardware or household shop.

Table 5.2 Numbers of paint tubes of different colours bought from 1976 to 1980

	Invoice number[1]								*Total no. of tubes*
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	
Titanium white	9 (3R[2])	9 (6R)	6 (3R)	3	9	3	6	4	49
Winsor orange	3		3		3	3	2		14
Permanent rose	6 (3W)		3	3		5	3	6	26
Cobalt violet dark	5					1			6
Jaune brilliant	3 (W)								3
Winsor emerald	3								3
Lamp black		3	3	9	3	3	3	6	30
Prussian blue		3		3	3		3	6	18
Alizarin crimson		3 (W)		3					6
Viridian		3 (W)	3						6
Yellow ochre		3 (W)	3	3	3		3	3	18
Raw umber		3 (W)				3	3		9
Flake white				3					3
Cobalt blue				1					1
Winsor yellow					3				3
Cadmium yellow pale acrylic					3				3
Cadmium red							2		2

[1] 1: 29/3/76-18/5/76, 2: 29/7/76-22/9/76, 3: 1/10/76-17/11/76, 4: 21/4/77-28/6/77, 5: 19/7/77-21/11/77, 6: 6/6/78-23/9/78, 7: 17/10/78-4/6/79, 8: 22/1/80 – 23/9/80
[2] R = Rowney, W = Winsor & Newton. In other cases the brand was not specified.

Titanium white is bought with the most consistency and in a far greater quantity than any other colour over this period. It is interesting to note that Bacon also bought three tubes of Flake white in 1977, although he was clearly using Titanium white as his principal white pigment at this time. Lamp black, Permanent rose, Yellow ochre and Prussian blue are also purchased often and in large quantities. Large amounts of turpentine are also bought regularly.

Pastels and pigments

Bacon is recorded to have used pastels on some occasions, to achieve the intensity of colour that he desired (Durham, 1985). In *Painting,* 1946 pastel is reported to have been ground and mixed with an oil binder for the pink and purple areas of background

(Shepard, 2009). This mixture appears to have caused continuing problems of flaking, possibly due to the combination of oil, pastel and primed canvas, rather than the raw canvas used in later works (Sylvester, 2000). Bacon writes in a letter to Sutherland about spraying the painting with fixative, thought to be dated 1946: 'I was glad to hear from you and thank you so much for spraying the picture. I believe all the magenta except the blinds wants doing.'[39] This may indicate that the surface was unstable since its creation.

Pastel is also reported to have been used much later, mentioned in an interview from 1984-6:

> '…a number of the backgrounds that I use are pastel, because I find that with pastel you can get a much more intense colour and it holds very well on the unprimed canvas.' (Sylvester, 1993, p.195)

In particular, many of the orange backgrounds in works from the 1980s are reported to be pastel (Durham, 1985).

Dry powdered pigments also appear to have been used and these may have exacerbated Bacon's asthma (Edwards & Ogden, 2001). In addition to oil paints, '1oz Cad lemon powder colour' was bought from Chelsea Art Store in August 1976 and 'artists powder colour Co blue 1oz' in June 1977. These are likely to be the pure pigments, although 'powder colour' can also mean the water-mixable poster paints sold in powdered form. Several cans of fixative are also purchased, which might have been used to stabilize friable pastel or pigment surfaces.[40]

Other additions

Bacon describes using some more unusual materials in interviews. Dust is used both in an early work, *Figure in a Landscape 1945*, to '...make that slightly furry quality of a flannel suit' (Sylvester, 1993, p.192), and in the paintings of sand dunes from the 1980s. '…I just took dust on a cloth and put it onto the wet paint and after it was dried I set it as one sets a pastel.' (Sylvester, 1993, p.192).

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[39] Letter from Bacon to Graham Sutherland, Monte Carlo, 20 Aug [1946?], reproduced in Hammer, 2005.

[40] One can is bought in 1976 ('aerosol perfix'), two in 1978 ('fixative Rowney'), two in 1979 ('fixative').

Letraset transfer lettering begins to appear in works from the 1970s, often to represent newspapers, and 6 sheets were bought from Chelsea Art Store in 1976.
Sand is also used, mixed into paint to give a gritty texture to areas of the background, or sprinkled on to the paint, leaving the sand colour visible.

Variation in materials may result from the periods when Bacon was working abroad, so bought materials locally. Though in many cases Bacon does not appear able to work successfully while abroad, there is evidence of him attempting to do so and purchasing materials. In a letter dated 27th February 1951, sent from Southern Rhodesia, Bacon says 'I want to buy some materials to try and work on the boat' (Bacon, 1951). In another letter sent from Tangier to Erica Brausen in June 1958, Bacon requests an advance, mentioning that he has to buy 'a lot of paint' (Bacon, 1958). However, in some cases these letters may disguise a more urgent request for funds due to mounting debts, which culminate in Bacon abruptly leaving the Hanover for the Marlborough in October 1958. Bacon's letters are often full of optimism about the work he is doing or planning, but the paintings mentioned usually fail to materialise. It has even been suggested that some of the works never existed, but were mentioned only to reassure Bacon's patrons in his requests for money that he was working, and not simply gambling his funds away (Clark, 2007).

It has been reported that Bacon brought Winsor & Newton oils from London to Tangier for a young Moroccan artist, Ahmed Yacoubi, who became his protégé (Sinclair, 1993, p.138). Therefore it is likely that Bacon would have done the same for himself and continue to paint with his usual materials where possible.

Destroying paintings

Bacon appears to have discarded many paintings throughout his career. An early article in Time magazine reports that Bacon has 'destroyed some 700 paintings to date' (Time, 1949). Isabel Rawsthorne writes in a letter thought to date from December 1948:

> 'He tells me he has destroyed all his last pictures. I would certainly like to destroy some of mine but I daren't' (Rawsthorne, 1948).

Cecil Beaton also describes the enthusiasm with which Bacon tells him he has destroyed Beaton's portrait in 1960, and reports him saying: ' ..I often destroy my work in any case; in fact I've destroyed most of the pictures for the Marlborough.' (Beaton, 1976)

In around 1976 John Edwards describes destroying ‘about twenty large canvases, many of which looked finished to me. I slashed them all into tiny bits with a Stanley knife. He insisted on this because in the past people had stolen discarded bits from the dustbin outside.’ (Edwards & Ogden, 2001).

Technique

Bacon did not receive any formal training and described himself as ‘lucky enough never to go to any art school’ (BBC, 1985). He said that he had little idea about technique and admitted to being influenced only by Picasso in terms of technique, attracted by his ‘rawness’ (Durham, 1985).

Very few accounts of Bacon at work exist. In 1960 Cecil Beaton sat for Bacon to paint his portrait and described him in action:

> ‘Francis started to work with great zest, excitedly running backwards and forwards to the canvas with gazelle-springing leaps – much toe-bouncing. He said how enthusiastic he was at the prospect of the portrait which he said would show me with my face in tones of pink and white.’ (Beaton, 1976)

Another interesting account is given by John Richardson, who visited Bacon in his Cromwell Place studio. He describes watching Bacon applying pan-cake make-up to his own face to practice the swooping movements of the brush to create his portraits:

> ‘The makeup adhered to the stubble much as the paint would adhere to the unprimed verso of the canvas that he used in preference to the smooth, white-primed recto.’ (Richardson, 2009)

Eddy Batache describes watching Bacon throwing paint when working on *Jet of Water,* 1979 (Batache, 1985). ‘Suddenly he put on a glove and hurled a pellet of white paint at the picture with all his might, crushing it against the canvas’. The thrown paint was then further worked on: ‘he set to work with astounding vehemence and in a few minutes the work was transformed and completed.’

Sylvester, writing about Bacon’s work in 1957 describes Bacon at work:

> ‘The paint is put on calmly, without violence or frenzy, for all the speed and spontaneity of execution. When Bacon is painting, his most characteristic gesture with the brush is a flick of the wrist made at arm’s length. Clearly he wants to distance himself from what he is painting, not to violate it.’ (Sylvester, 1957)

In the interviews carried out by Hugh Davies in 1973, some aspects of Bacon's practice of painting are revealed (Davies, 2009). Bacon said he usually began with the left hand panel of each triptych, moving from left to right. His restricted studio space meant it was not possible to view all three panels of a large triptych together. Bacon said he never did any sketches but started painting straight off, starting with the figure and putting the background in at the end, however Davies notes that paintings he observed in the studio at the time had elements of the background sketched out with a brush using black paint.

Some more details of Bacon's procedure of painting are described in the Sylvester interviews dated 1984-6:

> '...I sketch out very roughly on the canvas with a brush, just a vague outline of something, and then I go to work, generally using very large brushes, and I start painting immediately and then gradually it builds up ... I generally put the background in at the end.' (Sylvester, 1993, p.194-5)

Sylvester points out that this is very different from the earlier works in which a thin black or blue wash was used to stain the canvas, with the image painted on top (Sylvester, 1993, p.195), Bacon agrees:

> 'Yes, but then I used to put on very thin washes of colour. The paint was just mixed very thinly with turpentine and I put the whole wash on before I started putting the images down. But now I nearly always use acrylic paint for the backgrounds, and I don't want to work on the top of the acrylic because I like the absorption that the raw canvas has for the image.' (Sylvester, 1993, p.195)

Methods of actually applying paint are also described in some of Bacon's responses:

> '... I use anything. I use scrubbing brushes and sweeping brushes and any of those things that I think painters have used... I impregnate rags with colour, and they leave this kind of network of colour across the image.' (Sylvester, 1993, p.90)
>
> 'Sometimes I use a very large brush on portraits, because if you use very large brushes you can't control the way the bristles or the way the brush will make another mark that's quite unexpected and which may or may not be of some help to you.' (Saraben, 1996)

Throwing paint at the canvas is also discussed.

> '..I throw it with my hand. I just squeeze it into my hand and throw it on.' (Sylvester, 1993, p.90)

Bacon describes the techniques he is using as a way of getting away from an illustrative method of representation:

> '...the hopelessness in one's working will make one just take paint and just do almost anything to get out of the formula of making a kind of illustrative image – I mean, I just wipe it all over with a rag or use a brush or rub it with something or anything or throw turpentine or paint and everything else onto the thing to try to break the willed articulation of the image...' (Sylvester, 1993, p.160)

In discussing drawing, Bacon denies making sketches in the first Sylvester interview, dated1962:

> 'I often think I should, but I don't. It's not very helpful in my kind of painting. As the actual texture, colour, the whole way the paint moves, are so accidental, any sketches that I did before could only give a kind of skeleton, possibly, of the way the thing might happen.' (Sylvester, 1993, p.21)

A small number of sketches have now come to light, which *do* provide a 'kind of skeleton' to some compositions. These are usually very simple and may not have been considered by Bacon as drawings in the sense of a preliminary sketch made by one of the old masters he admired. Where he clearly did draw was on the canvas, with a thin paint applied with a dry brush. This 'underdrawing' can still be seen in many works, outlining features of the composition, especially because of Bacon's habit of leaving narrow margins of bare canvas around elements of the composition, such as between figures and backgrounds.

This distinction has led to some seemingly contradictory accounts, for example in the interview carried out as part of the 1966 documentary Bacon's answer is somewhat different:

> 'Yes I do, I nearly always make a sketch….I generally just make it out of thin paint ....especially in portraits I make a kind of outline of the position in which I want to try, I think I want to make the image, but after that chance and what I call accident takes over.' (BBC, 1966)

This part of the dialogue is not recorded in the published interviews, although the second interview in the book is based on the same exchange (Sylvester, 1993).

Major changes in composition are documented in some of Bacon's works, particularly in early abandoned works, for example the *Man getting out of car* and *Man with Microphones* (the fragments of which now form part of the Hugh Lane collection) pictured in Alley in both first and revised states (Alley & Rothenstein, 1964). Some paintings were photographed by his gallery before Bacon went on to make changes, as Bacon perceived he had let them out too soon (Sylvester, 1993). It is also reported that Marlborough Fine Art had to remove paintings from Bacon's studio otherwise they were in danger of being destroyed. This implies that the point at which works were thought finished might be flexible. An example of this might be seen in *Study for Portrait on Folding Bed*, 1963, which Bacon wished to add a green carpet to after its acquisition by the Tate, saying he had always intended to do this.[41] The *Triptych*, 1974 was first exhibited with a reclining figure in the foreground which was then painted out in 1977. The titles given to the works also give a feeling of being provisional, rather than definitive statements, with the frequent use of 'Study for', more often used by artists to denote a preparatory work.

Bacon does not appear to have been particularly aware of the conservation of his work, once remarking 'I don't know about the lastingness of things.' (Sylvester, 1993, p.192). He also commented on how his work might be viewed in the future and remarked how you never knew if you were 'any good' and if your work would continue to be well regarded. He wanted only his best work to survive, as demonstrated by his willingness to savagely destroy any paintings which didn't meet his own exacting standards. Ironically, many of his destroyed canvases do survive, although fragmentary, and have become desirable items in their own right for some, who are happy to own just a fragment of a Bacon work.

Glazing, framing and varnishing

In part of the interview with Sylvester broadcast in March 1963, the glazing of Bacon's pictures is discussed, as well as the lack of varnish on his works.[42] Bacon preferred his paintings to be shown behind glass, often in traditional gilt frames, unlike many modern artists who dispensed with frames entirely. Bacon gives two reasons – firstly because of the effect of separating them from their surroundings and secondly because of the materials he uses. Bacon explains that it would be impossible to use varnish because of his use of the reverse side of the canvas, much of which is only stained. He talks about wanting to 'make a chaos in an isolated area' which he can only do using 'this absolutely thin stained background against which I can do this image'. It appears that Bacon wishes to preserve the distinction between the matt canvas surface and his painting of the figure with thicker, more glossy areas of paint, which would be lost through the use of varnish. Glass is a substitute for unifying the painting and giving

[41] This offer was refused by the Tate, fearing the work would be significantly altered or even destroyed (Tate Modern painting caption, August 2010)

[42] Audio clip available at http://www.bbc.co.uk/bbcfour/audiointerviews/profilepages/baconf1.shtml This excerpt does not appear in the printed interviews.

added depth without losing this matt surface. Durham also reports that no final or intermediary varnish layers are used by Bacon during painting (1985).

Although the use of glass is undoubtedly beneficial for the protection of the delicate surfaces of these works from the accumulation of dirt, this is not cited as a motive by Bacon.

5.2 Studio materials

The materials in the studio were investigated using the database which was compiled when the studio contents were installed at the Hugh Lane Gallery. Access to the studio itself allowed a closer examination of some materials and the taking of samples for later analysis.

Care is needed in the interpretation of the studio contents as not all of the many tins, jars and tubes of materials there may have been used by Bacon to create his works. A tin of paint or varnish might have been employed elsewhere around the flat, then moved into the studio as a vessel for mixing other types of paint or for storing brushes, in the same way that numerous jars and tins that once contained marmalade, olives or butter beans are used in the studio. The paint contained in a tin may not be that described on the label, as examples have been found of paint mixed in food tins, or of a different colour to that expected from the label. However the duplication of many of the materials, in varying states from unused, through partly full, to empty, provides good evidence for their use in the studio, and it is likely that the majority were used on works of art. It can also be seen that, while at first glance the studio appears chaotic, there is in fact a distinct pattern to the distribution of many of the items which would be consistent with a systematic working environment.

The back wall of the studio appears to hold the oldest materials, with a considerable build-up of dust, and it is likely that the items here were used less often as the studio became increasingly filled up with material, making access to this area more difficult. The shelf below the mirror holds many tins of brushes, which appear much the same as in the photographs of George Dyer taken by John Deakin, dating from c.1964.

The table to the left of the mirror holds many paint tubes interspersed with paint-covered rags and clothing, and vessels used as palettes for holding and mixing paint, most frequently dinner plates. The database shows that in the lower layers of this material, tubes of an older design are to be found, and there is a marked increase in tubes of flake white, as opposed to the more modern titanium white which dominates the upper layers. The contents of this table therefore appear to have been laid down over a considerable period of time, with the earliest layers being relatively undisturbed by later activity. The shelf below the mirror already appears cluttered with jars of brushes, and the table piled high with rags and paint tubes in the 1966 documentary, just five years after Bacon moved in to the studio (BBC, 1966).

On the shelving unit opposite the door different types of material can be found – there are numerous tins and jars of pigment, and most of the cans of spray paint in the studio are also to be found here. A plate of fine sand is on the second shelf down, and on lower shelves are several tins of household emulsion paint. These materials point to this area having been used the most recently, as spray paints are only apparent on paintings from the late 1970s up to the final *Triptych 1991*. Cans of household emulsion paint also spread across the floor in front and to the left of these shelves. More tins are housed in another area on the floor behind the door.

Periodic clearance of the studio is recorded, where large amounts of material were removed. John Edwards describes removing ten dustbin bags of material from the studio soon after meeting Bacon in 1976, filled with 'newspaper cuttings, magazines, old books and tins of old paint hardened by the years and beyond use' (Edwards & Ogden, 2001). The remaining items therefore may represent a somewhat random selection, particularly of older items, though the most recently used items are more likely to be represented. Many duplicates of most types of materials are present.

The daubs of paint on the walls spread to different areas over time, as evidence from photographs shows. Many of the paint strokes around the mirror are visible in John Deakin's photographs of George Dyer from c.1964. In a documentary from 1964 these areas of paint are also seen, but the door and walls to the immediate left of the door appear largely unmarked (Koralnik, 1964). A photograph of Bacon in the studio from 1970 shows one section of wall which appears much as it does now, with another area above the radiator less filled with paint than at present. In the photo the section of wall over the table has many white and blue daubs, but now is predominantly black. Many of the paint daubs on the outside of the door are present in a photo from 1984, though a few additional patches applied after this can be identified from its present state.

5.2.1 Summary of materials found, including results of analysis

More than one hundred samples of material were collected from the studio, from a range of different items including paint tins, tubes, spray cans, pigments and pastels.

Pigments

Several jars, tins and packets of pure pigment were found, summarised in table 5.3.

Table 5.3 Containers of dry powdered pigments found in the studio

Manufacturer	*Colour*	*No.*
LeFranc & Bourgeois	Raw sienna	1
	Raw umber	2
	Alizarin crimson	9
	Cadmium red-orange	11
	Cadmium yellow-orange	13
	Cadmium red	4
	Cadmium red light	2
	Cadmium yellow lemon	2
	Cadmium yellow sulphide	2
	Emerald green	4
	Titanium white	2
	Black	1
Winsor & Newton	Titanium white dry ground	2
	Flake white pigment	1
	Winsor orange (Napthalene Carboxylic Acid)	2
	Lemon yellow deep (Barium chromate)	1
	Rose madder	5
	Chrome lemon	19
	Cobalt blue	2
	Cobalt violet dark	1
	French ultramarine	2
	Winsor yellow	3
	Cadmium lemon	5
	Cadmium orange	1
	Vermilion scarlet	1
	Zinc white	1
Cornelissen	Rose Madder genuine	3
	Cadmium yellow-orange	1
Unknown	Plastic container of cadmium orange	1
	Tin of Cobalt Blue pigment	1

Most containers of pigment were found on the top shelf of the unit opposite the door (this shelf has the catalogue number RM98F19 in the Hugh Lane Gallery's database) and on the shelf below the mirror (RM98F209). The majority are supplied by either LeFranc & Bourgeois or Winsor & Newton. Cadmium orange appears to be the most popular pigment, with 11 containers of cadmium red-orange and 13 of cadmium yellow-orange. There is also quite a large quantity of genuine rose madder, with one large paper packet and another glass jar. Two tubs of Rowney orange powder paint were also found, which appear to be the inexpensive water-mixable paints commonly used by children in schools. This would be a much less hazardous material to use than the cadmium orange pigments, but there is less evidence of it being used by Bacon, as neither of the tubs appear to have been opened, in contrast to the several empty tins of cadmium orange pigment. Samples were taken from several jars of pigment, including cadmium orange, alizarin crimson and rose madder. The results of analysis are shown in table 5.4.

Table 5.4. Analysis of pigment samples from studio

	Sample	*Composition*	*Analytical methods*
S5	Winsor Orange	PO43 (perinone orange)	FTIR
S8	L&B cadmium red-orange (cadmium sulphide)	Cadmium sulpho-selenide with barium sulphate	FTIR, SEM-EDX
S9	L&B cadmium yellow-orange (cadmium sulphide)	Cadmium sulpho-selenide (lower proportion of selenium than in S8) with barium sulphate	FTIR, SEM-EDX
S11	Winsor yellow	PY1 (arylide yellow)	FTIR, PyGCMS
S73	Rose Madder genuine	Aluminium hydroxide lake base	FTIR, SEM-EDX
S76	L&B Alizarin crimson	Alizarin crimson (PR83)	FTIR, SEM-EDX
S77	W&N Rose madder	Aluminium hydroxide lake base	FTIR, SEM-EDX
S78	W&N chrome lemon	Lead chromate with lead sulphate	FTIR, SEM-EDX

The alizarin crimson pigment was found to contain the elements aluminium, phosphorus and calcium when analysed by SEM-EDX, a combination also found in a reference sample of this pigment (see figure 5.2). The aluminium and calcium would be expected from the reported structure of alizarin (PR83, see Appendix B, A.12), while the presence of phosphorus can be explained by the frequent inclusion of phosphates of aluminium or calcium in the manufacture of Alizarin, which are reported to 'considerably improve the resulting lakes' (Harrison *et al.*, 1957). This pattern of peaks for Al, P and Ca might therefore be used to provide evidence for the presence of alizarin crimson in paint samples.

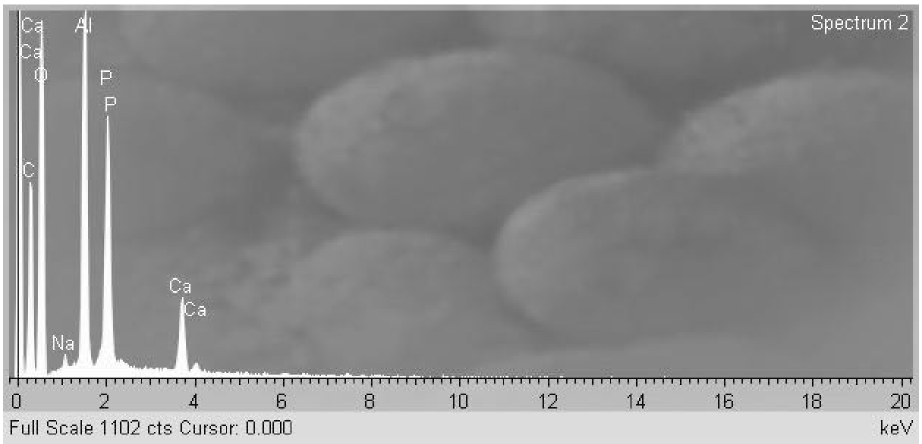

Figure 5.2. EDX spectrum of a reference sample of alizarin crimson pigment

Two vessels containing bright orange material, a small plastic bucket and rectangular baking tin (figure 5.3), were also sampled (S35 & S64). Both contained cadmium sulpho-selenide with barium sulphate, with no binder identified.

Pastels

A large wooden box of Talens Rembrandt pastels is open on the low table opposite the studio door. Another cardboard box of Rembrandt pastels was also found, and a box of Markal Artists Paintstik, described as 'permanent oil colours in stick form', which appear to be mostly unused. Several loose pastel sticks were scattered around the studio, also mostly Rembrandt brand. Samples were analysed from several of these materials (table 5.5).

Table 5.5 Analysis of pastels from studio

	Sample	*Composition*	*Analytical methods*
S12	Rembrandt pastel, blue	Ultramarine, viridian? Kaolin, barium sulphate	FTIR, PLM, EDX
S13	Rembrandt pastel, chrome green	Prussian blue & Chrome yellow Kaolin, barium sulphate	FTIR, PLM, EDX
S14	Flesh-coloured chalk/pastel	Iron oxide red/yellow, zinc white Kaolin, chalk, Barium sulphate	FTIR, EDX
S88	Markal paintstik, azo orange	Oil (p/s = 1.86), PO36 (arylide benzimdazolone)	FTIR, PyGCMS
S89	Markal paintstik, napthol red	Oil (p/s = 2.60), PR170 (Naphthol AS)	FTIR, PyGCMS

Spray paints and fixatives

The majority of spray paint cans were found on the shelving unit opposite the studio door. The colour of many of the Humbrol Krylon spray paint cans is not recorded in the database, probably because with this brand the colour is only identifiable from the cap, which was often missing. White appears to be the most popular colour (15), followed by black (7), red (5) and orange (5), as shown in table 5.6.

Table 5.6 Spray paint cans found in the studio

Make	*Details*	*No.*
Humbrol Krylon	Colour unknown	13
	Blue	1
	Black	1
	White	2
	Dark pink-red	1
	Red	1
U-spray	Matt white	13
	Matt, black	5
	Gloss, mid blue	3
	Gloss, black	1
	Gloss, deep green	4
	Gloss, pillar box red	2
Peinture aerosol	orange brillant	5
Unknown	red spray	1
	spray cap cherry red	2

In addition to spray paint, 12 cans of fixative were also counted, see table 5.7.

Table 5.7 Cans of fixative found in the studio

Details of can	*No.*
Letracote Matt (a quick drying lacquer coating for protecting Letraset)	1
Winsor & Newton Aerosol Fixative	6
Rowney Perfix Colourless Low Odour Fixative	3
LeFranc & Bourgeois Aerosol fixative	2

Nine cans were sampled by taking a scraping of dried paint drips around the nozzle. Red, orange, blue, white and black paints were sampled. Analysis of the samples of spray paint showed a variety of different binders are present, see table 5.8. Humbol Krylon spray-paint uses an acrylic methyl methacrylate / butyl methacrylate (MMA-BMA) copolymer, while several cans of 'U-spray' appeared to have a styrene-based polymer binder, as methyl-styrene was the main product detected using PyGCMS. The French 'aerosol peinture' appeared to have a nitrocellulose-alkyd binder.

Table 5.8 Analysis of Spray paint samples from studio

	Sample	*Composition*	*Analytical method*
S6	Peinture aerosol, orange brilliant	Nitrocellulose-alkyd, organic orange?	FTIR, PyGCMS
S7	U-spray red	Styrene-based polymer, organic red?	FTIR, PyGCMS
S10	U-spray blue	Styrene-based polymer, titanium white, organic blue?	FTIR, PyGCMS SEM-EDX
S61	Winsor & Newton Fixative	PVAc	FTIR, PyGCMS
S65	U-spray matt white	Styrene-based polymer, titanium white, chalk, silica	FTIR, PyGCMS SEM-EDX
S81	U-spray gloss, deep green	Styrene-based polymer, Prussian blue, phthalocyanine green	FTIR, PyGCMS SEM-EDX
S82	Humbrol Krylon spray paint, white	Acrylic MMA-BMA, titanium white, kaolin	FTIR, PyGCMS SEM-EDX
S97	U-spray black gloss	Styrene-based polymer, carbon black	FTIR, PyGCMS SEM-EDX
S98	U-spray matt black	Styrene-based polymer, chalk	FTIR, PyGCMS SEM-EDX

Paint tins

Many tins of household paint were found in the studio, mainly Carsons (54 tins) and Dulux brands (35 tins), with a small number from other manufacturers. The majority of these are described as ‘Vinyl Matt Emulsion’, with several tins from the Dulux ‘Trade’ range, described as a ‘High quality formulation for professional use’. Only three of the tins were recorded in the database as being gloss paint. Sixteen tins of paint were sampled, as summarised in table 5.9.

Four tins of Dulux paint were analysed, three of which were ‘Dulux Trade vinyl matt emulsion’. All three of these were found to have the same acrylic binder consisting of a Methyl methacrylate and 2-ethylhexyl acrylate (MMA/ 2-EHA) copolymer. Acrylic binders are less often used in household interior paints than PVAc, because of their greater expense. However they are more hard-wearing, which would explain their use in these ‘professional quality’ paints. The blue paint in the food tin (S67) also had this binder, so is probably also a Dulux paint. Kaolin was the principal extender found in all these samples, sometimes in combination with chalk. The remaining tin made by Dulux was from a different range, ‘Du-lite’, possibly of an earlier design. This paint had a PVAc binder with chalk and kaolin extenders.

Nine tins of Carsons paint were analysed, all but one were tins of vinyl matt emulsion and had a PVAc medium. This is a more usual component for everyday low-cost household emulsion paints. Five tins were from the Carsons 'Sunway' range (2 orange, 1 tan, 1 green) while 3 others were simply labelled 'Carsons Vinyl Matt'. The remaining tin (S87) was a gloss paint which had an ortho-phthalate alkyd medium.

Table 5.9 Analysis of samples of household paints from studio

	Material Sampled	*Medium*	*Pigments*	*Extenders*
S1	Carsons Sunway vinyl matt, yellow tint, orange	PVAc (with a little VeoVa[43]?)	Titanium white, Arylide PY1, disazo PR144/166/214	Chalk, kaolin
S2	Dulux Trade Vinyl Matt Emulsion, white	Acrylic (MMA/ 2-EHA)	Titanium white	Kaolin
S3	Dulux Trade Vinyl Matt Emulsion, pale blue	Acrylic (MMA/ 2-EHA)	Titanium white	Kaolin, chalk
S4	Dulux Trade Vinyl Matt Emulsion, orange	Acrylic (MMA/ 2-EHA)	Arylide yellow PY74, unidentified organic red/orange	Kaolin, chalk
S67	Blue paint in green food tin	Acrylic (MMA/ 2-EHA)	Titanium white	Kaolin
S68	Carsons vinyl matt pale, pink-purple	PVAc, phthalate plasticiser	Titanium white, iron oxide	Chalk, kaolin
S69	Carsons vinyl matt pale, purple	PVAc-VeoVa	Titanium white	Kaolin
S70	Carson Sunway vinyl matt, deep tint, tan	PVAc	Iron oxide, titanium white	Chalk, kaolin
S71	Carsons vinyl matt, vibrant, green	PVAc	Arylide yellow, probably PY65, PY73 or PY74	Chalk
S80	Chalkboard paint	Oil, p/s = 3.04	Carbon black?	Chalk, dolomite?
S83	Carsons Sunway vinyl matt, yellow tint, orange	PVAc (+ a little butyl acrylate)	Arylide yellow PY1, PY166/144/214, titanium white	Chalk, kaolin
S84	Du-lite emulsion, mushroom tint	PVAc	Iron oxide	Chalk, kaolin
S85	Blackboard black	Ortho-phthalate alkyd, p/s = 4.00	Carbon black?	Chalk
S87	Carsons full gloss vibrant	Ortho-phthalate alkyd, p/s=0.98	Titanium white, PG7, iron oxide	
S91	Carsons Sunway vinyl matt, vibrant tint, dark green	PVAc,phthalate plasticiser	Titanium white, iron oxide	Chalk, kaolin
S96	Carsons Sunway Colours vinyl matt, vibrant tint, yellow-orange	PVAc	Iron oxide	Barium sulphate, chalk

[43] Vinyl versatate resin, a mixture of highly branched C_9 and C_{10} vinyl esters added as an internal plasticiser (Learner, 2004)

Household paints were found in a range of colours including purple, blue, green, tan and orange, with white the most common colour. For many of the tins listed in the database, colour was not recorded, as the paint was in a generic tin with no colour information on the outside. In the paints analysed, pigments generally appear to be present in low concentrations, making them difficult to identify, with large amounts of extenders, usually chalk and kaolin. Synthetic organic pigments were identified in three orange paints analysed, and iron oxide pigments in several others. We would expect fairly cheap, non-toxic pigments with high tinting strength to be used in this kind of paint.

Two tins of blackboard paint sampled, S80 and S85, had oil and alkyd binders respectively, but appear quite matt, probably due to large amounts of chalk extenders. This extender is often used in blackboard paint to give a matt toothed surface (Crook & Learner, 2000).

Figure 5.3 orange material in plastic bucket (S35) and baking tin (S64) found in studio

Figure 5.4. Fabrics on studio floor in front of back shelves, left to right: corduroy fragment, dishcloth, brown knitted sweater.

Tools

Many brushes of varying sizes were found in the studio, including both artists' and household types, and a great many paint rollers. Other tools include palette knives and cutlery used for mixing paint/pigments. Plates, dishes and tins were used as receptacles for mixing colours, as were pieces of card and discarded canvases. The walls and door of the studio also acted as paint palettes. Several pieces of card and boards from books were found with areas of spray paint, which appear to have been used to mask off areas of the composition when applying spray paints. Some jar lids appeared to have been used to print circles on paintings, such as those seen around the keyhole and fingers of the figure in the central panel of *Triptych: In Memory of George Dyer,* 1971.

Rags and pieces of cloth with paint accretions were present in several areas, including white knitted dishcloths, woollen sweaters and pieces of corduroy fabric, probably cut from pairs of trousers (see figure 5.4). Some of these may have been clothes to be worn whilst painting, or might be simply rags to wipe hands or brushes on, but many show signs of having been used to apply paint. The corduroy would impart a striped effect, while the knitted texture of the dishcloths and sweaters would give a herringbone pattern when printed into paint. The narrower, more widely spaced threads used in the dishcloth would probably give a more distinct pattern. Paint samples were taken from pale pink and pale blue stains on a piece of corduroy fabric, and from orange and yellow paint stains on two knitted cloths (probably dishcloths), see table 5.10.

Table 5.10 Analysis of paint samples taken from fabrics in studio

	Sample	*Composition*	*Analytical methods*
S26	Pink paint from corduroy rag	Oil (p/s = 3.42), Titanium white, Al from pink lake base – permanent rose?, Magnesium carbonate, barium sulphate	FTIR, GCMS, SEM-EDX
S27	Light blue paint from corduroy (same as S26)	Oil, Titanium white, Prussian blue, Barium sulphate, magnesium carbonate	FTIR, SEM-EDX
S41	Orange paint from dishcloth	Cadmium sulphide-selenide with Barium sulphate	FTIR, SEM-EDX
S49	Orange-white paint on fine knit beige cloth	Titanium white, Perinone PO43 (Winsor orange), cadmium sulphide-selenide, kaolin	FTIR, SEM-EDX
S50	Yellow paint on beige cloth (same as S49)	Titanium white, arylide yellows PY1 & PY3, kaolin	FTIR, PyGCMS

Paint tubes

Many tubes of oil paint were found in the studio, most of which are made by Winsor & Newton, although a small number were produced by Rowney. Very few tubes of acrylic paint were recorded, all of which were Rowney Cryla brand (3 cadmium yellow pale, 2 cobalt blue, 2 ultramarine, 1 vermilion hue). The numbers of tubes of the different oil colours were counted using the database, to discover which were most abundant, as shown in figure 5.3. Flake white was present in the greatest quantities, followed by lamp black, permanent rose, titanium white, alizarin crimson and raw umber. In addition to these a further 18 colours were observed, of which 1-3 examples were found: Terra d'Ombre, Cadmium yellow pale, Cadmium yellow deep (3); Winsor lemon, Winsor emerald, Vermilion, Davy's grey, Cobalt green, Cadmium orange, Aureolin (2), Winsor violet, Terre verte, Terra rosa, Permanent mauve, Lemon yellow, Indian red, Harrison red, Charcoal grey (1).

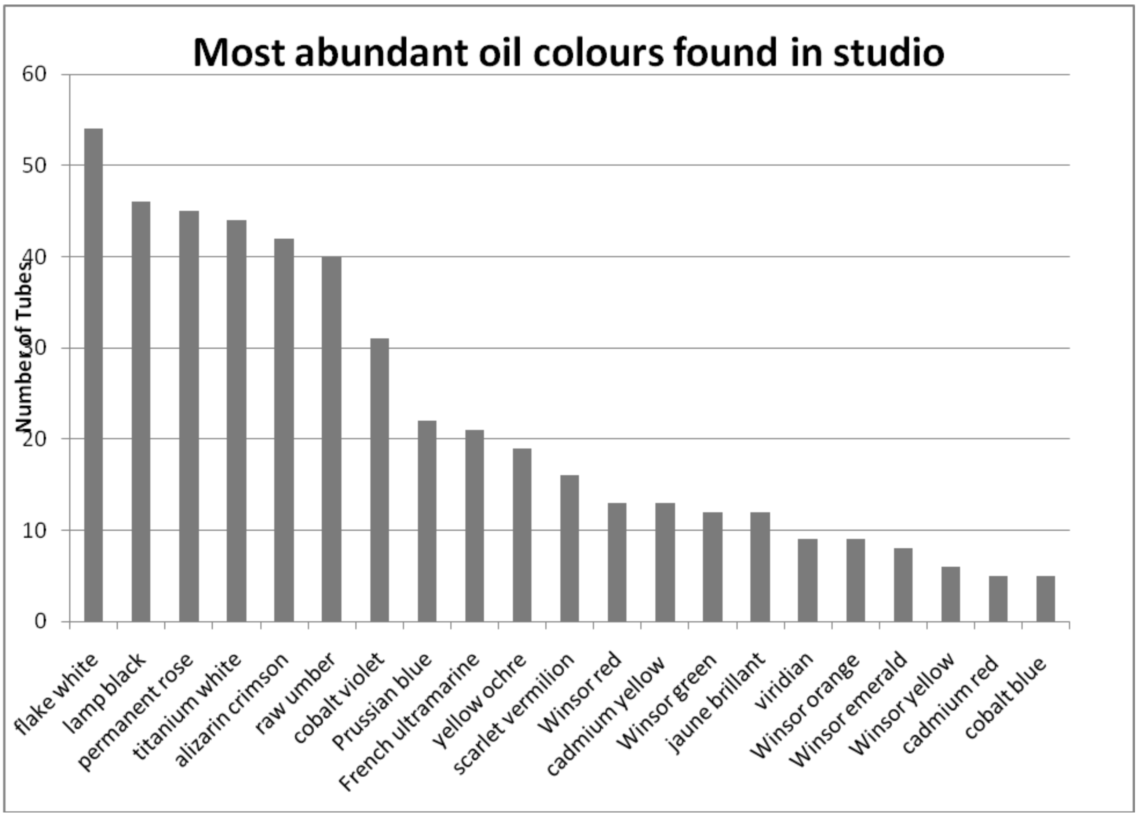

Figure 5.5 Number of tubes of oil paints of different colours

Table 5.11 Analysis of samples taken from paint tubes

	Material Sampled	*Medium*	*Pigments*	*Extenders*	*Method*
S15	Universal stainer, red	Oil, p/s = 1.72	Organic red PR144 or PR166	Chalk	FTIR, PyGCMS
S16	Roberson viridian	Oil	Viridian		FTIR, EDX
S17	W&N oil colour, Winsor red 173	Oil, p/s = 1.42	Naphthol AS PR188	Magnesium carbonate	FTIR, PyGCMS
S18	W&N permanent rose(?)	Oil, p/s = 4.70	Unidentified. Al from lake base?	Magnesium carbonate	FTIR, EDX, GCMS
S20	W&N oil colour, Alizarin crimson[44]	Oil, p/s = 2.75	Alizarin crimson	Barium sulphate	FTIR, EDX, GCMS
S21	W&N oil colour, Jaune brillant	Oil	Lead white, zinc white, Cadmium yellow/red		FTIR, EDX
S29	W&N oil paint, Cobalt violet	Oil, p/s = 2.25	Ammonium cobalt phosphate hydrate		FTIR, EDX, GCMS
S30	W&N oil paint, Titanium white	Oil, p/s = 2.59	Titanium white, zinc white	Barium sulphate, magnesium carbonate?	FTIR, EDX, GCMS
S31	W&N oil paint, Winsor red 173	Oil, p/s = 1.60	Naphthol AS PR188	Magnesium carbonate	FTIR, GCMS
S32	W&N oil paint, green	Oil, p/s = 1.33	Phthalocyanine green PG7	Barium sulphate	FTIR, EDX, GCMS
S37	W&N oil paint, green	Oil, p/s = 2.68	cobalt green/blue, zinc white	Magnesium carbonate	FTIR, EDX, GCMS
S38	W&N oil paint, Winsor orange	Oil, p/s = 3.00	Arylide yellow PY1 & Naphthol AS PR188	Barium sulphate	FTIR, EDX GCMS, PyGCMS
S39	Rowney cadmium yellow	Acrylic EA, MMA	Cadmium yellow	Barium sulphate	FTIR, PyGCMS, EDX
S40	W&N oil paint, Flake white	Oil, p/s = 2.50	Lead white, zinc white		FTIR, GCMS, EDX
S48	Rowney oil color, crimson alizarin,	Oil	Alizarin crimson		FTIR, EDX
S66	Kingston Universal Stainer, red	Oil	Organic red PR7?	Chalk/ dolomite	FTIR, PyGCMS, EDX
S74	Rowney acrylic, cobalt blue	Acrylic EA,MMA	Cobalt aluminium oxide	Barium sulphate	FTIR, PyGCMS, EDX
S75	Universal stainer, permanent green.	Oil	Phthalocyanine green PG7	Chalk	FTIR, PyGCMS, EDX
S94	W&N oil colour, Permanent rose	Oil	Quinacridone PV19?	Magnesium carbonate	FTIR, EDX
S95	W&N oil colour, Raw umber	Oil	Iron oxide, manganese oxide	Silica, chalk	FTIR, EDX
S99	W&N oil colour, Winsor red	Oil	Naphthol AS PR188	Magnesium carbonate	FTIR, PyGCMS
S100	W&N oil colour, Winsor yellow	Oil	Arylide yellow PY1	Barium sulphate	FTIR, PyGCMS

[44] SEM-EDX of this sample and of S48 showed the same pattern of peaks for Al, P and Ca as seen in the pigment sample S76, see p124-5.

Many tubes of 'Universal stainer' were also found, a highly coloured paint used for tinting household paint. Most were made by the same company that produces Carsons paint. Analysis showed these had an oil binder and organic pigments, often with chalk extenders.

Several tubes of oil paint were sampled. Several Winsor & Newton colours contained magnesium carbonate extenders, found particularly in red shades. Barium sulphate was also found as an extender in some paints, see table 5.11. The two tubes of acrylic paint analysed were found to have an ethyl acrylate-methyl methacrylate binder.

Miscellaneous media

A few more unusual items were sampled, see table 5.12. The acrylic modelling paste, marble medium and polyurethane varnish were the only examples of these materials found in the studio. Seven bottles of the retouching varnish were found, four of which were empty and on the back shelf below the mirror. The remaining three, on the shelves opposite the door, appeared little used. The marble medium was also on the far back shelf, so might have been used only in the early days of the studio. The polyurethane varnish, on the floor inside the door, might have been used as a floor varnish rather than an artists' material.

Table 5.12 Analysis of miscellaneous samples taken from studio

	Sample	*Composition*	*Analytical method*
S19	Liquitex acrylic modeling paste	Acrylic (Ethyl acrylate / Methyl methacrylate), Chalk	FTIR, PyGCMS
S79	Parris Marble medium	Beeswax, oil (Az/P= 0.09, P/S = 12.23)	FTIR, GCMS
S90	Ronseal polyurethane varnish	polyurethane-oil (Az/P= 0.09, P/S = 2.89)	FTIR, PyGCMS
S93	L&B Vernis à retoucher	Hydrocarbon resin ?	FTIR, PyGCMS

5.2.2 Information from paint companies

Winsor & Newton

Winsor & Newton oil paint was most commonly used by Bacon, so some research has been carried out into their oil paint range to see if tubes in the studio can be dated from changes in design, colour name or number. A series of Winsor & Newton catalogues have been examined from the Winsor & Newton archive to discover how the range of colours available has changed. Each colour has a three digit code, which is listed in the catalogue and appears on the tubes themselves from 1963 onwards. The three-digit codes are revised in the 1972 catalogue, and again in the 1986 catalogue, although here both new and old codes are used on the tubes, the older number in parentheses. Where visible, these numbers can be used to approximately date the paint tubes in the studio. However, these dates are not entirely reliable as shops could be selling old stock.

Figure 5.6 shows the total numbers of tubes of certain colours with different codes indicating the different periods (looking at Winsor & Newton artists' oil colours only). There are also a number of tubes for which no colour code was recorded. In most cases this data was collected by going through the descriptions of tubes in the database entries. Where numbers are not recorded we usually cannot tell whether there is no number on the tube (suggesting a pre-1963 date), the number is illegible through paint spatters or damage to the label, or the number was simply not noted.

We can see that the only tubes with post-1986 date codes are titanium white and Winsor green. This is good evidence that these colours were used in the final years of Bacon's life, particularly titanium white, of which 10 such tubes were found. The relatively small number of recent tubes might indicate Bacon's palette was becoming more limited, or may just mean that he was still using his existing supplies of paints, many of which, even now, still appear soft and usable. A third possibility is that a larger proportion of newer materials were removed during periodic clearances, as these are likely to be in the top 'layer' of material in the studio. Flake white is the only colour seen in large quantity from the period before 1972. Winsor green, Jaune brilliant, cobalt violet and scarlet vermilion are also well represented in this period.

The majority of the tubes in the studio appear to have been purchased between 1972 and 1986. It is notable that by far the most abundant colour dating from before 1972 is flake white oil paint. In contrast, no tubes of titanium white had legible pre-1972 codes, suggesting flake white was largely replaced by titanium white sometime after 1972. All the other most heavily used colours such as alizarin crimson, raw umber, permanent rose, lamp black and Prussian blue are predominantly from the 1972-1986 period. Winsor green was the only colour found from all three periods. Winsor emerald was introduced to the range in 1963 and Permanent rose (quinacridone) doesn't appear in catalogues until 1968.

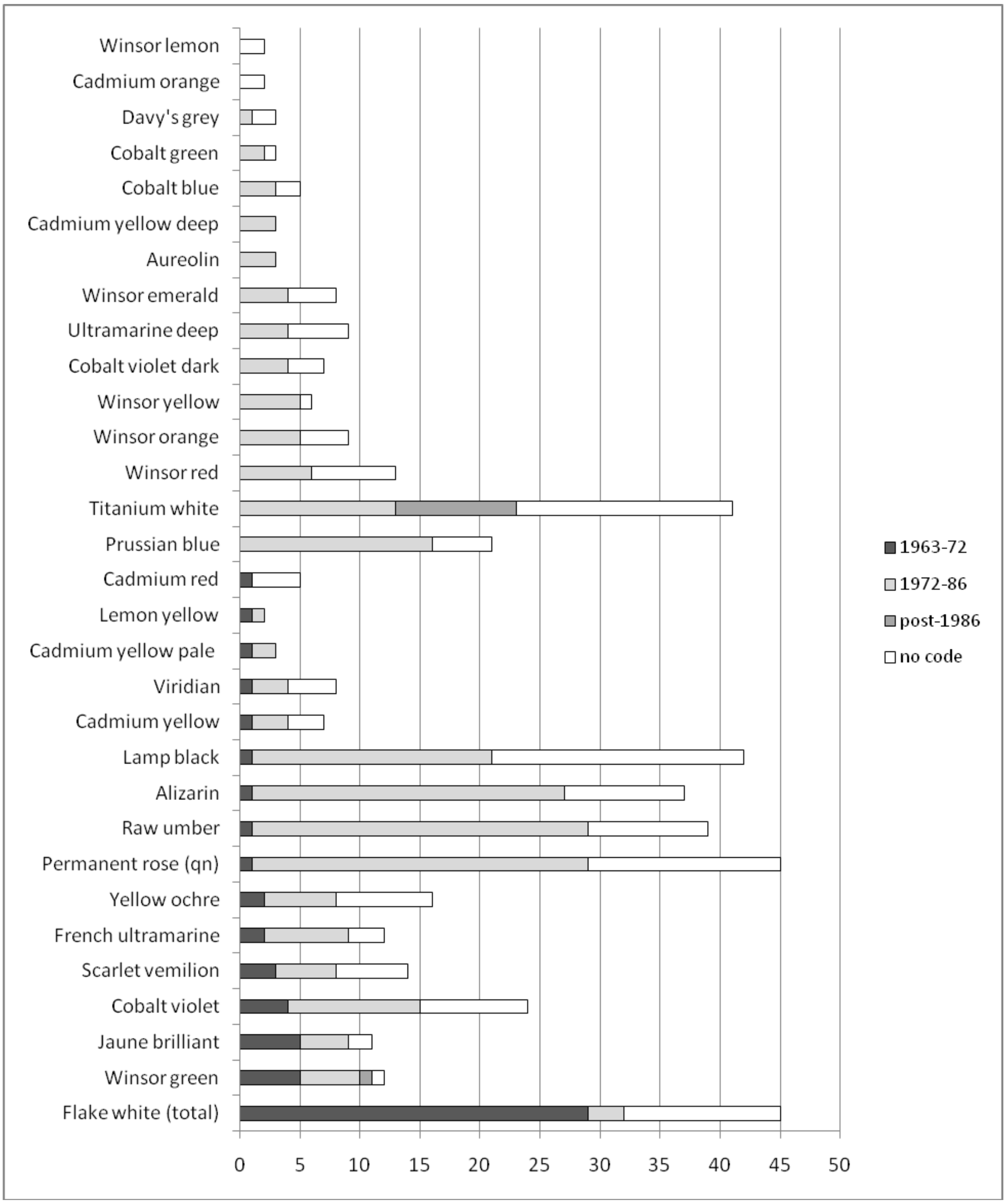

Figure 5.6 Chart showing numbers of tubes of Winsor & Newton oil colours from different dates

Some notable changes to the range of colours are outlined below:

- 'Cobalt violet' contained the pigment cobalt arsenate until 1977, when it was replaced by cobalt phosphate. 'Cobalt violet dark' has always contained cobalt phosphate
- Emerald green (copper aceto-arsenite) last appeared in catalogues in 1963. In the same year organic pigment Winsor emerald is introduced, based on chlorinated copper phthalocyanine with arylide yellows (reported as a mixture of PG7, PY1, PY3 and zinc white in 1977 catalogue).
- In the 1972 catalogue safflower oil is reported as the binder for white paints Flake white, zinc white and titanium white. Prior to this poppy oil is listed as the binder in these colours. Other colours appear to use linseed oil consistently.

Table 5.13 Pigments found in Winsor & Newton 'Winsor' colours*

Colour	*Paint / pigment*	*c.1984*	*1986*	*1990 cat*	*1993 cat*	*1997*
Winsor blue		PB15	PB15	PB15	PB15	PB15
Winsor emerald	Oil	PY1, PY3, PG7	PY3, PW4, PY1, PG7	PY3, PW4, PY1, PG7	PY3, PW4, PY1, PG7	PG36, PW4
Winsor green	Oil	PG7	PG7	PG7	PG7	PG7
Winsor lemon		PY3	PY3	PY3	PY3	PY3
Winsor orange	Oil	PR188, PY1	PY1, PR188	PY1, PR188	PY1, PR188	PY1, PR188
	Pigment			PO43		
Winsor red/fast red	Oil	PR188	PR188, PR172	PR188	PR188	PR188
	Pigment			PR168	PR168	PR168
Winsor violet	Oil	PV23, PV19, PB15	PV19, PB15, PV23	PV19, PB15, PV23	PV19, PB15, PV23	PV23 (dioxazine)
	Pigment			PV23	PV23	
Winsor yellow	Oil	PY1	PY1	PY4, PY3, PY1	PY4, PY3, PY1	PY74

*Pigments are listed in the same order as given in catalogues, believed to be listed with most abundant first.

The 'Winsor' colours are based on organic pigments, the composition of which has been changed periodically for some colours, see table 5.13. Colour index name codes, which allow us to identify the precise pigment used, only appear in catalogues from c.1984 onwards. Sometimes quite different pigments are used depending on whether the colour is sold as a dry pigment, oil, acrylic or alkyd paint. Most of these colours first appear in the 1948 catalogue, with the exception of Winsor emerald, as noted above. However, these are said to replace the earlier 'spectrum' colours, also based on organic pigments. Spectrum red and Spectrum yellow appear in catalogues at least from 1924 and are described as 'coal tar colour introduced in 1910'.

Alizarin crimson and Permanent Rose (quinacridone) were the most common synthetic organic pigments found in oil colours in the studio. Alizarin crimson is described as a 'lake from artificial alizarin' in catalogues from 1924 onwards, and as '1,2-dihydroxyquinone' in catalogues from 1968 and beyond. Both descriptions are likely to indicate the synthetic alizarin PR83 has been used throughout. Permanent rose (quinacridone) first appears in catalogues in 1968, where it is described as a quinacridone first produced in 1958. In the 1986 catalogue this is specified to be quinacridone PV19, industrial production of which began in 1958 (de Keijzer, 2002).

C. Roberson & Co.

Canvases prepared by C. Roberson & Co. appeared to have been used frequently, particularly the type known as '118'. The receipts for materials bought at Chelsea Art Store 1976-1980 include 100 canvases specified to have '118 on rev'[erse]. Several of the paintings examined had a stamp indicating they were prepared by Roberson. Two of the slashed canvases with dimensions of 164 x 142 cm, believed to date from the early1960s had Roberson 118 stamps, and two 78 x 58" paintings, one from c.1982, the other also believed to be from the 1980s, were also marked in this way. Five slashed 14 x 12" canvases had Roberson stamps, all but one also with the '118' mark, and several of these also had 1985 date stamps.

Roberson went into liquidation in 1985 and the brand was taken over by Cornelissen. We were not able to discover if records exist with information on when primings were changed, and of the recipes used. Analysis of the primings from Bacon's paintings will be discussed in chapter 6.

5.3 Conclusions

An overview of some materials and working techniques used by Bacon can be identified from documentary sources, however relatively little of this information is from independent sources, rather than originating from Bacon's own statements.

The studio should give us a clearer and less biased picture of the range of materials used. It contains large numbers of duplicates of certain materials, which we can be fairly confident were regularly used by Bacon. Artists' oil paints, mostly made by Winsor & Newton were found in the greatest quantities, and in addition to the colours catalogued here, many more tubes were found in which the label was missing or illegible. A small number of colours appear to have been heavily used, and many of the same colours bought frequently in 1976-80 (from receipts) are also the best represented in the studio, suggesting a sustained use of the same colours. Winsor orange is the only colour which was bought frequently in the late 70s but was not so significant in the studio contents, meaning it may have been used less heavily in later years.

Tins of household emulsion paint appear to have been used to a far greater extent than artists' acrylics, from the quantities found. And household gloss paints are also uncommon. Dry pigments also appear to be quite well represented, and these are not specifically mentioned in interviews. Pastels were found, but not in huge quantities, and many appeared little used. It is possible that when Bacon described using pastel to create intense orange backgrounds, he was actually using dry pigments such as cadmium orange. This would explain the large quantities of this pigment in jars and vessels around the studio, and the simultaneous lack of such intensely coloured pastels. The rose madder pigment might similarly have been used in backgrounds of works such as *Study for a Portrait of John Edwards*, 1989.

Some materials of which only one or two examples were found appeared to be little used, for example the acrylic medium and orange powder-paint, so might have been only briefly experimented with by Bacon before being abandoned in favour of other materials.

Chapter 6 Paintings

In this chapter the results from the examination and analysis of paintings are discussed. Firstly, the information gathered from the different components of the paintings is collated, including supports, primings, pigments and media. Tables arrange each category of material found, ordered by date. In the second part, Bacon's changing style and technique is discussed, by placing the works examined in the context of his oeuvre, identifying overall trends in his techniques and use of colour. In this way links can be drawn between the materials used and changes in style. Finally, the results from x-radiography of a small selection of works are examined. Reports for all works examined are included in Appendix E.

6.1 Results from the analysis of paintings

6.1.1 Supports

All but three of the works examined were painted on the reverse side of a commercially-primed canvas. Two early works were painted on a soft fibreboard, similar to the Sundeala board used for *Three Studies for Figures at the base of a Crucifixion*, 1944. In both of these works the support appeared to have been re-used; in one a piece of paper had been stuck to the board over an earlier composition, and the painting carried out on this second support, the other was painted over a composition by Roy de Maistre. The remaining work was on thin card, subsequently adhered to an unprimed canvas.

Most of the canvases appear to be of standard sizes, and match sizes used frequently by Bacon in his work, see chapter 5. For example, 12 works were on 78 inch high canvases, with widths ranging from 54 inches in 1951 to 58 inches from 1965 onward. The canvas always appears to be linen, with plain-weave pattern. The weave density varies, with a rather coarse canvas used in two early paintings examined, *Untitled (Figure Crouching)*, c.1950-1 and *Untitled (Figure in a Landscape)*, c.1950-2. A similarly coarse-looking canvas has also been observed in other works from similar date.[45] Many of the canvases examined from the 1960s had very similar thread counts, around 16 by 22 threads per cm^2. Many of the small 14 by 12 inch canvases also had similar thread counts, of around 20 by 20 threads per cm^2. In many cases the canvas surface appears to have been roughened before painting commenced, as raised fibres can often be seen on areas of bare canvas, and within paint layers.

[45] Similar coarse-weave canvases were observed on *Study after Velasquez, 1950, Pope I, 1951* and *Study of a Dog, 1952.*

Table 6.1 Details of supports of paintings examined

Title	*Date*	*Size (cm)*	*Size (inches)*	*Members* [46]	*Member dimensions*	*Joints*	*Attachment*	*Thread count /cm^2*	*P* [47]
FB01 Head	1949	82 x 66.5		4	5.1 cm	Mitred M&T[48]	steel tacks, 5mm	19 x 21	-
FB07 Head II	1949	80.5 x 65		6		Square, fixed	steel tacks, 5mm	15 x 14	
FB03 Untitled (Figure Crouching)	c.1950-1	179.5 x 120.6		-	-	-	-	12 x 12	A
FB10 Portrait of Lucian Freud	1951	198.5 x 137	78 x 54	7	5.1 cm	Square M&T	steel tacks 4mm	16 x 16	A
FB08 Untitled (Figure in a landscape)	c.1950-2	198 x 136	78 x 54	6	6.4 cm	Mitred M&T	staples (new), old tack holes	12 x 12	A
FB11 Study for Figure VI	1956-7	152.3 x 119	60 x 46.5	6	5.5 cm	Mitred M&T	grey metal tacks 5mm	16 x 16	A
FB17 Study for a Portrait of Van Gogh I	1956	152 x 115.6	60 x 46.5	6	6.1 cm	Mitred M&T	grey metal tacks 4-5mm	16 x 21	A
FB16 Two figures in a room	1959	198 x 142	78 x 56	6	6 cm	Mitred M&T	pale grey tacks, 5-6mm	14 x 15	A
FB06 Untitled (Pope)	1957-9	198.5 x 142	78 x 56	6	6.5 cm	Square M&T	staples (new), old tack holes	15 x 15	A
FB14 Head of a Woman	1960	85.2 x 85.2		4	5.3 cm	Mitred M&T	steel tacks, 5mm	14 x 15	A
FB13 Head of a Man	1960	38 x 32	15 x 12.5	4	4.4 cm	Mitred M&T	steel tacks, 4-5mm	14 x 15	A
F39 Untitled (figures on carpet)	1959-63	142 x 164.8	65 x 56	6	5.3 cm	Mitred M&T	light grey, 7mm	16 x 22	B
F51 Untitled (figure)	c.1960	155 x 140.3	61 x 55.5	6	5.8 cm	Mitred M&T	blue-grey metal, 6mm	16 x 22	C
F50 Untitled (figure on blue couch)	c.1962	164.4 x 142.7	65 x 56	6	6.3 cm	Mitred M&T	steel tacks, 6-7mm	16 x 22	B
F41 Untitled (figure study purple)	c.1962-3	198.5 x 145	78 x 57	6	5 cm	Mitred M&T	metal tacks, 7mm	16 x 22	A
FB09 Study for Self-portrait	1963	165.2 x 142.6	65 x 56	6	5.1-2 cm	Mitred M&T	grey metal tacks, 6mm	16 x 22	B
F54 Untitled (yellow/green figure)	c.1964	164 x 142	65 x 56	6	5.3 cm	Mitred M&T	grey metal tacks, 5mm	16 x 22	B

[46] In counting members, each cross bar is counted as one member, although it may be made of two separate pieces of wood.
[47] See table 6.2 on priming composition
[48] Mortise and tenon

Table 6.1 Details of Supports (continued)

FB15 Three studies for a Portrait of Isabel Rawsthorne	1965	35.6 x 30.5	14 x 12	4	2.9cm	Mitred M&T	pale grey tacks, 6-7mm	17 x 22	C
FB12 Henrietta Moraes	1965	198 x 147	78 x 58	6	5.2 cm	Mitred M&T	grey metal tacks, 6-7 mm	18 x 22	C
F48 Untitled (orange study)	c.1965	198 x 147	78 x 58	6	5 cm	Mitred M&T	grey metal tacks 6-7 mm	16 x 22	C
F226:4 Untitled (green portrait)	c.1967	35.5 x 30.6	14 x 12	4	3.1 cm	Mitred M&T	steel tacks, 6mm	18 x 22	C
FBA3 self portrait	c.1968	35.5 x 30.5	14 x 12	4		Square M&T	steel tacks	21 x 20	-
F65 Untitled (yellow figure study)	c1971	198.3 x 147	78 x 58	6	7 cm	Square M&T	grey metal 6-7mm	16 x 22	D
FB04 Figure going through doorway	c.1972	198.5 x 148	78 x 58	6	7 cm	Square M&T	steel tacks, 6mm	16 x 24	D
F245:8 Untitled (self-portrait in blue shirt)	c.1973	35.5 x 30.8	14 x 12	4	2.9 cm	Mitred M&T	light grey metal tacks, 6-7 mm	17 x 21	D
FB18 Three Figures and Portrait (T02112)	1975	198.1 x 147.3	78 x 58	6	6.7 cm	Square M&T	grey metal tacks, 6mm	16 x 17	D
FB05 Figure in cricket pads	c.1982	198.2 x 148	78 x 58	6	7 cm	Square M&T	steel tacks, 6mm	18 x 18	E
F206 Untitled (blue portrait)	1980s	35.2 x 30.8	14 x 12	4	5.2 cm	Mitred M&T	shiny metal tacks, 7mm	20 x 20	E
F204 Untitled (black portrait)	post-1985	35.7 x 30.6	14 x 12	4	5.1 cm	Mitred M&T	light grey metal tacks, 6.5-7 mm	19 x 20	F
F133:9 Untitled (self portrait)	post-1985	35.7 x 30.5	14 x 12	4	5.1 cm	Mitred M&T	light grey metal tacks, 6.5-7 mm	19 x 21	F
F122 Untitled (black portrait)	c.1989-90	35.8 x 30.6	14 x 12	4	5.1 cm	Mitred M&T	dark grey metal tacks, 6-7mm	19 x 20	F
F98 Untitled (black portrait)	c.1989-90	36.1 x 30.5	14 x 12	4	5.3 cm	Mitred M&T	grey metal tacks, 6mm	19 x 19	F
F36 Study for portrait	1986	198.3 x 147.3	78 x 58	7	5.1 cm	Mitred M&T	steel tacks, 5-6mm	14 x 18	
F85 Untitled (blue-green portrait)	1970s	35.4 x 30.5	14 x 12	4	5.2 cm	Mitred M&T	light grey metal tacks, 6.5-7 mm	17 x 22	D
F242 Untitled (orange canvas)	1980s	198 x 147.2	78 x 58	6	6.5 cm	Square M&T	grey shiny metal tacks, 6-7 mm	19 x 19	E

Head II was the only work examined to be on a strainer, all others were on softwood stretchers, see table 6.1. Mitred stretcher corners are more common, found on all stretchers from 1956 to 1967, except for one work, *Untitled (Pope)*, 1957-9.[49] Larger stretchers usually have one horizontal and one vertical cross bar, but two stretchers had a second horizontal cross bar (FB10, 1951 and F36, 1986). Many of the small portraits (14 x 12 in) examined had similar stretchers. Two different stretcher bar widths were commonly encountered, approx 3.0 cm and 5.2 cm, with the wider bars more common on later works. A pale grey galvanized tack of approximately 6mm diameter was the most common method of attachment.

6.1.2 Primings

Most of the commercial primings examined appeared to have a double layer of white priming, over a protein-based size. A size layer was not detected in all cases, but this may be because this lowest layer was not always collected in the sample, and does not necessarily mean it was not present. The two priming layers often appear very similar in cross-sections, and are sometimes only distinguishable under UV, but generally had different compositions, sometimes containing different pigments/extenders, sometimes with different proportions of the same pigments. The upper layer tended to have a higher proportion of white pigment and fewer extenders.

The composition of priming layers on the paintings examined are summarized in table 6.2. Comparison shows many of the paintings have the same type of priming, showing these canvases are likely to have been bought from the same supplier. The variation in pigments and binders allow us to classify the primings into several different types. The different categories appear to be associated quite closely with works from particular dates or of a particular size.

On all of the earlier paintings examined the priming was oil-based, with an alkyd priming first detected on a work from c.1971. A lead white-chalk priming was found on all canvases sampled from the 1950s and early 60s, which had a higher proportion of lead white in the upper layer and more chalk in the lower layer. The same priming was found on different canvas types, and in combination with different stretchers. In four paintings from the early 1960s a little kaolin was also present – all four were on the relatively unusual canvas size of 65 by 56 inches. Two of these also had a stamp indicating they were prepared by Roberson, with number ‘118’. A third oil-priming

[49] This work has been re-stretched and may not be on its original stretcher

composition was found on several other paintings from the 1960s, containing lead white and titanium white with kaolin used as the filler.

Table 6.2 Comparison of priming compositions

Painting	*Date*	*Size* [50]	*Top Layer*	*Lower Layer*	*Binder*	*Marks* [51]	*P* [52]
FB07	1949	-	Lead white		Oil (az/p = 0.71, p/s = 2.65)		
FB03	c.1950-1	-	Lead white, chalk	Chalk, Lead white	Oil (Az/P = 0.71, P/S = 2.23)		A
FB10	1951	Y (p)	Lead white, chalk	Chalk, Lead white, barium sulphate	Oil (Az/P = 2.29, P/S = 1.70)		A
FB08	1950-2	-	Lead white, chalk	Chalk, Lead white, barium sulphate	Oil (Az/P = 1.23, P/S = 2.32)		A
FB17	1956	Y (f)	Lead white, chalk	Lead white, chalk	Oil (Az/P = 1.30, P/S = 1.69)		A
FB11	1956-7	Y (p)	Lead white, chalk	Chalk, Lead white, barium sulphate	Oil (Az/P =1.21, P/S = 2.85)		A
FB06	1959	Y (f,p)	Lead white, chalk	Lead white, chalk, barium sulphate	Oil (Az/P = 1.54, P/S = 2.57)		A
FB16	1959	-	Lead white	Lead white, chalk, barium sulphate	Oil (Az/P =1.18, P/S =2.21)		A
FB14	1960	-	Lead white, chalk	Chalk, Lead white, barium sulphate	Oil (Az/P =1.40, P/S =2.63)		A
FB13	1960	-	Lead white	Lead white, chalk, silica	Oil (Az/P =0.68, P/S = 2.93)		A
F39	1959-63	Y (f,p)	Lead white	Lead white, chalk, kaolin	Oil (Az/P = 2.05, P/S = 2.20)	R 118	B
F51	1960s	Y (f)	Lead white	Lead white, kaolin, titanium white	Oil (Az/P = 1.30, P/S = 1.49)		C
F50	c.1962	Y (f,p)	Lead white	Lead white, chalk, kaolin, barium sulphate	Oil (Az/P = 0.48, P/S = 2.75)		B
F41	c.1962-3	Y (f,p)	Lead white	Lead white, chalk	Oil (Az/P =1.61, P/S = 1.61)	R?	A
FB09	1963	Y (f,p)	Lead white, chalk	Lead white, chalk, kaolin	Oil (Az/P = 0.61, P/S = 2.32)		B
F54	c.1964	Y (f)	Lead white	Lead white, chalk, kaolin	Oil (Az/P =1.82, P/S = 2.04)	R 118	B
F48	c.1965	Y (f,p)	Lead white	Lead white, titanium white, kaolin, barium sulphate	Oil (Az/P = 0.57, P/S = 2.07)		C

[50] f = fluorescent size layer identified in cross sections using UV microscopy, p = protein identified using FTIR
[51] R = Roberson canvas stamp, 118 = number 118 stamped/written on back
[52] Each different priming type has been given an identifying letter, also shown on table 6.1

Table 6.2 Comparison of priming composition (continued)

FB15	1965	Y (p)	Lead white	Lead white, titanium white, kaolin, barium sulphate	Oil (Az/P = 1.25, P/S = 2.16)		C
FB12	1965	Y (f,p)	Lead white	Lead white, Kaolin, Titanium white	Oil (Az/P = 0.65, P/S = 1.57)		C
F226:4	c.1967	Y (f,p)	Lead white	Lead white, titanium white, kaolin, barium sulphate	Oil (Az/P = 1.28, P/S = 1.87)		C
F65	c.1971	Y (f)	Lead white, kaolin, titanium white	Lead white, Kaolin, titanium white, barium sulphate	Alkyd (Az/P = 0.53, P/S = 1.50)		D
FB04	c.1972	-		Lead white, kaolin, titanium white	Alkyd (Az/P = 1.48, P/S = 1.86)		D
F245:8	c.1973	Y (f,p)	Lead white, kaolin, titanium white	Lead white, Kaolin, titanium white, barium sulphate	Alkyd (Az/P = 0.46, P/S = 1.60)		D
FB18	1975	Y (f,p)	Lead white, kaolin/silica, titanium white	Kaolin, Lead white, titanium white	Alkyd (Az/P = 1.53, P/S = 2.82)	118	D
FB05	c.1982	-	Lead white, kaolin/silica, titanium white	Lead white, Chalk?	Alkyd (Az/P = 0.71, P/S = 3.34)	R 118	E
F206	1980s	-	Lead white, kaolin/silica, titanium white	Lead white, chalk, talc, titanium white	Alkyd (Az/P = 1.31, P/S = 3.08	R	E
F204	Post-85	Y (f,p)	Titanium white, kaolin, lead white	Lead white, talc, titanium white, chalk?	Alkyd (Az/P = 0.52, P/S = 1.67)	R 118	F
F133:9	Post-85	Y (f,p)	Titanium white, kaolin/silica, lead white	Lead white, titanium white chalk	Alkyd (Az/P = 0.82, P/S = 1.91)	R 118	F
F36	1986	-	Lead white, titanium white, chalk	Chalk, zinc white	Acrylic MMA-BA Oil (Az/P = 2.23, P/S = 0.78)		
F98	c.1989-90	-	Titanium white, kaolin/silica, lead white	Lead white, talc, titanium white, chalk	Alkyd (Az/P = 1.07, P/S = 2.01)	R 118	F
F122	c.1989-90	Y (f,p)	Titanium white, kaolin/silica, lead white	Lead white, talc, titanium white, chalk, kaolin?	Alkyd (Az/P = 0.55, P/S = 1.43)	R 118	F
F85	1970s	Y (f,p)	Lead white, kaolin/silica, titanium white	Kaolin, lead white, titanium white, barium sulphate	Alkyd (Az/P = 1.46, P/S = 1.45)		D
F242	1980s	-	Lead white, kaolin/silica, titanium white	Lead white, titanium white, chalk	Alkyd (Az/P = 1.70, P/S = 2.01)	R 118	E

Four paintings from the 1970s appeared to have the same priming type, now with an alkyd binder. A written inscription on the 1975 canvas appeared to indicate this work had been prepared with '118' priming on the reverse.[53] Another three canvases from the 1980s appeared to have an ortho-phthalate alkyd priming with the same upper layer as the 1970s works, but now including chalk in the lower layer. All three of these appeared to be Roberson '118' canvases, showing the composition of this priming had been changed by the manufacturers since that used on the c.1964 canvas. Another different '118' priming was found on several small canvases dated 1985, with titanium white, kaolin and lead white in an alkyd binder. Examination of these canvases appears to show several changes were made by Roberson to their priming recipes, but we don't know exactly when these changes occurred, or if other variations might also have been used.

The painting examined from 1986 was the only work to have a unique priming type, but this may be because it was the only large work examined from the late 1980s. It was also the only priming to include an acrylic component, but also contained a drying oil, so may have used a different binder in the different layers.

The date of F41 is uncertain, but this canvas size (78 by 57 inches) was only used in relatively few works from 1962 & 3, being replaced by the slightly larger 78 by 58 inch canvas from c.1963. Figure turning, 1963 (also on a 78 by 57 inch canvas) shows many similarities in composition. The priming type might also suggest the painting was started in the late 50s to early 60s.

F51 was also of uncertain date. The canvas size, 61 x 55¼ inches is unusual and similar dimensions have been noted in only two other examples, *Seated man, orange background*, 1958 and *Portrait of Lucian Freud on orange couch*, 1965. The priming type matched that found on four works from 1965-7. The priming on F85 matched that found on several works from the 1970s, and this work might be related to the portraits of Peter Beard made in the 1970s with a similar green background.

[53] This was reportedly written on the stretcher bar, rather than stamped as was the case in other examples (as reported in Tate documentation, unfortunately the note could not be examined as it was covered with a stretcher-bar lining).

6.1.3 Pigments

The following results are compiled from the analysis of samples both from complete works and from slashed canvases. Some results of analysis carried out by other departments are also included by kind permission of the relevant institutions. Analysis was carried out at Tate of *Three Studies for figures at the base of a crucifixion* 1944 (Tate N06171) and of a sketch believed to be an earlier version of the right hand panel in this work, *Study for a Figure at the Base of a Crucifixion*, 1943-4 (Private Collection) (Townsend, 1997; 2000). Analysis of selected pigments has also been carried out at MoMA on *Painting* 1946 (Ordonez, 1985).

White pigments

In 24 of the paintings sampled, lead white was the principal white pigment, often identified in several samples. A small amount of zinc white was also usually identified, as a component often used in commercial formulations of lead white oil paint. Zinc white does not appear to have been used much as a pigment on its own, however, it was found as a component of several pale pink paint layers in *Head II*. Lithopone appears to have been used in *Untitled (Landscape)* as well as in *Three Studies for Figures at the Base of a Crucifixion* 1944, and in the Sketch, both analysed at Tate (Townsend, 1997). Its use in these works may be connected with the war period and the difficultly of obtaining materials.

Titanium white appears first in combination with synthetic media, but is not usually found in oil paints until much later. The earliest occurrence of titanium white was in *Untitled (Figure in a Landscape)*, c.1950-2, where it was present in combination with barium sulphate in an alkyd medium in many samples. Titanium white was also found in Figures in a Landscape 1954-5, unusually on a paper/card support, as part of a white ground layer and in a pale blue paint. Both of these works appear to be unusual, as all other works from the 1950s used only lead white. The next occurrence, in 1963, again has titanium white as part of a white alkyd paint, but all other colours include lead white. In canvases from c.1973 and 1975, lead white is still used for flesh paint, but in flesh paint from all paintings sampled from c.1982 onwards, titanium white was found. Some titanium white was detected in samples from the beige (oil paint) background in *Three Figures and Portrait*, 1975 (FB18), along with lead white and zinc white. This might show that titanium white oil paint started to be used around this time, and some was added into the sand and oil paint mixture along with lead white and yellow ochre paints.[54] Commercial oil paint formulations again use a small amount of zinc white to improve properties. Titanium white was also found in all synthetic household paints, usually with large amounts of extenders such as kaolin and chalk.

Table 6.3 White pigments found in samples from paintings

Painting	*Date*	*Material*[55]	*Analysis*	*Found in colours*	*Samples*
Sketch	1943-4	Lead white	EDX	White hide of fury, crimson flower	s8, 10
		Lithopone	EDX	White hide of fury, green & crimson flowers	s8, 9, 10
Tate N06171	c. 1944	Lead white	EDX	Yellow grass, black hind leg, orange, white blindfold, crimson	s2R, 3R, 9R, s3M, s4M, s5M, s6L
		Lithopone	EDX	Black hind leg, yellow grass, crimson	s3R, s9R, s4M
FBA1	c.1945	Lithopone	EDX	Grey, pink, yellow white	1, 2, 3
		Zinc white	EDX	White, yellow	3
FB07	1949	Lead white (+Zn)	EDX	White, blue, grey	1, 2, 3, 4, 6, 8
		Zinc white	EDX	White, grey, pink, orange	3, 4, 5, 7
FB01	1949	Lead white (+Zn)	EDX	White, grey, purple	1, 2, 3, 4, 5
FBA2	c.1949	Lead white (+Zn)	EDX	Grey, pink	1, 2, 3
FB03	c.1950	Lead white (+Zn)	EDX	Grey, pink, white	1, 2, 3, 4, 5
FB10	1951	Lead white (+Zn)	FTIR, EDX	Grey	1, 7, 9
		Zinc white	EDX	Green	2
FB08	1950-2	Titanium white (+Zn)	EDX	White, pink, orange, blue, lilac, green	1, 2, 3, 4, 5, 6, 7, 8
		Lead white (+Zn)	EDX	Lilac	5
FB02	c.1954	Titanium white (+Zn)	EDX	White, blue, pink, green	1, 2, 4, 5, 6
FB17	1956	Lead white (+Zn)	EDX	Grey, blue, green	3, 4, 6
		Zinc white	EDX	Green grass	2
FB11	1956-7	Lead white	EDX	Green stain	1, 4
FB06	1957-9	Zinc white – barium sulphate / lithopone?	EDX	White, blue-green, pink	5, 6, 10
FB16	1959	Lead white (+Zn)	FTIR, EDX	White, pink, purple, green	1, 2, 3, 4
FB14	1960	Lead white (+Zn)	FTIR, EDX	Green, white, pink	1, 2, 3, 4, 6

[54] This might indicate the two white pigments were being used more-or-less interchangeably.
[55] Pigments found as major component of at least one layer, '+Zn' indicates zinc white was found as an associated minor component.

FB13	1960	Lead white (+Zn)	FTIR, EDX	Blue-black, green, pink, grey	1, 2, 3
F39	1959-63	Lead white (+Zn)	FTIR, EDX	Pale blue, beige, pink	1, 2, 3, 4, 5
F51	1960s	Lead white (+Zn)	FTIR, EDX	Orange, pink	1, 2, 3, 6, 7
F50	c.1962	Lead white (+Zn)	FTIR, EDX	White, pink	2, 3, 4
F41	c.1962-3	Lead white (+Zn)	FTIR, EDX	White, beige, pink, green	2, 3, 4, 5
		Titanium white	EDX	Purple, white	1
FB09	1963	Lead white (+Zn)	EDX	Blue, yellow, pink	2, 3, 5, 6
		Titanium white	EDX	White background	4, 7
F54	c.1964	Lead white (+Zn)	EDX	Green, red, yellow, white, pink	1, 2, 3, 4, 5, 6, 7
F48	c.1965	Lead white (+Zn)	EDX	Red, pink	2, 3
FB15	1965	Lead white (+Zn)	EDX	Pink, green, pale pink	3, 4, 5, 6
FB12	1965	Lead white (+Zn)	FTIR, EDX	Blue, pink	1, 2
		Titanium white	EDX	White	4
F226:4	c.1967	Lead white (+Zn)	EDX	White, pink, green, yellow	1, 2, 3, 5, 6, 8, 9
FBA3	c.1967-8	Lead white (+Zn)	EDX	Green, white, yellow, white	1, 2, 3
F65	c.1971	Titanium white	EDX	Yellow	1
FB04	c.1972	Lead white (+Zn)	EDX	Green, pink	1, 2
F245:8	c.1973	Lead white (+Zn)	FTIR, EDX	Pink, blue	2, 3
FB18	1975	Lead white (+Zn)	FTIR, EDX	Beige, pink	3, 6, 8, 9
		Titanium white	EDX	Grey, orange, beige	1, 2, 3
FB05	c.1982	Titanium white	EDX	Grey, orange	1,3,7
		Titanium white (+Zn)	EDX	Pink	4, 5
F206	1980s	Titanium white	EDX	Pale blue, buff	1, 4, 7
		Titanium white (+Zn)	EDX	Pink	3
F204	Post-85	Titanium white (+Zn)	EDX	Pink	2, 4
		Titanium white	EDX	Purple	3
F133:9	Post-85	Titanium white (+Zn)	EDX	White, pink	1, 4
		Titanium white	EDX	Grey	5
F36	1986	Titanium white	EDX	White	5, 7
		Titanium white (+Zn)	EDX	Pink	1, 2
F98	c.1989-90	Titanium white (+Zn)	EDX	White, pink	2, 4, 5
F122	c.1989-90	Titanium white (+Zn)	EDX	Pink, grey	2, 3, 4
		Titanium white	EDX	Green	1
F85		Lead white (+Zn)	FTIR, EDX	Green, white, pink, blue	1, 2, 3, 4

Table 6.4 Black and brown pigments found in samples from paintings

Painting	*Date*	*Material*	*Analysis*	*Found in colours*	*Samples*
Sketch	1943-4	Ivory black	PLM	White hide of fury, Deep crimson	s8, 10
Tate N06171	1944	Ivory black	EDX	Black	s2M
		Carbon black	EDX	Black hind leg	s3R
FBA1	c.1945	Ivory black	EDX	Black-red	4
FB07	1949	Ivory black	EDX	Grey	2, 4, 6
		Raw umber	EDX	Grey	3
FB01	1949	Carbon black (lamp?)	EDX	Black	6
		Ivory black	EDX	Grey	6
		Raw umber	EDX	Grey	4
FB03	c.1950	Carbon black (lamp?)	EDX	Grey	4
FB10	1951	Carbon black (lamp?)	EDX	Grey, Black	1, 5
FB08	1950-2	Carbon black (lamp?)	EDX	Black	3, 8
FB02	c.1954	Carbon black (lamp?)	EDX	Black	1, 6
		Raw umber?	EDX	Pink-red	1, 6
FB17	1956	Ivory black	EDX	Grey	3
		Raw umber	EDX	Dark green	6
FB06	1957-9	Ivory black	EDX	Black-blue	2, 3
F39	1959-63	Ivory black (1 particle)	EDX	Black-blue	2
F50	c.1962	Carbon black (lamp?)	EDX	Black	4
FB12	1965	Carbon black (lamp?)	EDX	Black-grey	5
F245:8	c.1973	Carbon black (lamp?)	EDX	Black background	6
FB18	1975	Iron oxide	EDX	Beige	3, 9
FB05	c.1982	Carbon black	EDX	Black	8
		Iron oxide brown	EDX	Brown	1, 2
F206	1980s	Iron oxide brown	EDX	Buff	7
F204	Post-85	Carbon black (lamp?)	EDX	Black background	1
F133:9	Post-85	Carbon black (lamp?)	EDX	Black background	3
F36	1986	Carbon black	EDX	Black background	4
F98	c.1989-90	Carbon black	EDX	Black background	1, 3
F122	c.1989-90	Carbon black	EDX	Black background	1, 2, 5

Black and brown pigments

Black pigments were frequently difficult to identify. Ivory black can be identified though the presence of calcium phosphate, but the presence of wholly carbon-based blacks could usually only be inferred from the lack of other elements identified using EDX. Ivory black was identified in some works from the 1940s and 50s, and appears to have been more commonly used in early works. In other paintings a carbon-based black was thought to be present, likely to be lamp black. Raw umber was identified in several samples from the combination of iron and manganese, see table 6.4.

Many works from the 1980s use a black background, and several different types of black paint were found in different works, although all appeared to use a carbon-based pigment. An alkyd paint with a high proportion of chalk was found in *Study for Portrait*

1986, thought to be a blackboard paint, as it closely matched a tin found in the studio. A black PVAc-based paint was found in two other works.

Table 6.5 Blue pigments found in samples from paintings

Painting	*Date*	*Material*	*Analysis*	*Found in colours*	*Samples*
Sketch	1943-4	Phthalocyanine blue	PLM	Green of flowers, yellow grass	s9, s11
FBA1	c.1945	Ultramarine	EDX	Blue grass	3, 5
FB07	1949	Cerulean	EDX	Grey, blue under grey	2, 3, 4, 6
		Cobalt blue?	EDX	Blue under grey	3
		Phthalo blue ?		Blue under grey	6
FB01	1949	Cerulean	EDX	Blue spots	4
FBA2	1949	Cobalt blue	EDX	Grey	1
FB03	c.1950	Ultramarine	EDX	Pink	1
FB10	1951	Ultramarine	EDX	Green	3
FB08	1950-2	Prussian blue	FTIR, EDX	Blue	2, 6, 8
		Ultramarine	EDX	Blue-lilac	1, 4, 8
		Cerulean blue	EDX	Pale blue	4, 8
FB02	c.1954	Prussian blue	EDX	Dark blue	4
FB17	1956	Prussian blue	FTIR, EDX	Blue stain, dark background, green	2, 3, 4, 6
		Ultramarine	EDX	Blue-grey	3
		Cerulean	EDX	Blue underlayer	6
FB06	1957-9	Prussian blue	FTIR, EDX	Dark blue	1, 2, 8
		Ultramarine	EDX	Bright blue	3, 8, 11
		Cerulean blue	EDX	Blue-green	10
FB16	1959	Ultramarine	EDX	Purple	3
FB13	1960	Prussian blue	FTIR, EDX	Blue background	1
F39	1959-63	Prussian blue	FTIR, EDX	Pale blue, blue stain	1, 4, 6
F50	c.1962	Prussian blue	FTIR, EDX	Blue couch	1
F41	1962-3	Prussian blue	FTIR, EDX	Blue-black, blue-pink	2, 4
FB09	1963	Prussian blue	FTIR, EDX	Blue couch	2
FB15	1965	Prussian blue	FTIR	Green background	4
FB12	1965	Prussian blue	FTIR, EDX	Blue couch	1
FB04	c.1972	Prussian blue	EDX	Green outline	1
F245:8	c.1973	Prussian blue	FTIR, EDX	Blue shirt, face	3, 5
		Cobalt blue	EDX	Blue on face	5
FB18	1975	Prussian blue	EDX	Blue from figure	6
		Ultramarine?	EDX	Grey	5
F206	1980s	Prussian blue	EDX	Blue stain	5
F85		Prussian blue	FTIR, EDX	Blue stain	3, 4
		Ultramarine	EDX	Green background	1

Blue pigments

Prussian blue appears to be the most frequently used blue pigment, see table 6.5. It was found as an initial staining layer in *Untitled (Figure in a Landscape)* c.1950-2, *Study for a Portrait of Van Gogh I*, 1956 and *Untitled (Figures on carpet),* 1959-63. It is likely that the same pigment was used on other works with a dark blue ground, such as the *Man in Blue* series. The blue couches in F50 and *Study for Self-portrait,* 1963 also use Prussian blue, in the latter case mixed with lead white. Ultramarine, cerulean and cobalt blues were also fairly commonly used, with some works, such as *Head II* 1949 and *Study for a Portrait of Van Gogh I,* 1956 using at least 3 different blue pigments.

Green pigments

Most green-coloured paint samples were found to contain green pigments viridian or phthalocyanine green, rather than being mixed from blue and yellow.

Table 6.6 Green pigments found in samples from paintings

Painting	*Date*	*Material*	*Analysis*	*Found in colours*	*Samples*
FB07	1949	Viridian	EDX	Grey	4
FB01	1949	Phthalocyanine green	EDX	Green smear	7
FB10	1951	Viridian	EDX	Green shadow	2, 3
FB02	c.1954	Viridian	EDX	Green grass	3, 5
FB17	1956	Viridian	EDX	Green grass, green underlayer	2, 6
		Phthalocyanine green	EDX	Green underlayer	6
FB11	1956-7	Phthalocyanine green	FTIR, EDX	Green stain	1, 4
		Emerald green	EDX	Green edge	2
FB16	1959	Phthalocyanine green	EDX	Green stain	4
FB14	1960	Phthalocyanine green	EDX	Green stain	1, 2, 6
F41	c.1962-3	Phthalocyanine green	EDX	Green	5
F54	c.1964	Phthalocyanine green	PLM	Green-yellow background	1
FB15	1965	Phthalocyanine green	EDX	Green background	4, 5, 6
F226:4	c.1967	Viridian	FTIR, EDX	Green background	1, 9, 3
		Phthalocyanine green	FTIR, EDX	Green background	1, 9
FBA3	c.1967-8	Phthalocyanine green	FTIR, EDX	Green background	1, 4
F65	c.1971	Phthalocyanine green	EDX	Green outline	2
FB04	c.1972	Phthalocyanine green	EDX	Green outline	1
FB05	c.1982	Phthalocyanine green	EDX	Grey-green	7

Green smears and shadows are found in several works with a predominantly grey palette completed from 1949 to the early 1950s. In most cases the pigment used was viridian. A lighter green made from a mixture of viridian and cadmium yellow was found in two paintings from 1951 and 1956. In many works from the late 1950s and 1960s, a thin bright green stain was used as the background, being particularly common in works from 1959-60. Three works were examined which had this green layer applied to the canvas as a first step, and in all cases was found to be phthalocyanine green PG7, see table 6.6. Emerald green was the only other green pigment identified, but was found on only one work, on the edge of the canvas.

Yellow pigments

Table 6.7 Yellow pigments found in samples from paintings

Painting	*Date*	*Material*	*Analysis*	*Found in colours*	*Samples*
Sketch	1943-4	Cadmium yellow	EDX	Orange, flowers, yellow grass	s1, s2, s7, s9, s11
Tate N06171	1944	Chrome yellow	EDX	Yellow grass, teeth	s1R, s2R, s4M
		Cadmium yellow	EDX	Yellow grass, orange,	s1R, s5R,s7R, s9R, s1M, s6M
FBA1	c.1945	Cadmium yellow	EDX	Yellow under pink foreground	3
FB07	1949	Cadmium yellow	EDX	Orange, grey	4, 7
FB03	c.1950	Barium chromate	EDX	Pink	1
FB10	1951	Cadmium yellow	EDX	Green	2
FB08	1950-2	Cadmium yellow	EDX	Yellow	1
FB02	c.1954	Chrome yellow (lead chromate)	EDX	Yellow	5, 7
FB17	1956	Cadmium yellow	EDX	Green grass, yellow, light green	2, 3, 6
		Arylide yellow PY1	FTIR, PyGCMS	Yellow strap	7
FB11	1956-7	Cadmium yellow	EDX	Yellow	S1, 4
F39	1959-63	Barium chromate	EDX	Flesh	2, 3
		Yellow ochre	EDX	Yellow	4
FB09	1963	Cadmium yellow	EDX	Yellow	3, 6
F54	c.1964	Cadmium yellow	EDX	Green, yellow	1, 3, 4
FB15	1965	Barium chromate	EDX	Pink flesh	6
FB12	1965	Barium chromate	EDX	Pink	2
F226:4	c.1967	Yellow ochre	EDX	Yellow	5
FBA3	c.1967-8	Barium chromate	EDX	Grey-green	1, 2
F65	c.1971	Arylide yellow PY1	EDX	Yellow background	1
FB04	c.1972	Barium chromate	EDX	Green outline	1
FB18	1975	Cadmium yellow	PLM, EDX	Yellow	5
FB05	c.1982	PY1	PyGCMS	Orange background	3

Cadmium yellow was found in the background of F54, and was also used as a component of mixed greens in *Study for a Portrait of Van Gogh I* (FB17, with viridian), see table 6.7. Winsor yellow (arylide PY1) was only found in an oil paint in only one sample, also from the *Van Gogh* work. However the same organic yellow pigment was found in several examples of synthetic (household) paints, including the yellow background of F65 and orange background of *Figure with cricket pads* (FB05). Barium chromate (lemon yellow) was found as a component of flesh paint in several works.

Orange pigments

Cadmium orange appears to be the most commonly used orange pigment, but cadmium red and cadmium orange were sometimes difficult to distinguish in cross sections. The orange background on *Figure with cricket pads* contained a mixture of red and yellow organic pigments, as part of a household paint. Another unfinished canvas (F242), prepared with an orange background only, consisted of cadmium orange pigment, with no binder apparent.

In samples it can sometimes be difficult to judge whether a pigment is red or orange, especially if the pigment is seen only as a few particles, rather than as a bulk colour. Similarly, the distinction between red, pink and violet can be difficult to draw. For this reason, the occurrences of orange, red, pink and violet pigments are grouped together in table 6.8.

Red and pink pigments

Vermilion was found in both early works *Untitled (Landscape)* and *Three Studies for Figures at the Base of a Crucifixion*, 1944, and was also frequently found as a component of flesh paints. In one portrait from c.1967 it was identified as the pigment in the bright red paint printed over white using a textured cloth. It is likely that the same pigment was used to create the same effect in many other portraits from the 1960s. Cadmium red was also found in both pre-1946 works in backgrounds and was used for the red couch in F54. Cadmium red was a component of flesh paint in some works, including *Study for Portrait*, 1986, though appears to have been used less often than vermilion.

Table 6.8 Orange, red and violet pigments found in samples from paintings

Painting	*Date*	*Material*	*Analysis*	*Found in colours*	*Samples*
Sketch	1943-4	Cadmium orange	EDX	Orange	s2, s3
		Molybdate orange?	EDX	Orange	s2
Tate N06171	1944	Cadmium orange	EDX	Orange background	s1R, s5R, s1M, s5M, s7M, s1L, s2M
		Vermilion	EDX	Orange background, discolouration	s7M, s1L, s2M
		Al based red (alizarin?)	EDX	Crimson	s4M, s6L
FBA1	c.1945	Vermilion	EDX	Red-brown	1, 4
		Cadmium red/orange	EDX	Red-brown	1, 4
		Alizarin crimson	EDX	Pink foreground	3
Painting (MoMA)	1946	Cobalt violet	PLM	Purple blinds	
		Organic pink ('Phoenician red' – aniline?)	PLM	Pink background	
FB07	1949	Vermilion	EDX	Grey, orange	2, 3, 4, 7
		Alizarin	FTIR	Pink	5
		Cobalt violet	EDX	Grey	3, 4
FB01	1949	Cobalt violet (P, As)[56]	EDX	Purple under grey	2, 5
FBA2	1949	Cadmium red	EDX	Pink	2
		Cobalt violet (P)	EDX	Pink	2
FB03	c.1950	Cobalt violet (P)	EDX	Pink	1, 4
FB10	1951	Cobalt violet (As)	EDX	Purple	4, 6
FB08	1950-2	Cadmium red/orange	EDX	Orange, pink	2, 3, 7
		Vermilion	EDX	Pink	7
FB02	c.1954	Alizarin crimson	EDX, FTIR	Red	2, 4
FB17	1956	Vermilion	EDX	Red underlayer	5
		Cadmium red/orange	EDX	Grey, yellow strap	3, 7
FB11	1956-7	Cadmium orange	EDX	Orange on edge	3
FB06	1957-9	Cadmium red	EDX	Pink	5
		Cobalt violet	EDX	Lilac	6
		Iron oxide	EDX	Flesh paint	10
F39	1959-63	Cobalt violet (As)	EDX	Pink flesh	2, 5
		Alizarin crimson	EDX	Pink flesh	3, 5
		Vermilion	EDX	Pink flesh	5
		Cadmium red	EDX	Pink flesh	5
FB14	1960	Cadmium red	EDX	Pink	4
FB13	1960	Cobalt violet (P)	EDX	Pink	2
		Alizarin crimson	EDX	Red-brown background	1
F51	1960s	Vermilion	EDX	Red, pink	3, 4, 7
F50	c.1962	Vermilion	EDX	Pink, red	3, 5
F41	c.1962-3	Cadmium red	EDX	Pink	JS2
		Cobalt violet	EDX	Pink, purple	4, JS1
		Alizarin crimson	EDX	Blue-pink	4
		Manganese violet	EDX	Purple	JS1

[56] P = phosphorus present, indicating Cobalt phosphate, As =arsenic, indicating Cobalt arsenate

FB09	1963	Cadmium red	EDX	Red smear	7
		Cobalt violet (P)	EDX	Pink under yellow	5, 6
F54	c.1964	Cadmium red	EDX	Red couch	2
		Cobalt violet (P)	EDX	Pink flesh	4
		Alizarin	EDX	Pink flesh	4
F48	c.1965	Vermilion	EDX	Red-orange background	1
		Cadmium red	EDX	Red outline	2
FB15	1965	Vermilion	EDX	Red, pink	1, 6
		Alizarin	EDX	Pink	3, 5
		Cobalt violet (As)	EDX	Pink	3, 5
FB12	1965	Cobalt violet (P & As)	EDX	Pink, purple	2, 3
		Vermilion	EDX	Pink	2
F226:4	c.1967	Vermilion	EDX	Red	2, 3, 6
		Alizarin crimson	EDX	Pink, purple	3, 6
FBA3	c.1967-8	Vermilion	EDX	Red	2
		Cadmium red	EDX	Pink, red	1, 2
		Iron oxide	EDX	Pink	1
		Cobalt violet (As)	EDX	Yellow-pink	1
FB04	c.1972	Cadmium red	EDX	Red on back	4
F245:8	c.1973	Vermilion	EDX	Pink flesh	2
FB18	1975	Permanent rose?	EDX	Pink	7
		Vermilion	EDX	Grey-brown	5
FB05	c.1982	Cobalt violet (P)	EDX	Pink flesh	4
		PR144/166	PyGCMS	Orange background	3
F206	1980s	Alizarin crimson	EDX	Red	4
		Cadmium red	EDX	Red	4
		Cadmium orange	EDX	Orange splash	2
F204	Post-85	Rose madder	UVF, EDX	Pink flesh	2, 4
F133:9	Post-85	Cadmium red/ orange	EDX	Pink	4
		Red iron oxide	EDX	Red spray	1
F36	1986	Cadmium red	EDX	Pink	2, 8
F98	c.1989-90	Rose madder	UVF, EDX	Pink flesh	2, 5
		Red iron oxide	EDX	Red spray	2, 4, 5
F122	c.1989-90	Rose, madder	EDX, UVF	Pink	3, 4
		Iron oxide	EDX	Red spray	7
F85		Vermilion	EDX	Pink, red	4, 5

Alizarin crimson was found in several works but was not always easy to identify. If at sufficient concentration, it could be identified using FTIR, otherwise its presence was suggested by the presence of the elements calcium, aluminium and phosphorus (identified in reference samples of alizarin crimson). Some other organic red pigments were thought to be present, but were difficult to identify due to the small amount of material present. Permanent rose (quinacridone) was believed to be present in one sample, by comparison of the FTIR spectrum with that of a tube of this colour sampled from the studio. Rose madder was believed to be present in some samples, from the fluorescence of pink particles and identification of aluminium from the lake base. Iron oxide reds and browns also appeared to be present in some paintings. In works from the 1980s a red spray paint was often used as a component of flesh paints, which usually appeared to contain a small amount of an iron oxide red, possibly also with an organic pigment component.

Violet pigments

Cobalt violet was found in works spanning a considerable period, and was the principal violet pigment found. Examples of both cobalt arsenate and phosphate were found, sometimes within the same paint layer. It is not known whether this was a commercial mixture or was mixed by Bacon from separate cobalt phosphate and cobalt arsenate paints.[57] Manganese violet was also believed to be present in one painting, but only one particle was identified in a cross section.

Some analysis of Painting 1946 was carried out by MoMA using polarised light microscopy to investigate pink and purple pigments in the background, which had faded considerably by the 1980s (Ordonez, 1985). Bacon even offered to repaint the background, an offer refused by MoMA (Kirsh & Levenson, 2000). A red lake pigment was found in the pink background, possibly with titanium white and chalk filler, while the purple blinds were predominantly cobalt violet. Bacon recalled using 'Phoenician red' in the pink area.[58]

Flesh paints

The tone of flesh paints appears to change through Bacon's career, with pale greyish tones being used in early works, sometimes with green or bluish tinges. In *Untitled (Figure Crouching),* c.1950-1 the flesh is largely lead white with a very few coloured particles. Redder flesh tones are used from the late 1950s, which develop into a method using swirls of thick white and pink paint, with bright red paint printed on top. Vermilion appears to be used for this printing, identified in *Three Studies for a Portrait of Isabel Rawsthorne,* 1965 and *Untitled (green portrait)* F226:4, c1967. Barium

[57] In Winsor & Newton catalogues *Cobalt violet dark* is reported to be cobalt phosphate, and *Cobalt violet* is reported to be cobalt arsenate up until 1972 (replaced after this with cobalt phosphate) (Winsor & Newton, 1957, 1972), but it is possible that a mixture was actually used in some formulations.

[58] The only reference to this colour was found as part of LeFranc & Bourgeois Linel range of gouaches, said to be a fugitive aniline lake (Ordonez, 1985). 'Phoenician purple' is sometimes used as a synonym for the ancient Tyrian purple dye, 'Phoenician red' might be used as a name for a similar but redder-hued modern pigment.

chromate is found mixed into flesh paint in several cases. Sand is also sometimes added.

In several works from the 1980s, much thinner, pinker flesh tones are used, made from titanium white, often with rose madder. Red spray paints are applied on top to make redder flesh colours. Components of flesh paint samples are summarised in table 6.9.

Table 6.9 Comparison of samples taken from Flesh paint

Painting	*Date*	*White*	*Red/pink*	*Other*
FB03	c.1950	Lead white	Cobalt violet	Barium chromate, ultramarine, sand
FB06	1957-9	Zinc white /lithopone	Iron oxide Cadmium red	
FB14	1960	Lead white	Cadmium red?	
FB13	1960	Lead white	Cobalt violet (P)	
F39	1959-63	Lead white	Vermilion Cobalt violet (As) Alizarin crimson	Barium chromate
F51		Lead white	Vermilion	
F50	c.1962	Lead white	Vermilion	
F54	c.1964	Lead white	Alizarin Cobalt violet Cadmium red	
F48	c.1965	Lead white		Sand
FB15	1965	Lead white	Vermilion	Barium chromate
F226:4	c.1967	Lead white	Vermilion	Sand
F41	c.1962-3	Lead white	Cobalt violet Cadmium red	
FB04	c.1972	Lead white		
F245:8	c.1973	Lead white	Vermilion	
F85		Lead white	Vermilion iron oxide?	
FB18	1975	Lead white		
FB05	c.1982	Titanium white	Cobalt violet	
F206	1980s	Titanium white		
F204	Post-85	Titanium white	Rose madder	
F133:9	Post-85	Titanium white		
F36	1986	Titanium white	Cadmium red	
F98	c.1989-90	Titanium white	Rose madder Iron oxide (spraypaint)	
F122	c.1989-90	Titanium white	Rose, madder Iron oxide (spraypaint)	

Other additions

In two works from the early 1950s a yellow-orange coloured sand was used in the figure. In several paintings from the 1960s, and one from the 70s, sand appeared to be mixed more uniformly through oil paint used in areas of the background, see table 6.10. In cross sections these sand grains have a much paler, almost colourless appearance. Dust was observed as a deliberate addition on only one work, from 1986, although many of the slashed canvases from the studio did have an accumulation of dust on the surface.

Table 6.10 Additional materials found in samples from paintings

Painting	*Date*	*Material*	*Paint*
FBA1	c.1945	Grit	Grey
FB03	c.1950	Sand (dark yellow)	Grey figure
FB10	c.1951	Sand (dark yellow)	Face
FB06	c.1959	Grit	Background
F39	1959-63	Sand	Beige carpet
F41	c.1962-3	Sand	Beige background
FB09	1963	Sand	Yellow background
F54	c.1964	Sand	Green background, red couch
F48	c.1965	Sand	White/pink (flesh?)
F226:4	c.1967	Sand	Face
FB18	1975	Sand	Beige background
F36	1986	Dust	White circle

6.1.4 Works on Paper

No analysis was carried out on any works on paper in this study, but results have been made available from the analysis of pigments carried out by Joyce Townsend at Tate, from a small collection of sketches on paper (Townsend, 1999). These sketches are apparently executed in oil paint, although no media analysis has been carried out, and are believed to date from 1957-61. The results of analysis are summarised in table 6.11.

Table 6.11 Summary of analysis carried out on works on paper in Tate collection

Item	*Date*	*Sample*	*Materials identified*	*Analytical method*
T07354	c.1961	S1 lowest pink-red band	Lead white Titanium white Zinc oxide/sulphide	EDX EDX EDX
		S2 lower mauve band	Cobalt violet (As) Zinc oxide/sulphide	EDX EDX
		S3 purple band	Organic pink (Al substrate)	EDX
		S4 flesh colour	Lead white Zinc oxide/sulphide Organic red	EDX EDX PLM
T07357	c.1957-61	S1 pale pink on reverse	Lead white Zinc oxide/sulphide Organic red Cobalt violet Cerulean blue	EDX EDX PLM PLM PLM
		S2 grey on front	Lead white Zinc oxide/sulphide Bone black	EDX EDX EDX
T07359	c.1957-61	S1 emerald green shade	Phthalocyanine green Lead white Zinc oxide/sulphide	EDX EDX EDX
T07362	c.1957-61	S1 deep pink flesh	Lead white Zinc oxide/sulphide Organic red	EDX EDX EDX
		S2 emerald green	Lead white Zinc oxide/sulphide	EDX EDX
T07363	c.1957-61	S1 Prussian blue	Prussian blue Bone black	EDX EDX
T07369	c.1957-61	S1 red/pink	Lead white Zinc oxide/sulphide Organic red Cobalt violet Viridian	EDX EDX PLM PLM PLM
T07371	c.1957-61	S1 vermilion red shade	Lead white Zinc oxide/sulphide Organic red	EDX EDX EDX
T07379	c.1957-61	S1 pink flesh paint	Lead white Zinc oxide/sulphide Organic red Viridian Bone black	EDX EDX EDX PLM PLM
T07380	c.1957-61	S1 maroon	Lead white Zinc oxide/sulphide Bone black	EDX EDX EDX
T07382	c.1957-61	S1 black	Lead white Zinc oxide/sulphide Bone black	EDX EDX EDX

The pigments identified appear to be consistent with those found in paintings over a similar period. Lead white with a minor zinc component was the principal material found, with bone (ivory) black and cobalt violet as other common materials. Most of the red/pink pigments appear to be organic, and it is possible that alizarin crimson is present in some of these samples, as the elements calcium, aluminium and phosphorus were detected in several cases[59], which have been noted in several reference samples of alizarin paints and pigments.

6.1.5 Media

Drying oils

Oil binders were found in all paintings in at least one sample, analysed using GCMS. Azelate: palmitate and palmitate: stearate ratios were calculated from peak areas in the Gas Chromatogram. These ratios have been used frequently in past research to identify the type of oil present, generally to distinguish linseed, walnut and poppy oils (Mills & White, 1994). However, they cannot be used with such confidence for the identification of oils in modern paints for a number of reasons. Firstly, the range of oils that may be used has increased to include semi-drying oils such as safflower, soya and sunflower oils. The ratios reported for some of these oils cover a very wide range, or overlap with those of other types, making it difficult to make any identification based on these alone (see table 6.11).

Table 6.12 Palmitate: stearate ratios for oils reported in different sources

	Kirk-Othmer	Gunstone	Dubois	Sabudak	Schilling & Khanjian	Mills& White	Range
Linseed	1.8	2.0			1.4-1.6	1.1-2.3	1.1-2.3
Safflower	2.7	2.3	2.7				2.3-2.7
Soya	2.8	3.0	2.8				2.8-3.0
Sunflower	1.4		1.4	11.6			1.4-11.6
Poppy		2.7			5.6	2.9-3.7	2.7-5.6
Walnut		7.0	2.7	1.8	3.6	2.2-3.6	1.8-7.0

(Gunstone, 1967; Kirk *et al.*, 1978; Mills & White, 1994; Schilling & Khanjian, 1996; Dubois *et al.*, 2007; Sabudak, 2007)

Additives may also be present which will skew the ratios, such as aluminium stearates used as stabilisers. The ratios cannot therefore be relied upon to identify the type of oil with confidence, but can be compared to identify trends. The fatty acid ratios calculated from GCMS analyses of all samples are shown in table 6.13.

[59] For example, in T07354 s1 & s2

Table 6.13 Azelate palmitate and palmitate stearate ratios of samples calculated from GCMS analysis

Painting	*Date*	*Sample*	*Colour*	*Az/P*	*P/S*
FBA1	1943-5	2	Grey	1.46	2.17
		4	Red-brown	1.18	2.16
FB07	1949	1	White	0.52	2.82
		2	Pale blue	0.49	2.58
		8	Grey	0.71	2.17
FB01	1949	1	White	0.62	2.89
		3	Grey	0.45	2.48
FBA2	1949	3	Grey	0.70	3.98
FB03	c.1950-1	2	White	0.88	3.42
		3	Grey		3.52
		5	Blue-grey	0.59	2.52
FB10	1951	1	Grey	0.69	3.63
		2	Green	0.87	3.98
		5	Black	0.45	3.14
		7	Grey	0.44	4.41
FB08	1950-2	2	Orange	0.02	5.42
FB02	c.1954	3	Green	0.78	2.51
		6	Blue-white	0.88	3.44
FB17	1956	2	Green grass	0.78	4.81
		4	Pale blue	1.15	4.63
		7	Yellow	2.08	2.17
FB11	1956-7	1	Green	0.55	2.85
		2	Green	1.10	4.95
		3	Orange	0.32	3.95
FB06	1957-9	4	Black	1.68	1.65
		10	Pink	1.03	1.80
FB16	1959	1	White	1.06	2.97
		2	Pink	1.35	2.19
		3	Purple	0.97	1.80
		4	Green	0.87	2.23
F39	1959-63	1	Beige	0.56	3.28
		5	Pink	1.75	3.75
FB14	1960	3	White	1.37	2.29
		4	Pink	1.37	3.86
FB13	1960	1	Blue-black	1.16	4.33
		2	Pale pink	0.36	3.53
		3	Pale green	0.56	3.24
F50	c.1962	3	Pink	0.95	3.52
		4	White	0.52	2.62
F41	1962-3	2	Blue-black	0.61	2.02
		3	Beige	1.33	1.23
		4	Pink	0.38	3.12
FB09	1963	2	Blue	1.24	1.34
		3	Yellow	0.98	1.54
		5	Pink	1.10	1.88
F54	c.1964	1	Green	0.72	2.90
		2	Red	0.79	2.51
		3	Yellow	0.20	3.63
		7	White	0.91	2.22
F48	c.1965	1	Orange	0.41	2.75
		3	White	0.89	2.42

FB15	1965	3	Pink	0.94	5.03
		4	Green	0.14	1.90
		6	Pale pink	0.92	4.18
FB12	1965	1	Blue	0.64	1.84
		2	Pink	0.24	13.19
		3	Purple	0.60	2.68
		5	Black-grey	0.53	3.53
F226:4	c.1967	5	Yellow	0.87	3.65
		8	Pink	0.61	3.06
		9	Green	0.80	1.81
FBA3	1967-8	3	Red	1.20	3.14
		4	Green	1.63	6.17
F65	c.1971	2	Green	0.72	4.49
FB04	c.1972	4	Red	0.42	5.97
F245:8	c.1973	3	Pale blue	0.99	2.12
		5	White	1.53	2.28
		6	Black	2.66	2.07
FB18	1975	3	Gritty beige	1.20	2.59
		5	Yellow	1.53	2.90
		9	Beige	0.87	3.25
FB05	c.1982	4	Pink	0.44	3.78
F206	1980s	3	Pink	1.36	3.88
		5	Blue	0.42	2.71
F204	Post-85	1	Black	1.30	1.26
F133:9	Post-85	3	Black	1.67	2.45
F36	1986	1	Pink-white	0.13	4.01
		2	Pink	1.44	3.02
F98	c.1989-90	4	Pink	0.97	3.14
F122	c.1989-90	2	Pink	1.02	2.57
F85		1	Green	1.06	2.32
		3	Blue	1.11	3.14
		4	White-pink	1.02	2.30

Plotting the ratios on a scatter plot and grouping them according to date appears to show a fairly random distribution of values, see figure 6.1. The samples from the 1949-50 paintings appear to be the most closely clustered, but are still fairly scattered. The oil used in Winsor and Newton white oil paints was changed from poppy to safflower between 1968 and 1972, which might lead to some identifiable change in ratios. However, when only white paints or those appearing to have a high proportion of white are included, it is still difficult to see any significant differences (figure 6.2).

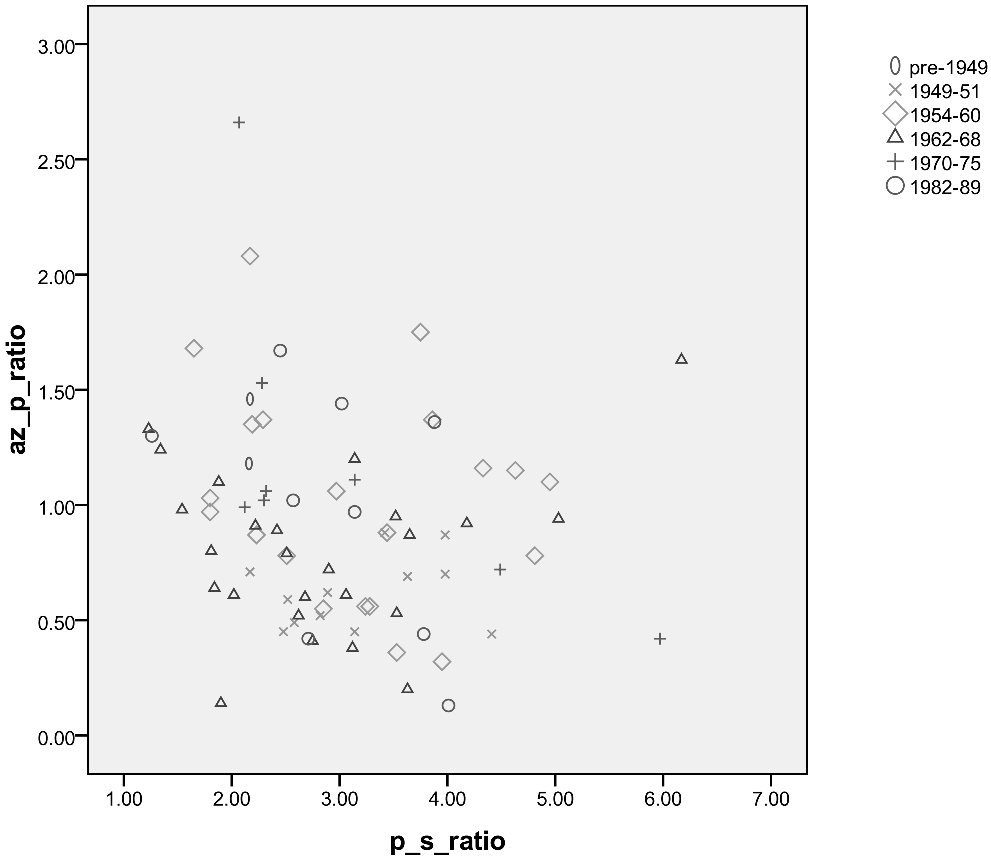

Figure 6.1. Scatterplot of ratios found from GCMS analysis

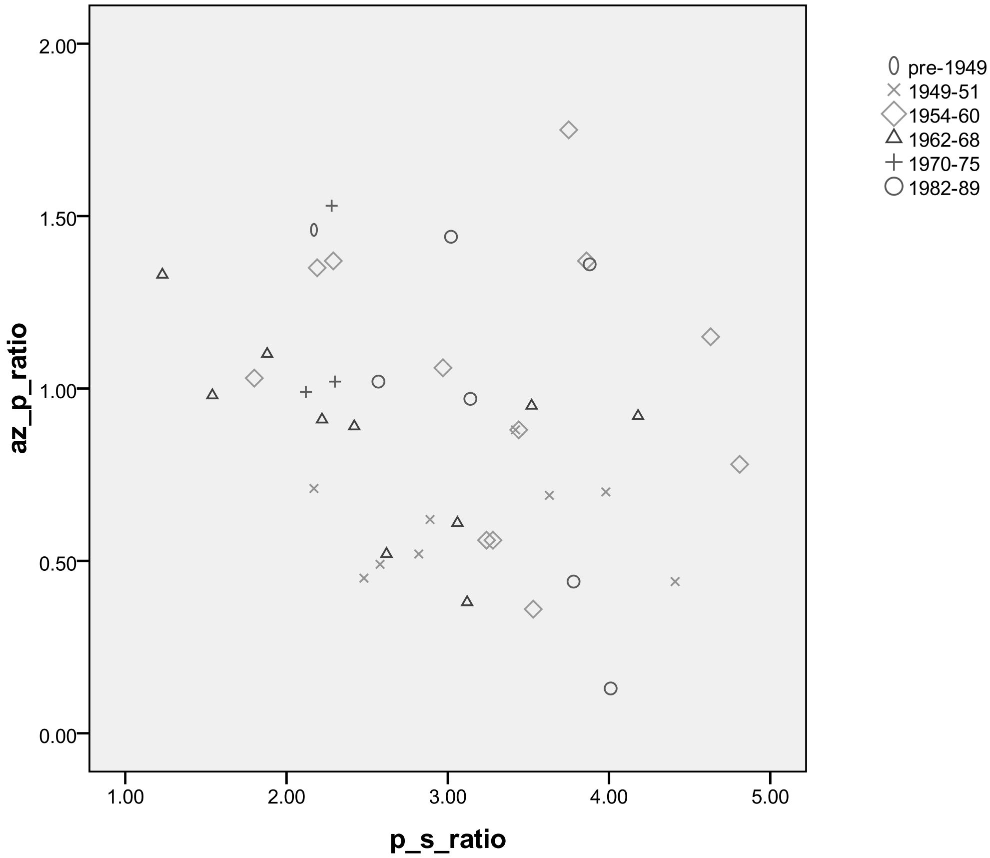

Figure 6.2. Scatterplot of ratios, with only white and mostly white samples included

Other materials

Samples in which materials other than oil paints were found are listed in table 6.13. Pastel was thought to be present in two samples from FBA1, and in several samples from FB06, identified from the large proportion of chalk or kaolin extenders with very little medium. In some other paintings a stroke of material thought to be pastel was observed, but could not be sampled.

A gum medium was identified in samples from the right hand panel of *Three Studies for Figures at the Base of a Crucifixion*, 1944, taken from the hide of the fury and in one sample from the orange background (Townsend, 1997). However, an oil medium was detected in another sample from a different area of orange background. The gum could be the binder in pastel materials or might be from a gouache paint, which Bacon used in several early works on paper.

An ortho-phthalate alkyd paint was identified in many samples from FB08, and appeared to have been used as the only white paint in this work, mixed with several other colours. A terephthalate alkyd was found in samples of white paint from two different works. This type of alkyd is relatively rare and is reported to have inferior properties to the more common ortho-phthalate alkyd (Wicks, Jones, & Pappas, 1992). Although alkyds are often associated with household gloss paints, none of these appeared particularly glossy. This might be partly due to the sinking effect of applying them to absorbent canvas, or they might have been relatively matt formulations to start with, due to the addition of extenders.

Table 6.14 Materials other than oil paint identified in samples from paintings

Painting	*Date*	*Material*	*Analysis*	*Found in colours*
Tate N06171	c.1944	Gum tragacanth & sugar*	GCMS	White hide of fury, orange background
FBA1	c.1945	Pastel (?)	EDX	Blue grass strokes, pale yellow patches
FB08	1950-2	Alkyd (orthophthalate)	GCMS	Pink, green, blue, lilac
FB06	1957-9	Alkyd (terephalate?)	GCMS	White
		Pastel	EDX	Grey, blue, pink
FB09	1963	Alykd (terephthalate)	GCMS	White background
FB12	1965	PVAc + 2-EHA	PyGCMS	White door
F65	c.1971	PVAc + 2-EHA	PyGCMS	Yellow background
FB18	1975	PVAc-acrylic (MMA-2EHA)	PyGCMS	Orange, grey
FB05	c.1982	PVAc	FTIR, PyGCMS	Orange, brown, grey
F206	Post-85	PVAc	PyGCMS	Blue background, buff spot
F204	Post-85	Acrylic (MMA-2EHA)	PyGCMS	Purple splash
F133:9	Post-85	Acrylic (MMA-2EHA)	PyGCMS	Grey
		Acrylic (MMA-BMA) spraypaint	PyGCMS	Red spraypaint
F36	1986	Alkyd (orthophthalate)	PyGCMS	Black background
		Acrylic (MMA-2EHA)	PyGCMS	White square
		Styrene	PyGCMS	Spray-paint
		Nitrocellulose alkyd	PyGCMS	Spray-paint
F98	c.1989-90	PVAc + 2-EHA	PyGCMS	Black background
		Acrylic (MMA-BMA) spraypaint	PyGCMS	Red spraypaint
F122	c.1989-90	PVAc + 2-EHA	PyGCMS	Black background
		Acrylic (MMA-BMA) spraypaint	PyGCMS	Red

*Analysis carried out by Bronwyn Ormsby for Tate (Townsend, 2000)

A PVAc household paint was first identified on a work from 1965, used in only one area of the background.   In several works from the 1970s and 80s PVAc paints were used more widely in backgrounds, to cover large areas of canvas.   An acrylic emulsion was found on one work from 1986 and acrylic spray-paints were found on several canvases from the 1980s. The PVAc and acrylic paints were found only in areas of background, with the exception of the acrylic spray paints, which are often sprayed on top of oil-based flesh paint.

6.2 Development of style and technique

The paintings examined are discussed in the context of Bacon's career. As well as those works sampled, many others were viewed in gallery settings, and some of these observations are also recorded. Several broad phases can be identified in Bacon's work, and his work is discussed here in date order, identifying major developments in style. In the following discussion, the titles of paintings examined and sampled for this study are shown underlined.

Before 1948

In Alley and Rothenstein's Catalogue Raisonné published in 1964, the earliest work recorded is a watercolour dating from 1929, which appears to be related to Bacon's rug designs from the same year. Only 14 works are recorded which predate the 1944 *Three Studies for Figures at the base of a Crucifixion*, many of which are in gouache, ink or pastel on paper, although four 'abandoned' works in oil are also included from this time. Even after 1944, Bacon's output appears to be intermittent, with four works dating from 1945-6, nothing in 1947 and only one from 1948 (Alley & Rothenstein, 1964). From 1949 onwards the number of completed works greatly increases and it is likely that this was largely due to the demands of his Gallery; the first show at the Hanover Gallery was held in late 1949, and featured the six head studies produced in 1948-9.

The fragmentary survival of his early work makes it difficult to draw overall conclusions, but it has been argued by Hugh Davies that the 1944 *Three Studies* represents a culmination of an early period of experimentation, heavily influenced by Picasso and his biomorphic forms (Davies, 1978). Other works from around this time, some surviving only in photographs, also use non-human forms, often with a mouth on the end of an extended neck.

The small number of surviving works from before 1948 means it has been difficult to examine many works from this period. The *Three Studies for Figures at the Base of a Crucifixion,* 1944 has been subjected to analysis by Tate (Hackney, 1999). This work is believed to be oil and pastel, and both oil and gum media were detected through analysis (Townsend, 1997). A cross section from the wrap in the left panel showed several layers with reworking of paint wet-in-wet (Hackney, 1999).

One other work has been analysed which is believed to date from c.1943-5, the *Untitled (Landscape)*. This is one of two paintings which have only recently come to light, believed to have been left behind in Bacon's Cromwell Place studio when he hurriedly moved out in 1951. This painting appears to draw on Nazi imagery, as do several other (mostly destroyed) works from the 1940s (Hammer & Stephens, 2009). Like the *Three Studies*, it is on board, and appears to use several of the same materials. It has a rough red-orange background colour with a glossy pale grey paint on top. In the foreground a pink base-colour is used, over which are strokes in a variety of colours forming the grass, in pastel or another dry medium. This manner of painting grass is repeated in many works from the 1950s.

Several other works from around this time use a similar palette, with an intense red-orange background, and black and a pale grey also principal colours, for example *Figure Study I* & *Figure Study II* from 1945-46. In these works, thin strokes of black are used in a linear fashion to form the intricate pattern of the herringbone tweed overcoats.

In *Figure in a Landscape* 1945, again black linear strokes are used to create a background which is detailed compared to later works. A narrow brush appears to have been used like a pen drawing wandering scribbles and short linear strokes over the white priming. Dust is used for the first time here according to Bacon's own account, to create the fuzzy texture of a grey suit (Sylvester, 1993). Presumably the dust is present in what looks like brownish fingermarks on the sleeve and lapel, but doesn't now have the fuzzy appearance Bacon describes.[60] It is unknown whether this was the original appearance or is due to the effect of time.

Painting 1946 is the first surviving work to use a large, 198 cm height canvas. Canvases of this height were to be used consistently by Bacon in following years, as discussed in chapter 5. This painting is painted on the primed side of the canvas and is reported to use a mixture of pastel and oil, which has contributed to problems of flaking (Shepard, 2009).

[60] Based on examination of the work at Dublin City Gallery The Hugh Lane, October 2009

1948-9

After *Painting* 1946, there appears to be a considerable gap as, according to Alley, the next work is the 1948 *Head I* (on board), followed by *Head II*, apparently the first surviving work to use the unprimed side of the canvas. Letters from Bacon indicate that he was in Monte Carlo frequently during this time, where he found it difficult to work and although several paintings are mentioned, they do not appear to have survived (Clark, 2007). The destroyed *Man with microphones* appears to fit in this gap, painted on the primed side of the canvas. Bacon's first exhibition for the Hanover Gallery in 1949 may have helped him to focus on producing work and provided a reason to resist destroying his work quite so freely as he had prior to this. Bacon's palette at this time, in contrast to the bright colours of the earlier period becomes very muted and monochrome.

The first of the series, *Head I* is painted on board and dated 1948, while the remainder are on canvas, painted on the reverse side, dated 1949. All but the final *Head VI* (the first painting based on Velasquez' *Portrait of Pope Innocent X*, which includes large areas of deep purple) use a predominantly grey palette, often with grey vertical strokes in the background suggesting the folds of a curtain.

Both *Head I* and *Head II* are extremely thickly painted, with paint built up to produce a three-dimensional relief effect for some of the features. Although these works are predominantly grey, both appear to use many other colours in preparatory layers, some of which can be seen as traces within the grey surface (figure 6.3). Cross-sections taken from Head II show multiple paint applications in a wide variety of colours (figure 6.4), but the majority of these do not appear to contribute to any surface appearance. A similar phenomenon was observed on *Man with microphones* (Shepard, 2009).   In the Sylvester interviews Bacon appears to discuss *Head II* and describes it as one of the very few examples where he has continued to work on a canvas to 'pull it through' rather than destroying it (Sylvester, 1993, p.18). Although some of the use of colour may have been deliberate to achieve the effects described, the very large number of separate paint applications suggests repeated reworking of the composition, rather than being planned use of colour. These works may therefore show a transitional period from the colour used in the 1940s to a monochrome palette. They also appear to have been worked on over a considerable period of time, from the number of paint layers seen in cross sections, some of which appeared to have already dried when they were worked over.

Interestingly, *Head I* is reported as being oil & tempera on board, and *Painting* 1946 is also described as 'oil and tempera' (Alley & Rothenstein, 1964). It is difficult to know what is meant by this, as 'tempera' is an imprecise term which could indicate a number of different types of (probably water-based) media. It might indicate gouache paint which was possibly present on the *Three Studies for figures at the base of a Crucifixion,* 1944*.* Another possibility is that Bacon used this term for the pastel component of these paintings, although 'oil and pastel' is a description given to some other works.[61]

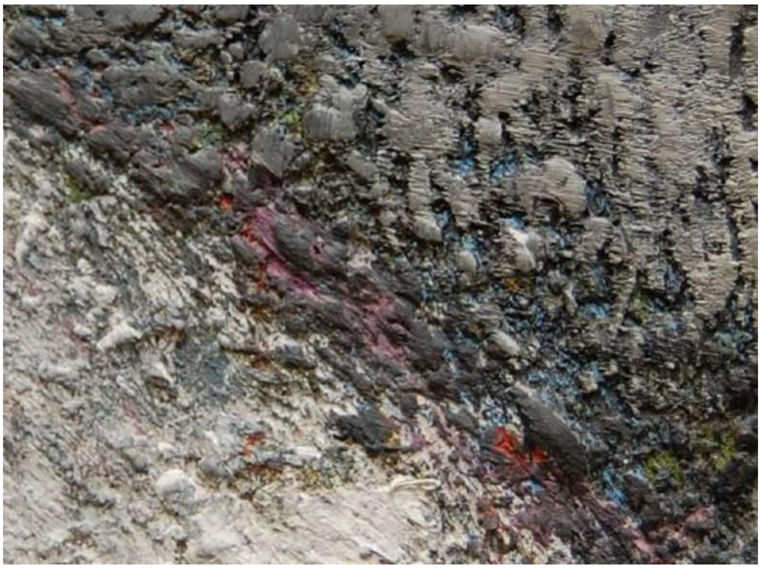

Figure 6.3. Detail from *Head II,* edge of white shirt

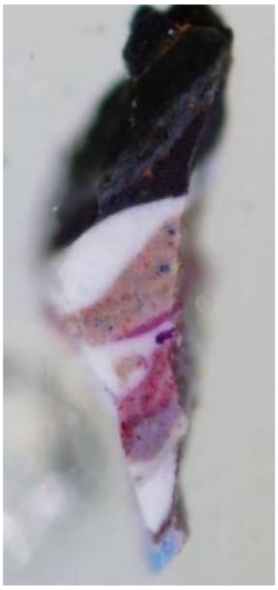

Figure 6.4. Cross section from top edge showing coloured layers under grey surface

Figure 6.5. Left, detail of lower edge of *Head* (FB01), showing grey paint dragged over canvas texture. Right, cross section taken from figure in *Untitled (Figure Crouching)* (FB03), showing brownish sand particles.

[61] Reported as the medium in *Three Studies for Figures at the Base of a Crucifixion*, 1944 and *Figure in a Landscape*, 1945.

Two more works were examined which appear to be similar to the Head series, as both are largely grey portraits. *Head (FB01)* is pictured as one of the 'Abandoned Works' in Alley, and appears to be closely related to the Heads series, as this is on a canvas of the same dimensions as *Heads II* to *V* (32 x 26 inches). *Head (FBA2),1949* was believed to have been left behind in Bacon's Cromwell Place Studio, along with *Untitled (Landscape) (FBA1)*. This work is on fibreboard, and was painted over a work by Roy de Maistre.[62] Both works are much more thinly painted than *Heads I & II* (as are *Heads III* to *VI*). *Head (FB01)* has grey vertical strokes forming the curtain behind the head, which drag over the raw canvas texture at the lower edge. Like in *Head II*, traces of a pale purple coloured paint from an underlying layer were found at the edges.

The grey head in *Head (FBA2)* was painted over a work by Roy de Maistre, therefore the initial layers of the painting examined in samples are likely to be de Maistre's work. No example has been found of any technical examination carried out on de Maistre's paintings to compare with this work. The painting is on fibreboard of a similar type to that used in the Three Studies, and appears to have a chalk and gypsum ground. The orange and pink paint layers seen in the samples also appear to be part of de Maistre's composition, with only the uppermost grey layer being applied by Bacon (confirmed by x-ray, see section 6.3). Both of these paintings appear to be much more thinly painted than the earlier, very thick, works, showing Bacon might have been refining his techniques and perfecting the effects he wanted to achieve.

1950s

Many other works from 1949 and the early 1950s use sparsely applied paint over raw canvas and a monochrome palette, e.g. *Study from the Human body* and *Untitled (Figure Crouching),* c.1950-1. Strokes of grey paint are dragged over the canvas, which catch at the canvas weave texture, and sometimes substantial areas of canvas are left uncovered. This is often contrasted with areas of thick paint, e.g. in *Untitled (Figure Crouching)* the figure is very thickly painted, with a large amount of sand added to the paint. Sand particles appear to be incorporated in grey and white/pink paint mixed wet-in-wet (figure 6.5).

From around 1951 Bacon begins to use a thin dark stain in black or dark blue to cover large areas of the canvas before working up the composition, e.g. *Study for nude*, 1951 (Alley & Rothenstein, 1964, cat.32). *Portrait of Lucian Freud*, 1951, apparently one of

[62] De Maistre's signature can still be seen in two places along the lower edge.

Bacon's earliest portraits of a named person, uses a black stain but still leaves substantial areas of bare canvas. The figure here appears to be painted onto the bare canvas, with the black applied around the edges. A dark orange-coloured sand is used on the face, not mixed into the paint but remaining visible on the surface.

Further paintings based on Velasquez's portrait of Pope Innocent X were executed in 1950 and 1951, with a dark blue background used in the latter series. Some of these works now use the staining layer over the whole canvas as a first step, made with oil paint thinned-down with turpentine. The layer is so thin that the canvas weave remains visible, so that thicker paint applied on top can be dragged over the surface and will still be picked up unevenly by the canvas texture.

More colour is introduced in several landscape-based works completed in 1952, said to be inspired by Bacon's visits to South Africa in 1951 and 52. Many have grassy plains made up of colourful and energetic brush-strokes over a bare canvas ground. Although the human figure remains a constant subject, several animal paintings are also produced around this time, including several studies of dogs and monkeys, and one with an elephant fording a river (Alley & Rothenstein, 1964). However, a dark palette is maintained for many pictures of figures in interiors produced in 1952-3, including the series of 8 popes from 1953 on a blue-stained-canvas ground.

Several more works from the mid-1950s place figures against vigorously painted grass like that in the African 'jungle' pictures, e.g. *Two figures in the grass*, 1954. The 'abandoned' *<u>Figures in a landscape</u>*, c.1954 might be related to this work. Again, different coloured strokes are used for the grass, but unusually this work is on a paper support, rather than on bare canvas. The figures, like those in *Two Figures,* 1953 have a greyish flesh-tone.

Another extended series, the *Man in Blue* series was embarked on in 1954, showing a sparsely painted suited man against a dark blue ground. The background colour is often used to form elements such as the tie, with a white collar painted to leave the shape of the tie in reserve. In this way effects are achieved in a very minimal way, with sparing use of paint. The colour used for the flesh paint is fairly pale and greyish with tinges of blue. A similar technique appears to have been used for the series of heads based on the life mask of William Blake, 1955, and for the portraits of Robert and Lisa Sainsbury, 1955, although the latter works use a black background.

In contrast to these thinly painted works *Study for Van Gogh I* from 1956 appears more like works such as *Head II* in its evidence of repeated reworking and very thick paint passages. This is the first in the series of works inspired by van Gogh's *The Painter on the Road to Tarascon.* The rest of the series were produced the following year, with even brighter colours and abundant paint, which now appears to be applied in generous application with a single colour, rather than being built up though repeated working. The works were created very quickly for a show being put on at the Hanover Gallery in March 1957.[63] They showed a marked contrast to the dark isolated figures in interiors produced before, showing bright hot colours, sunshine and landscape in a much freer style with a large quantity of paint. The bright colour and vigorous impastoed technique has been compared to the work of Karel Appel, Willem de Kooning and Chaim Soutine (Harrison, 2006). Sylvester marks these works as not very successful experiments, but necessary ones, as they paved the way for Bacon's confident mature style, and lead to a brightening of his palette to include the reds, oranges and mauves that are so characteristic of in his work post-1962 (Sylvester, 2000).

Lone figures in dark interiors are also still being made at this date, such as *Study for Portrait X*, 1957 and *Study for Figure VI, 1956-7* (figure 6.6). At around this time a dark green stain is first used in backgrounds, again applied thinly over the whole surface, like the dark blue used in earlier works. A lightening of the interior begins to take place in some works, subtly in *Study for Figure VI* with a purplish box around the figure, more markedly in *Study for Portrait of P.L.*, 1957.

This lightening of palette continues more decisively in works from 1958-9, where the background is composed of lighter and brighter shades arranged in stripes to form the different elements of the interior, e.g. *Seated Man, orange background*, 1958, *Two Figures in a Room,* 1959. The latter work and several others from the same date use a bright green stain over the whole canvas, part of which is covered with a semi-opaque white layer, resulting in a pale blue-green effect, as the green partially shines through. Similar green backgrounds dominate in works painted in 1959-60, many of which were completed while Bacon was in St Ives, where he stayed from late September 1959 to mid January 1960. The bright green was apparently referred to by Bacon as 'Belcher's green' after the portrait of Muriel Belcher using this colour produced in 1959 (Edwards & Ogden, 2001). The composition of some of these works with their interiors

[63] It is reported that the works were still wet at the start of the exhibition, and two did not arrive until after the opening (Alley & Rothenstein, 1964, p111).

composed of clear blocks of colour have been compared to stripe paintings of artists such as Patrick Heron, also a St Ives artist (Harrison, 2005), and were also possibly influenced by the work of colour-field artists such as Mark Rothko and Barnet Newman (Tufnell, 2007)

In these green portraits completed in St Ives and after Bacon's return in early 1960, flesh colours become brighter, including more vivid reds and pinks compared to the flesh tones in earlier figures. Cecil Beaton described Bacon's portrait of him, produced in 1960 but later destroyed, as 'looking like a piece of raw offal against an emerald green background' (Beaton, 1976). In some cases traces of green are present in the flesh tones, showing the portrait was started while the green base was still wet, allowing the colour to be picked up and smeared. The paint used in faces becomes thicker, with clear, wide brushstrokes used to create the impression of nose or eye-socket, as in *Head of a Woman*, 1960, see figure 6.6.

Early 1960s to early 70s

The 1962 *Three Studies for a Crucifixion* is identified by Sylvester as marking the beginning of Bacons' new assured style, and was included as one of the most recent works in the first Tate retrospective (held from May-July 1962). This was apparently the first work to purposely use a triptych format since the 1944 work.[64] Twenty-eight large Triptychs were released by Bacon over the next 30 years (Calvocoressi, 2005). Bacon's technique appears to become more consistent, following a regular pattern. Several works from the 1960s were sampled which appear to belong to this phase of work, several of which are unfinished or destroyed canvases, which allow us to see different stages of completion.

Figure going through doorway, c.1972 and F65, c.1971 appear to show the earliest stage, in which the basic composition is sketched on to the bare canvas with a narrow brush, see figure 6.7. In both cases a dark green is used to form the outline of the figure, with lines forming features of the interior space. The lines are thinly painted using either a dry, sparsely loaded brush, or with added turpentine to form more dilute, liquid strokes. It is likely that Bacon used aids such as rulers and T-squares to construct lines, and possibly a string compass for the arcs forming the edges of curved rooms. Other items may have been used as templates, such as dustbin lids (Peppiatt,

[64] One other triptych, *Three Studies of the Human Head*, 1953 was completed in the intervening period, but was not originally conceived as a triptych (Alley & Rothenstein, 1964, p80). Many other works were made in series.

1996, p.259), which might have been used for the circles found in works such as *Three Figures and Portrait*, 1975.

Figure 6.6 Left, *Study for Figure VI*, 1956-7, 152.3 x 119 cm. Right, *Head of a Woman*, 1960 showing flesh over green-stained canvas

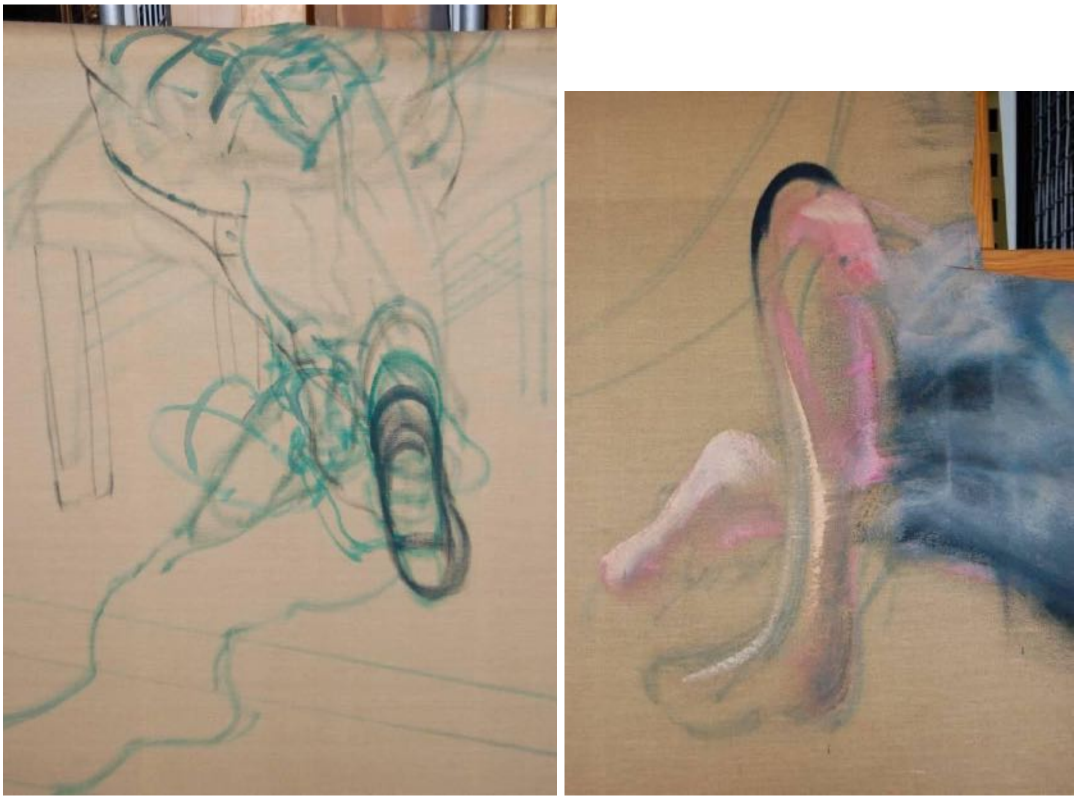

Figure 6.7. Left, green lines sketching figure in slashed canvas F65 (detail). Right, pink and orange paint strokes outlining legs on slashed canvas F51 (detail).

Thicker oil paint was then applied to start forming the contours of the figure, as can be seen in destroyed canvas F51. Deliberate brushstrokes in a variety of colours outline different parts of the leg and foot (figure 6.7) in dry oil paint, over the green lines of the sketch. Work on the figure appears to concentrate first on the head and upper part of the body, with the legs remaining rather sketchy, as in F50 (figure 6.8). After some work on the figure, areas of background colour are added, usually leaving margins of bare canvas between the different blocks of colour (the lines of 'underdrawing' are often visible in these gaps). In the destroyed canvases it is difficult to tell how extensively worked the figures were before being discarded, but several have areas of background colour at what appears to be a fairly early stage. Background colours appear to be added first in the top part of the canvas (see F48 and F65).

In *Study for Self-portrait,* 1963 the figure appears to have been outlined on the canvas first with strokes of black paint, which can still be seen in some areas, for example in the legs and in the margins of bare canvas within the blue couch (figures 6.8 and 6.9). Although some of the figure was probably painted before the background, the outer outlines of the sleeves are clearly painted on top of the blue of the couch. Many separate dabs of cloth with different colours are used, building up a pattern of colour and texture which would have taken quite a number of separate operations to achieve (figure 6.10).

Paint may be thrown as a finishing touch, particularly used in paintings dating from mid-60s to mid 70s, usually with thick white paint, but the image may then be further worked on. For example in *Study of George Dyer in a Mirror, 1968*, a thick splash of white paint has been flung at the canvas, but this has then been carefully worked over so that the splash does not continue onto the blue carpet, instead ending abruptly at the black line of the mirror stand.

At this time household paints begin to appear in backgrounds, as seen in the white wall in *Study for Self-portrait*, 1963, however oil paints are also often found in backgrounds throughout the 1960s. These are used to form areas of background in two distinct ways, either as thin stains to the canvas, similar to the all-over approach used in works in the 1950s, but now in carefully planned areas, e.g. in F50. The blue couches seen in many works appear to be painted in this way, using a Prussian blue oil paint. Conversely, they may be applied thickly with added sand to give additional bulk, resulting in a craggy, gritty texture, as seen in the yellow area of *Study for Self-portrait* and the green carpet in F54. In some works this type of surface appears to be used for the whole background, as in *Portrait of George Dyer Riding a Bicycle*, 1966. The figure is now worked directly on the bare canvas, so its position must be established from the outset.

Figure 6.8. Left, F50, 164.4 x 142.7 cm, showing sketchy painting of legs and black and blue stained areas of background. Right, *Study for Self-portrait*, 165.2 x 142.6 cm.

Figure 6.9 Line of black 'under-drawing' exposed in margin of bare canvas on couch

Figure 6.10 Detail of fabric pattern on upper part of nose

Where household paints are used they generally give a flatter surface, with little canvas texture visible, as they are probably applied without dilution. These paints are generally designed to have a levelling effect to reduce the appearance of brushstrokes. With this type of paint it is probably easier to change background colour without changing the surface texture, unlike with the thinned oil paints, where a second layer of oil paint will not be so readily absorbed, and will make the weave texture less visible. In some works the background colour appears to have been changed several times, e.g. *Three Studies for Portraits including Self-Portrait,* 1969 (Private collection), where overlapping edges of different colours can be seen around the heads.

Small portrait triptychs on 14 by 12 inch canvases become an important part of Bacon's work in the 1960s. Many examples were painted of friends such as Isabel Rawsthorne, Henrietta Moraes and Lucian Freud. The technique used for the painting of the head appears to be similar to that used in the larger paintings, but many use a thin wash of oil colour to stain the whole canvas initially, over which the head is worked. This technique is used for *Three Studies for a Portrait of Isabel Rawsthorne* (FB15) with a deep pink stained background, over which thick strokes of a mixed pink paint are used to start painting the head. Different coloured strokes in white, pink and green are worked on top, often blended on the canvas, with the sweep of a wide brush used to describe contours of the face. Sweeps of the finger appear to be used to wipe away paint from some areas and fabric is used to print bright red over areas of the face (figure 6.11).

In some cases a second layer of colour is applied around the head for the background colour, as in FB15. In other cases the head is worked directly on the raw canvas, often leaving an area of bare canvas for the shoulders of the sitter. A background colour is then added around the outlines of the head. In these cases the background colour usually has the flat appearance of a household paint.

Several paintings from the late 1960s and early 1970s use a pale lilac shade in areas of background, which looks very much like a pastel shade which might be used for interior decorating. Household paints appear to be used more overtly, producing a flat surface over expanses of background, giving a clean modern feel, and are usually applied to represent an interior space, echoing the paint's intended use. Flesh paint gradually becomes thinner and is applied with smoother blending of colour, compared to the variegated brushstrokes of works from the 1960s. In some works paint is very thinly applied, giving an insubstantial quality, such as in *Portrait of Michel Leiris, 1976*.

Larger works appear to be carefully planned. *Three Figures and Portrait* from 1975 is quite complicated in its build-up, with several paint layers in many areas. Whilst some layering may result from changes of mind, some aspects appear to be carefully planned from the start. Because figures are worked directly on the bare canvas, and this surface appears to be important to Bacon, the position of figures must be decided from the outset. Some changes can sometimes be seen, but the overall composition is usually retained in completed works. Chance might be allowed to operate in final touches, but the majority of the image is carefully built-up using techniques Bacon had perfected over the years. Even the effects of chance splashes of thrown paint could be altered after the event by removing excess paint, or further working on the paint to incorporate it into an area of composition.

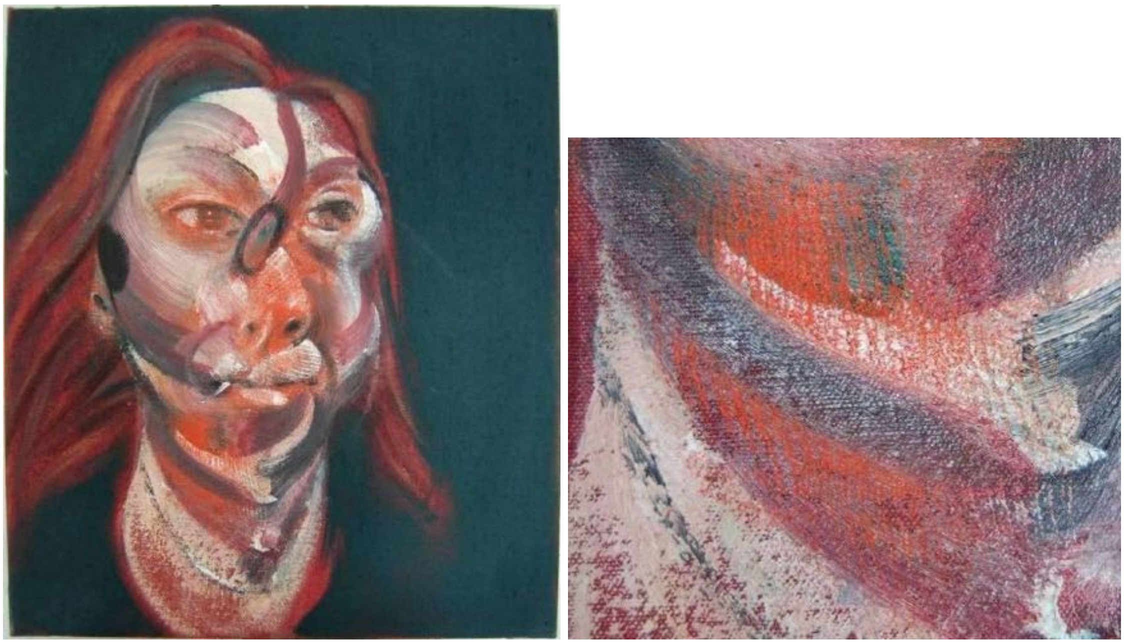

Figure 6.11. Centre panel of Three Studies for a Portrait of Isabel Rawsthorne, showing face and hair painted over dark pink base colour. Right, detail from same panel showing bright red printing with dark red line stroked across neck.

Figure 6.12. Slashed canvas F122, 35.8 x 30.6cm, possibly a portrait of John Edwards

Figure 6.13. Detail of F98 from neck showing thin pink paint applied over black, with red spray-paint on top

Late 1970s and 1980s

In works from the 1980s, analysis showed that household or thinned-down oil paints are still used in backgrounds, but now the paint used for the faces is not so thick and sculptural. Oil paint still appears to be used for faces, but in much thinner layers and colours are more likely to be mixed prior to application, rather than the colour being created through a combination of colours mixed wet-in-wet on the canvas, with overprinting from fabric. Paint is still applied using textured cloths, but now this is nearly always with corduroy rather than the knitted textures detectable in earlier works. Pale blue or pink is used, rather than the bright reds and deep blues used before. The corduroy creates stripes which are usually placed across eyes and mouths. Instead of purely adding texture and colour as before, this has the effect of bars placed across the features, possibly blocking the sitter's breath or obscuring their eyes.

In the late 70s and 80s Bacon made many more small portraits, often self-portraits, usually as small triptychs. Many of the portraits have black backgrounds with thin pink layers used for the face and patches of red, white and blue spray paints, for example the destroyed portraits F122 and F98 (see figures 6.12 and 6.13), which appear similar to portraits of John Edwards, such as *Portrait of John Edwards*, 1989, and F133:9, probably a self-portrait.

In some cases the pink is so thin that some of the background black can be seen through the paint. The use of spray paint is also a new departure, first used in the late 1970s, which can be sparsely applied to achieve very subtle gradations of colour. Spray paint may be used over faces, where it often gives the impression of flesh dissolving into the background. It is also used sometimes to modulate flat backgrounds, creating patches of faintly varying colour reminiscent of the mottled backdrops sometimes used by photographers in studio portraits. In some cases it is used in combination with dust, where the spray is picked up by raised fibres of dust stuck to the surface of the paint, giving a three-dimensional effect. These portraits use much thinner paint layers than the earlier ones, and possibly would need more planning, as the thin layers would be less forgiving to reworking.

A bright orange background is used in several paintings in the 1980s, recalling the early 1944-6 works, for example, *Figure with Cricket pads* and another unfinished work, F242. In late works Bacon's palette generally consists of fewer colours, with grey, black, white, pink and pale blue used often, in addition to the orange. Black, white and pink are particularly common in small portraits (see F98, F122, F133:9 and F204).

6.3 Information from x-radiography

Several paintings were x-rayed to further investigate technique and to look at particular areas of interest.

FBA1 Untitled (landscape), c.1943-5

This painting was on paper which had been stuck to board. Where the paper was lifting at the edges, paint traces believed to be from an earlier composition could be seen. In the x-ray some features were apparent which did not appear to relate to the surface image, therefore could be from an underlying composition. Several curved shapes can be seen, particularly in the upper part of the composition. However, the shapes are ill-defined and difficult to interpret.

FB02 Figures in a Landscape, c.1954

Like *Untitled (landscape)* this painting was painted on paper or thin card, which was stuck to an additional support, this time canvas. Very little could be seen from the x-ray, apart from some of the thicker strokes in the background, e.g. at the upper left side. The joins between the x-ray plates are rather obvious and distracting due to the variation in contrast across each plate. In this case it was thought more likely that the painting had been lined onto canvas after leaving Bacon's hands, rather than being on a re-used canvas. The construction of the canvas support does not appear to be typical for Bacon, and there is no priming layer on the reverse. Pinholes in the corners of the paper show it could have been pinned to a board while being worked on.

FBA2 Head (de Maistre), c.1949

This painting was known to have been painted on a re-used board originally bearing a composition by Roy de Maistre, as his signature was still visible along the bottom edge. The painting was x-rayed to investigate the underlying composition to assist with dating the painting and to judge how much of the work might be attributed to Bacon or to de Maistre. The x-ray revealed that the underlying composition appears to be very similar to de Maistre's *Mariage*, of which at least two versions were made, dated 1936.[65]

Comparison with the Tate work shows that much of de Maistre's composition remains visible in the bottom third of the painting, e.g. the white shapes which could be seen as parts of jacket and shirt in the new composition, the bottom of the right hand figure's

[65] One version is considerably larger: 152.4 x 114.3 cm and on canvas, c.1936, Tate. Another version with very similar composition also exists, on masonite, with dimensions similar to the work examined here (73 x 52.6 cm), 1936, Private Collection (Johnson, 1995).

trousers, and the white panelling on the wall. The pink at the top edge and orange at left side seen in cross sections taken from these areas therefore appear to have been applied by de Maistre, with only the surface grey layer and white paint marking out the head applied by Bacon. Even the curling motif on the jacket of the standing figure is only partially covered (Figure 6.16)

Figure 6.14. Untitled (landscape), c.1943-5 in normal light (left) and x-ray (right)

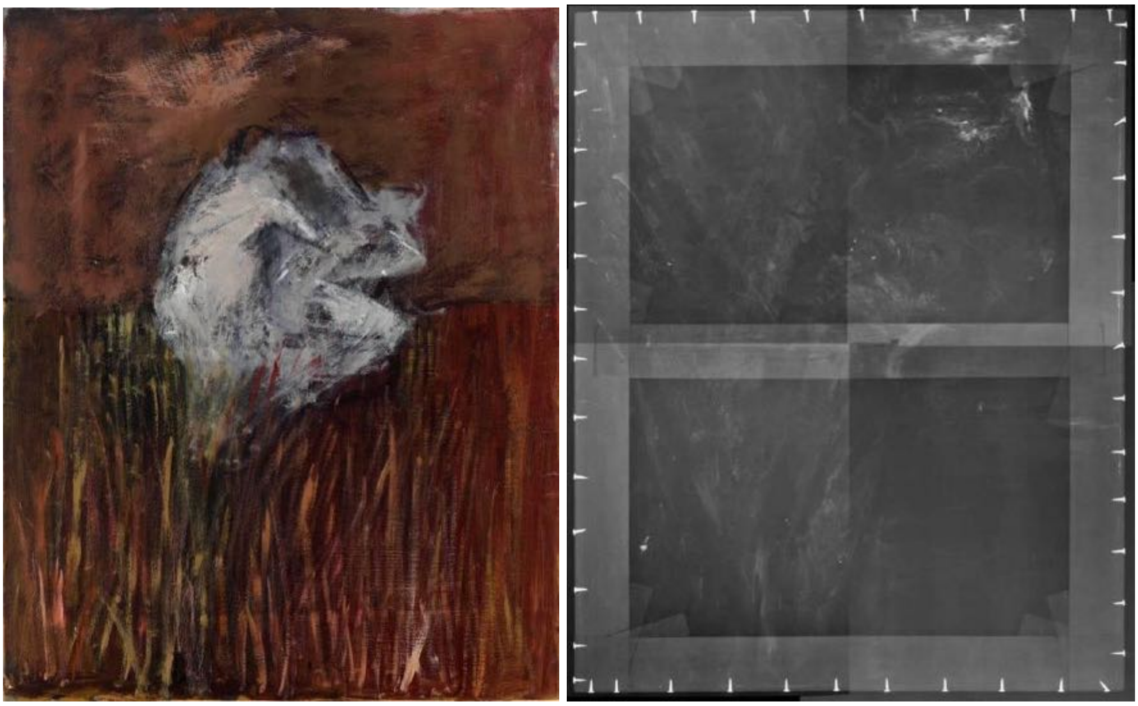

Figure 6.15 Figures in a Landscape, c.1954, in normal light (left) and x-ray (right)

Figure 6.16 Head (de Maistre), c.1949 in normal light (left) and x-ray (right)

Figure 6.17 Detail of *Head (de Maistre)* showing curling design from underlying composition

FB17 Study for a Portrait of Van Gogh I, 1956

The figure of Van Gogh in this painting was reported to have been cut from another canvas and stuck to a new background, from the account given by Alley & Rothenstein (1964, p.102). In an interview in 1973 Bacon said Alley was 'mistaken', but it was also noted that Bacon was 'obviously not pleased' by the mention of this practice, which definitely did occur in some other works of the early 1960s (Davies, 2009, p.110). Therefore this denial was taken as obfuscation by Bacon, motivated by regret at letting these works out. The area of the figure is clearly a lot thicker than the surrounding background, but it is uncertain whether this is just due to a thicker build-up of paint. An x-ray was taken of this painting to see if we could clarify whether or not a second canvas was used for the figure.

Examination of the x-ray showed no evidence of a second canvas, and the weave texture could be seen to be continuous over both thinner and thicker areas (figure 6.18). The figure appears as a lighter shape in the x-ray, presumably due to the thicker paint layers, and around the edges, ridges of white can be seen which seem to correspond to traces of thicker paint left behind in the scraping-down process, e.g. around the hat (figure 6.21). The dark blue background was then thinly applied, working around the figure to cover the remaining traces of scraped-away paint. The shape of the shadow extending to the right of the figure does not correspond exactly to the shape seen in the x-ray, as the part extending furthest to the right appears to be done in thinner paint (figure 6.20).

Narrow parallel ridges can be seen in the paint of the face, which may have been made by a wide-toothed comb used to press texture into the paint (figure 6.19).

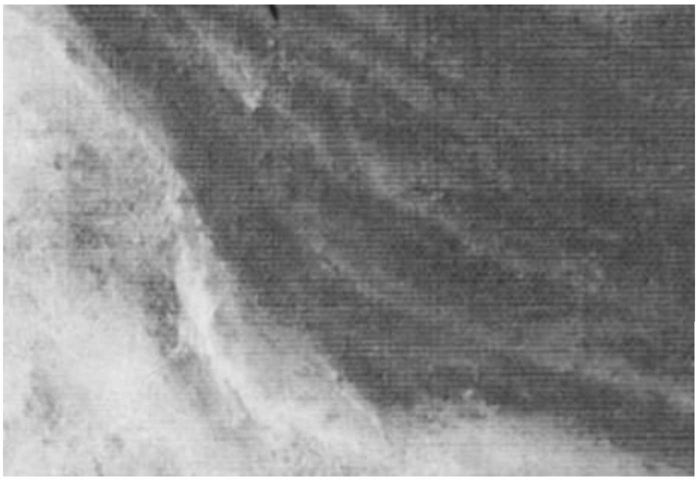

Figure 6.18. Detail of x-ray from edge of hat, showing canvas weave continuing across both thick & thin areas of paint

Figure 6.19 Detail of x-ray of face, showing parallel lines, possibly made by comb or similar.

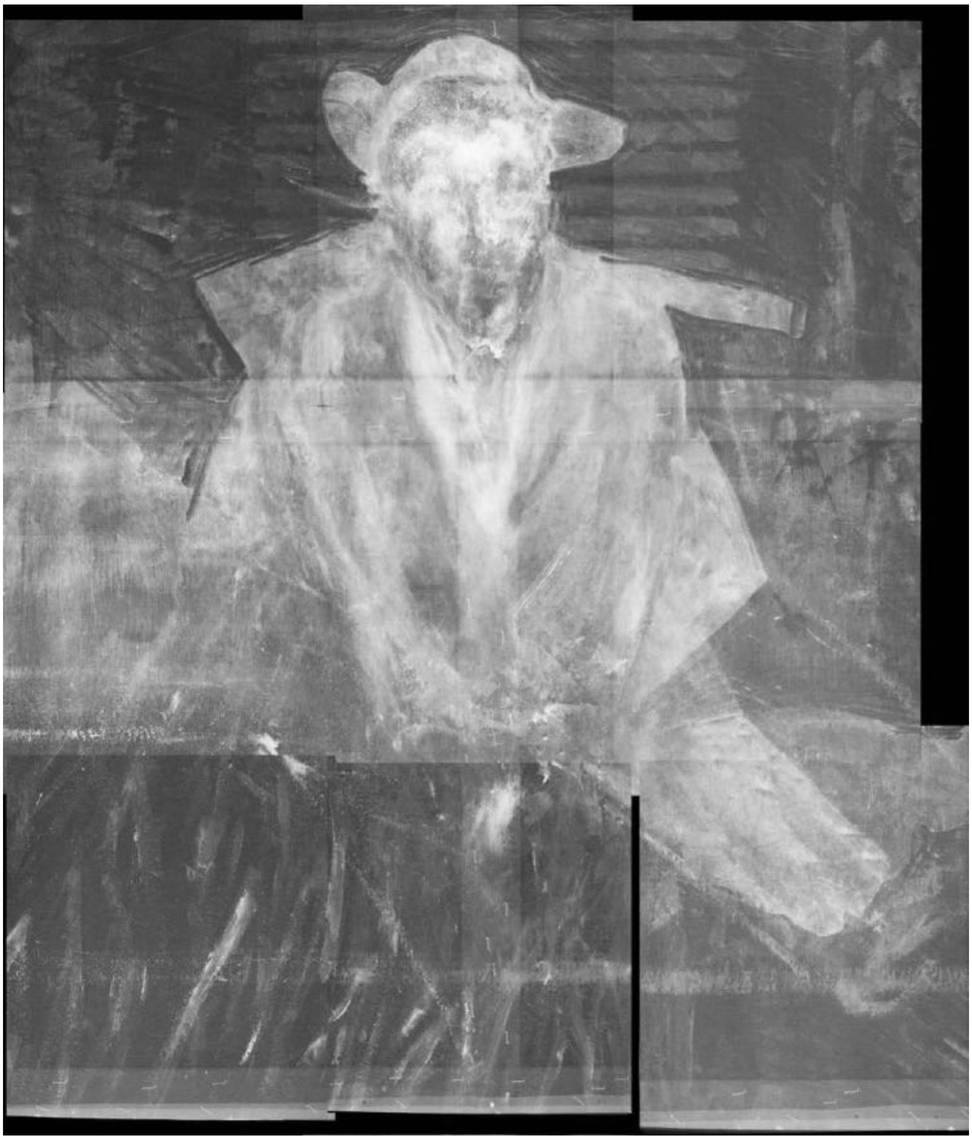

Figure 6.20. X-ray of *Study for a Portrait of Van Gogh I*

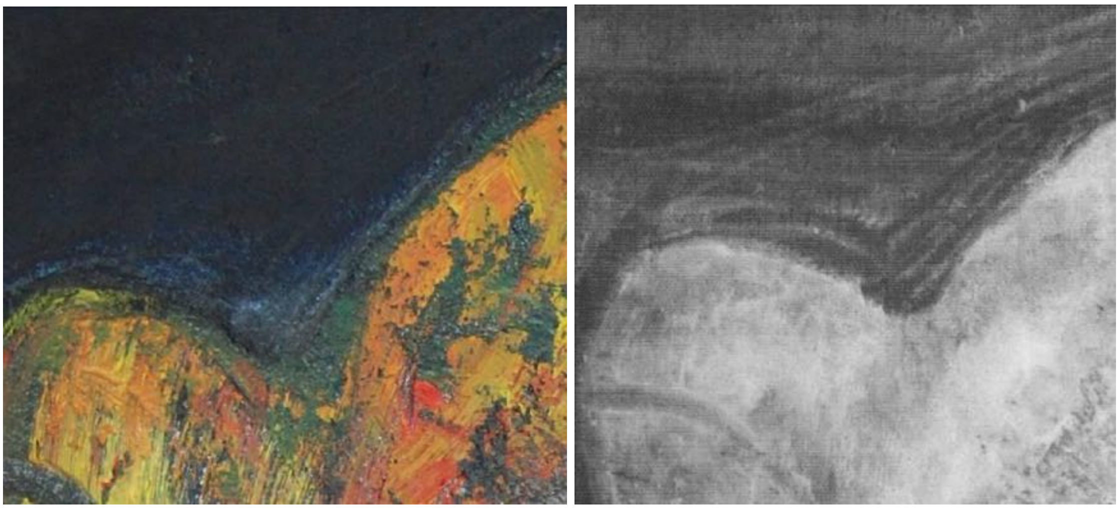

Figure 6.21 Detail of left side of hat in visible light, left and x-ray, right. Pale residues of paint can be seen around the edges of the hat in the x-ray, subsequently covered with dark blue paint.

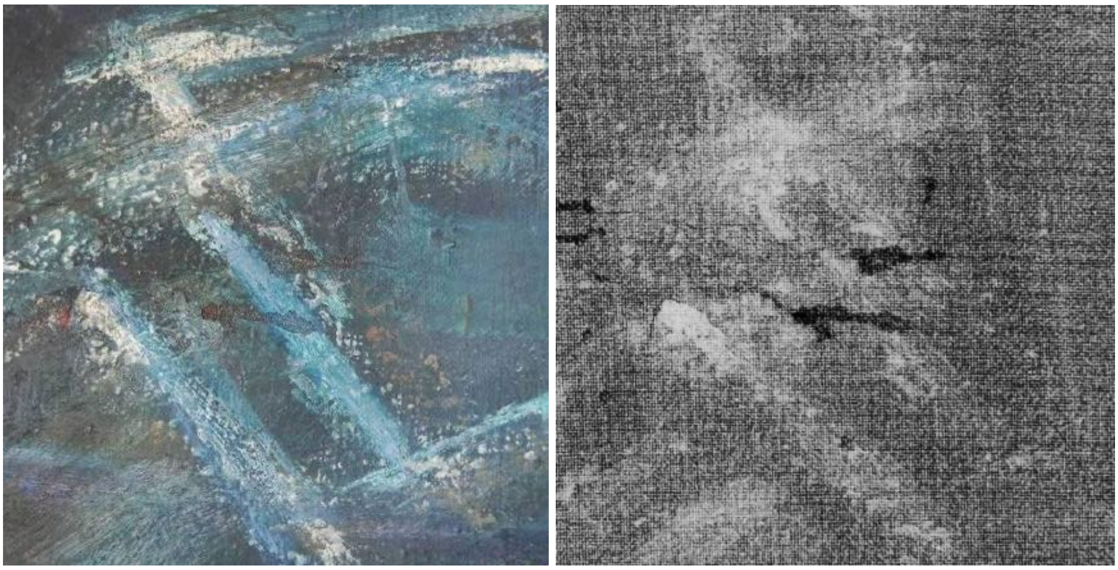

Figure 6.22 Detail of FB06 from area on right side of booth, showing paint losses in normal light (left) and in x-ray (right)

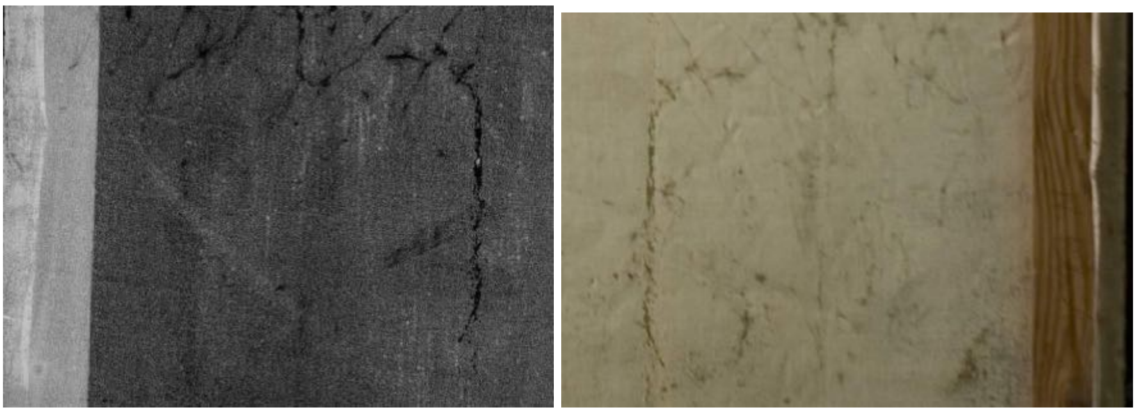

Figure 6.23. Lower left area of FB06 showing long scratch to priming layer on back of canvas in x-ray (left) and normal light (right)

FB06 Untitled (Pope), 1959

In the x-ray a faint curved line can be seen to the left side of the booth, which appears to show the edge of the booth was originally much further to the left and lower down than it now appears. This line appears to have been covered by the background colour.

Many losses can be seen as black patches in the x-ray, but not all relate to paint losses on the front of the canvas – some are due to losses to the priming layer on the back, for example the large area of loss in the upper left corner. It is not easy to tell the difference without close examination of the front and back of the canvas.

Chapter 7 Discussion of Bacon's Materials

This chapter brings together the information gathered from the studio and paintings in Chapters 5 and 6. Bacon's choice of materials is discussed here, as well as the importance of this to his work and evolving style. Implications for the conservation of Bacon's works resulting from his use of materials are also explored.

7.1 Timeline of materials

Supports and primings

The supports of the paintings examined in the study appear to be consistent with the overall trends identified from the survey of supports carried out in chapter 5. A limited number of different canvas sizes are used regularly, particularly in later works, and in earlier works the sizes used appear to link fairly closely with date. Similarly, analysis of primings found several distinct groups of works from similar dates with the same type of priming. All earlier canvases had oil-based primings, with alkyd primings found from 1971 onwards. Only one acrylic priming was found, on a work from 1986. Three different groups of canvases appeared to include a work with the Roberson '118' stamp (types B, E & F), from c.1960-64, c.1982 and 1985, showing the variation in priming in what would have been sold as the same canvas type. It is not known whether the other groups identified were made by a different manufacturer, or represent other changes in formulation made by Roberson.

Comparing these results with the information from staff at Chelsea Art Store (Winner, 2009), we might expect that priming type A is also on a Roberson canvas, used from c.1949-60. Type C, found from c.1965-7 might be made by a different manufacturer, as Bacon was said to have switched to a Winsor & Newton canvas in the early1960s, however no makers marks were found. Another alkyd priming, Type D, was found on works from c.1971-5. One of these canvases had an inscription indicating this was a '118' priming, although this was not an actual maker's stamp, so it is uncertain how reliable this information is. However this might indicate that Type D is also a Roberson canvas. Bacon had evidently returned to using Roberson 118 canvases by the late 1970s, as shown in receipts from 1976-80 and the marks on works from the 1980s. The 1986 canvas with an acrylic priming might be the acrylic-primed Daler-Rowney canvas reported by staff at Chelsea Art Store, used in later years. If so this appears to have been adopted after March 1985, when several small Roberson canvases were bought. However, it's also possible that canvases from different manufacturers were used for different sized works.

White pigments

The results from paintings showed lithopone and zinc white used in a few early examples, but lead white was the most commonly used white pigment for much of Bacon's career, found in works from 1944 to 1975. Zinc white was specifically mentioned by Bacon in a letter to Sutherland from 1947 (see chapter 5). No tubes of zinc white oil paint were found in the studio, although one jar of dry pigment was present. This might suggest that zinc white was mainly used early on in Bacon's career. Flake white was the most abundant white pigment found in the studio, with a large number of tubes dating from before 1972, but fewer examples from after this date.

Titanium white was first found in a work from 1950-2 and was found occasionally after this in a small number of works, often as a component of household paints, but did not appear to fully replace lead white until the 1980s. The use of titanium white in preference to lead white occurred much more quickly and completely in household paints than in artists' materials, due to concerns over toxicity, with the larger volumes used. Most tubes of titanium white in the studio were from post-1972, and receipts showed titanium white was the most common colour bought in the late 70s, although three tubes of flake white were also bought in 1977. A mixture of both lead and titanium whites was found in samples of oil paint forming the beige background in a painting from 1975, possibly an indication that titanium white oil paint was introduced at around this time, and appears to show that the two white pigments were being used more-or-less interchangeably.

Black and brown pigments

Ivory black was found in some early works, but a wholly carbon-based black appeared to be more commonly used, likely to be lamp black from the evidence of the studio and receipts. Lamp black was the only black found amongst the oil paint tubes in the studio, although some other kinds of black paint were found, including two tins of blackboard paint. Analysis showed that both blackboard paints contain a wholly carbon-based black pigment, one with an oil and the other an alkyd medium. Both also contained large amounts of chalk added to give a matt surface. The black paint used in the black background of F36 from 1986 closely matched the alkyd blackboard paint. The black background in two other works from the 1980s appeared to be made from a household PVAc paint, again with chalk extenders.

Raw umber was only identified on a small number of early paintings, despite many tubes of raw umber oil paint being found in the studio. However, this material might not always be easy to distinguish from other iron oxide pigments, particularly at low concentration. Other iron oxide pigments were identified in some household paint samples, probably Mars colours.

Red, pink and violet

Vermilion was the most common red encountered on the paintings, with cadmium red also found in many samples. In the studio, tubes of both colours were found, but permanent rose and alizarin crimson were by far the most abundant. Alizarin crimson was thought to be present in several paintings. Permanent rose was thought to be present in only one sample, on a work dating from 1975, although this may partly reflect the difficulty of identifying this pigment, reported to be quinacridone PV19, which cannot be identified by PyGCMS. Permanent rose was thought to be present in this one sample from the close similarity of the FTIR spectrum to that of a tube of this colour sampled from the studio.

In many cases pinks used for flesh colours are very pale, and results are dominated by the white pigments, making it difficult to identify the red or pink, present at low concentration. In some cases red pigments present in isolated areas in cross sections were thought to organic, but could not be identified due to the small amount of material present. Winsor red was a fairly abundant colour in the studio, identified as naphthol red PR188 in three tubes analysed, but was not identified in samples from paintings.

Also in the studio were large amounts of dry pigments alizarin crimson and rose madder. Particles of what appeared to be rose madder were identified in several samples from 1980s works, from their distinctive fluorescence in UV.

Orange

Cadmium orange was identified in the background of 3 works from the 1940s and was also found as the background of an unfinished canvas dating from the 1980s. This was by far the most common colour found as a dry pigment in the studio (more than 25 containers), and Bacon said that orange was his favourite colour (Archimbaud, 1993). In contrast only two tubes of cadmium orange oil paint were found in the studio. One sample in the Sketch from 1943-4, analysed at Tate, was thought to contain molybdate orange, but this was not found elsewhere. Winsor orange was the most common orange oil paint colour in the studio, and was also represented as a dry pigment (identified as Perinone orange PO43), but was not identified in any painting. Several orange household paints sampled, both in the studio and on a painting, appeared to use mixtures of organic red and yellow pigments.

Blues

Amongst the studio materials Prussian blue was most abundant blue pigment and was also most commonly found in the paintings analysed, particularly used in the 1950s and 60s. This was often used as a thin stain to the canvas, to form areas of background and dark blue couches. It is likely that it was also used for backgrounds in works such as *Man in Blue,* 1954. French ultramarine was also well represented in the studio materials, but less commonly identified in paintings. A small quantity of cobalt blue was found in the studio, and identified on works from 1949 and 1973. Cerulean blue was also identified in works from 1949 to 59, but not seen among studio materials.

The colour blue was generally less used in later works, except for a pale blue with the appearance of a household paint, used in areas of background in works from the 1980s, often as a pale blue window within an orange background. A similar colour was analysed from the background of a small portrait from the 1980s. However the concentration of blue pigment was very low and it could not be identified. In a household paint such as this, phthalocyanine blue is likely to have been used, as an inexpensive blue pigment with high tinting strength.

Greens

Viridian was used as the green pigment in several early works, but from the late 1950s phthalocyanine green becomes more common, and was found in several paintings as the pigment used for the green ground layer. *Study for Figure VI 1956-7* was the first work examined to have a green background, made with phthalocyanine green PG7. This pigment is marketed as Winsor green by Winsor & Newton and this was the most common green among the studio materials, followed by viridian and a small number of cobalt green tubes. Although a single example of emerald green was found on a painting, this colour was not found in the studio, and was phased out of the Winsor & Newton range in the early 1960s.

Phthalocyanine green PG7appears to have been used consistently in all the paintings sampled with a green-stained background. It is probable that this is the 'Belcher's green' Bacon referred to (Edwards & Ogden, 2001).

Yellows

Cadmium yellow and barium chromate were found most frequently in paintings, the latter sometimes as a component of flesh paints. Barium chromate is the pigment found in Winsor & Newton Lemon yellow, of which only two tubes were found in the studio. The dry pigment chrome lemon was well-represented in the studio, but analysis showed this to be lead chromate (found on only two early works).

Yellow ochre was the commonest yellow oil paint in the studio, followed by Cadmium yellow (including pale and deep shades). 'Jaune Brilliant' was also fairly common – a mixture containing cadmium yellow, flake white and vermilion. Winsor yellow was found as both oil paint and pigment in the studio, both of which contain arylide yellow PY1. This pigment was found in only one oil paint sample from a painting. However, it was also a component of household paints found both in the studio and on paintings, both in yellow paints and mixed with other pigments to form orange and green shades.

Timeline of pigments

The occurrence of different pigments over Bacon's career is summarised in the following two charts, with crosses used to indicate the pigment was found in a painting from this year. Crosses in bold are used to show the pigment was found in more than one work from this year.

	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76-81	82	83	84	85	86	87	88	89
Lithopone	x	x														?																									
Zinc white		x				x		x					x																												
Lead white	x					**x**	x	x	x				x	x		x	**x**		**x**	x	x	**x**		x	x				x	x		x									
Titanium white									x		x								x	x		x						x				x		x			**x**	x			**x**
Ivory black	x	x				**x**							x			x																									
Lamp black						x	x	x	x		x								x			x								x							**x**	x			**x**
Raw Umber						**x**					x		x																												
Sand							x	x											x	x	x			x								x									

Figure 7.1 Distribution of black and white pigments found in works from c.1944 to 1989. The hatching indicates no painting was sampled from this year. Crosses in bold indicate the pigment was found in more than one painting analysed from this year.

	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
Iron oxide red																x		
Vermilion	x	x				x			x				x					
Cadmium S/Se	x	x							x				x	x		x	x	
Alizarin crimson	?	x				x					x						x	
Cobalt violet			x			**x**	x	x								x	x	
Rose madder																		
Ultramarine		x					x	x	x							**x**		
Cerulean blue						**x**			x							x		
Cobalt blue						**x**												
Prussian blue									x		x		x			x	x	
Viridian						x		x			x		x					
Phthalo green						x							x	x		x	x	
Cadmium yellow	x	x				x		x	x				x	x				
Ba chromate							x									x		
PY1 arylide													x					
Yellow ochre																x		
Lead chromate	x										x							

	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76-81	82	83	84	85	86	87	88	89
Iron oxide red							x									x			x				**x**
Vermilion	x			**x**		x	x					x		x									
Cadmium S/Se	x	x	x	x			x				x								x	x			
Alizarin crimson	x		x	x		x																	
Cobalt violet	x	x	x	**x**			x									x							
Rose madder																			x				**x**
Ultramarine														x									
Cerulean blue																							
Cobalt blue												x											
Prussian blue	**x**	x		**x**							x	x		x									
Viridian						x																	
Phthalo green	x			x		x	x			x	x					x							
Cadmium yellow		x	x											x									
Ba chromate				**x**			x				x												
PY1 arylide										x						x							
Yellow ochre						x								x									
Lead chromate																							

Figure 7.2 Distribution of pigments found in works from c.1944 to 1989. The hatching indicates no painting was sampled from this year. Crosses in bold indicate the pigment was found in more than one painting analysed from this year.

Zinc white is only noted where this was a major component of a paint layer, not as a minor component in combination with lead white or titanium white. The majority of pigments were found in at least four works. Only a very small number of pigments were found as isolated examples in just one work, summarised below.

Table 7.1 Pigments found in only one painting examined

Year	*Pigment*
1957	Emerald green
1962	Manganese violet
1975	Permanent rose
1982	PR144/166/214 (disazo condensation pigment)

Media

Oil paint was used in all works examined, and was always found in flesh paint samples, where analysed. It was also used to create the thin stained backgrounds, probably thinned with turpentine, and mixed with sand for thicker textures. Relatively few acrylic or PVAc paints were found, but this probably reflects the spread of dates of works sampled. No artists' acrylic paints were identified in paintings, and very few tubes were found in the studio. The extenders found in acrylic and PVAc paint samples indicate that these are household paints. The three samples of acrylic housepaint found on paintings all have the same copolymer as that found in tins of Dulux paint from the studio. Six other paintings include PVAc housepaints, like the Carsons tins from the studio. Another painting appeared to have an acrylic-PVAc copolymer housepaint in two samples from background colours.

An alkyd paint, possibly a primer or household paint was first found in a work thought to date from the early 1950s, and appears to have been used as the principal white paint, and mixed with other colours, probably oil paints. This work appears fairly unusual, as in all other paintings analysed from the 1950s, only oil paint was found. Not a lot is known about this work's history, making it difficult to draw further conclusions.

The binders in spray-paints were not always identified due to the thin nature of these paints in many cases. These paints were usually identified using pyrolysis of a paint sample including layers of spray paint, but in this case it was sometimes difficult to identify which pyrolysis products originate from which paint components. An acrylic binder was identified using pyrolysis in the red spray-paint on F98 and F122, which matched that found in the Humbrol Krylon spray-paint from the studio. Spray paint on F36 had a styrene-based binder, apparently the same as that in U-Spray paints from the studio.

Pastel is reported to have been used in several accounts, particularly in order to get an intensity of colour, but was difficult to identify in samples, particularly if mixed with other media, as Bacon is reported to have done. Pastels are compressed sticks of pigments and inert fillers with a binding medium which might be oil, casein or gum (Townsend, 1998). However the small amount of binder compared to pigment and filler makes this difficult to identify, and also to distinguish pastel from an underbound oil paint. However, the pastel samples taken from the studio contained a high proportion of kaolin filler, which would not be seen in an artists' oil paint sample.

One of the works sampled was reported to be oil and pastel on canvas, but no evidence of pastel was found in any of the samples taken, although some strokes of what was believed to be pastel were observed (*Three Figures and Portrait*, 1975). It appears that pastel was used more extensively in some earlier works, for example in *Painting* 1946, and in one work examined in this study from c.1959. In these cases pastel appears to have been used mixed with oil paint in large areas, and in both cases appears to have led to problems with flaking. Bacon may have stopped using pastel in this way when these problems became apparent, as pastel appears to be used more sparingly in later works, observed as thin strokes of material used to outline features fairly late on in the painting process.

Dry pigments also appear to have been used to create intense areas of colour, and several containers apparently used to hold cadmium orange pigment were found in the studio. One abandoned canvas prepared with an initial layer of cadmium orange was also found, and it is likely that this was also used in the intense orange background in works such as *Figure in Movement* 1985. In all samples tested, from the studio containers and canvas, no binder could be identified, although the pigment in one case had the appearance of having been mixed in some kind of liquid so that it could be applied by brush. Whether this was simply a solvent which would have later evaporated, or contained some kind or resin or oil binder, it has not been sufficient to bind the particles. The matt orange surface of the canvas is extremely powdery and subject to loss of pigment.

7.1.1 Discussion of Pigments

It appears that Bacon was very consistent in his choice of materials and certain pigments were found on numerous occasions. In addition, the paint tubes found in the studio show a small number of colours were heavily used, from the number of duplicate tubes. Many of these were used over an extended period, with the same colours often used for the same types of features in paintings.

One significant change was the replacement of lead white with titanium white, in common with many artists. However, this change was not made until relatively late on in the mid-1970s. The use of lead white in household paints declined since 1921, when health concerns became known, and its use began to be restricted (Seymour & Mark, 1990). Titanium white was listed in Winsor and Newton's catalogues from 1935 onwards (Winsor&Newton, 1935), and was being recommended in several artists' manuals in the 1960s (Bazzi, 1960; Hiler & Gordon, 1962) though some advised caution (Laurie, 1967). The correspondence between Bacon's friends Isabel Rawsthorne and Peter Rose Pulham discusses the merits of various colours; Rose Pulham writes in 1956:

> 'Titanium white, this is a great discovery, Hiler recommends it and so does Gowing, I am now using it – do try it, it is very much whiter than zinc or lead and has what I find an extremely agreeable quality, it is light in weight and has an infinitely more agreeable texture than the rather sticky others.' (Rose Pulham, 1956)

Bacon's use of lead white paint well into the 1970s, as well as the continued use of other hazardous materials such as powdered cadmium pigments seems to indicate that he was not overly concerned about the toxicity of these materials.

Because Bacon tended to use the better quality artists oil paints, rather than the cheaper ranges, there are relatively few organic pigments in his work. Winsor & Newton use fewer organic pigments in their artists' oil colour range, compared to their cheaper oil paint and acrylic ranges (Winsor&Newton, 1986). The majority of the organic pigments detected in paintings were found in household paints, where they offer a cheap means of obtaining bright yellows and oranges (Wicks *et al.*, 1992). In oil paints, inorganic pigments appear to be used more frequently, such as vermilion, chrome yellows and cadmium colours. Although several tubes of the organic ‘Winsor’ colours were found in the studio, these were not much found in paintings, apart from Winsor green. Winsor yellow (Arylide pigment PY1) was found in only one oil paint sample but ‘Winsor green’ (phthalocyanine green PG7) was very commonly used, and ‘Windsor green’ is mentioned in several notes found in the studio. Prussian blue however, appears to be the most common blue pigment, rather than phthalocyanine (‘Winsor’) blue. Alizarin crimson appears to be the most frequently used organic colour and rose madder pigment was also found in some late works.

Organic pigments were found in several tins of orange household paints in the studio. One of the same orange paints was found in the background of a work from 1982, but some orange backgrounds, even in later works, appear to still use cadmium orange, and compared to the household paint this is noticeably more vibrant (although it is possible that the colour of the household paint has changed over time).

In examining the paintings it was noted that Bacon’s palette was generally more limited in later works, with black, white and pink being the most commonly used colours, especially in small portraits. In the studio also, large amounts of lamp black, titanium white, alizarin crimson and permanent rose were found, likely to be related to this final period of work.

7.1.2 Discussion of Media

Oil paints were found throughout Bacon’s career, applied in a variety ways to create different effects and textures. Oil paint in early works is used in broken strokes, the strokes of thick paint picked up unevenly by the canvas weave, showing the canvas texture in gaps. In addition, by thinning the oil paint with turpentine he could stain the canvas to give a variety of ground colours, while still retaining the grab of the canvas weave for his strokes of pastel or dry paint. This could be used to create effects with minimal application of paint. Oil paint could also be mixed with sand to create thick impasto textures in backgrounds.

With the introduction of synthetic household paints, Bacon appears to have started to substitute these for his oil paint in some areas of background. The desire for a flat neutral background seems to be a common theme, and is mentioned often by

Bacon in interviews. He describes wanting ‘a very clear background against which the image can articulate itself’ or ‘make chaos in an isolated area’. Thus making a sharp contrast between figure and setting to throw the subject forward more starkly. In the 1963 interview he talks about doing this using an ‘absolutely thin stained background’[66], but at around this time he also starts using household paints to get this flat background effect. In this case an even greater flatness can be achieved, as the housepaint will cover and fill the canvas weave texture, and leave a brushstroke-free surface.

Bacon used household paint in backgrounds but continued to prefer oil paint for figures. One might think that although the household paints would have been no good for his manner of painting figures, an artists’ acrylic paint with a similar texture to an oil paint might have been used effectively. But there are a number of reasons why this might not have been the case. The faster drying time of acrylics, while marketed as an advantage, would not have suited Bacon’s way of working, blending the colours on the canvas wet-in-wet. The fluid blending of colour would need a soft consistency of paint which does not quickly form a surface skin, as acrylics would. It is also likely that the use of oil paint provided a physical connection to the work of the old masters who Bacon admired, particularly Rembrandt and Velasquez in whose work the paint surface is also very apparent. Bacon was aware of the importance of the material of which his art was made, illustrated by his comments about the interlocking of paint and image recounted in chapter 1 (Bacon, 1953). In one discussion with Sylvester he talked about the different effect on the sensibilities of the Sphinx if it were made of bubblegum (Sylvester, 1993, p.58).

> ‘I think it has to do with endurance…images accumulate sensation around them the longer they endure’

It is possible that the modern, plastic acrylic paint could be seen as a similar material to bubblegum, in contrast to the long-lasting evidence from the painters of the past.

Bacon did not draw particular attention to his use of household paint, and although mentioned in interviews its use does not appear to have been recorded in any specific works. In one work from 1975 it is interesting to note that Bacon wrote on the reverse that the media was ‘Oil and pastel on canvas’ with no mention of the

[66] Audio clip available at http://www.bbc.co.uk/bbcfour/audiointerviews/profilepages/baconf1.shtml . This excerpt does not appear in the printed interviews.

acrylic household paint which appears to have been used over much of the background.

7.2 Bacon's choice of material

Most of Bacon's materials do not appear to be unusual, as they are commonly available commercial artists' materials. Canvases were bought from Roberson, a long established company supplying artists' materials since 1810, with a long list of eminent artists as clients (Woodcock, 1995). Roberson 118 canvases were reportedly used by William Scott and Sir William Coldstream in works from 1946 and 1967-8 respectively, and several artists including Graham Sutherland report using Roberson oil paints (Cobbe, 1976). Bacon's oil paints were nearly always bought from Winsor & Newton, another established supplier, with a reputation for producing good quality artists' materials. These oil paints have also been used by many 20th century British artists, including Barbara Hepworth and Ivon Hitchens (Cobbe, 1976).

Roy de Maistre is the first artist Bacon is known to have associated closely with and is said to have guided Bacon's first attempts at painting in oils, after his initial experiments using pastel and gouache. We might expect that the two artists would have used similar materials at least in this early period while Bacon was learning from the more established artist. De Maistre developed his own theory of colour, in which colours were associated with musical notes, and patented a colour wheel based on this system in 1925 (Johnson, 1995), but little is known about the materials he used. The only evidence of de Maistre's materials we have is from the initial layers of the painting *Head* (FBA2) analysed here. This work was on board, which was also used by de Maistre in other works, and by Bacon in several early paintings, most notably the 1944 *Crucifixion*. A chalk-gypsum ground was found in the de Maistre work, with a pink made from lead white with cobalt violet. Ground layers are not often found in Bacon's work, and do not appear to have been used on the panels of *Three Studies for Figures at the base of a Crucifixion*,1944, also on board, as areas of exposed board can be seen in places.

Graham Sutherland also used Sundeala board and it has been suggested that Bacon's choice of this support might have been influenced by its use by de Maistre or Sutherland (Hammer, 2005). This support might have been easier to obtain at a time when canvas fell under rationing. Similarities can be observed between many of their works in the 1940s, for example in the use of modelled grisaille forms against a brightly coloured flat ground (Hammer, 2005). In particular, the bright orange colour used in Sutherland's *Horned Forms*, 1944 might be the same as that used in *Three Studies for Figures at the base of a Crucifixion*, 1944.

In these early works we might also expect wartime shortages and post-war rationing to have an effect on the materials used. Canvas was in short supply during the war years and restrictions continued for some time afterwards (Harley, 1987). The white pigment lithopone found in the two 1944-5 works is a low-cost material which might have been used in paints as an alternative to more expensive or difficult to obtain materials in wartime.

In common with many artists working in postwar London, Bacon's palette became very monochrome in the 1950s (Calvocoressi *et al.*, 1995). From 1949 Bacon's work becomes more 'raw' in appearance, with significant areas of canvas left uncovered. Sand is also used extensively in some works. Bacon said he admired the 'rawness' of Picasso's technique (Durham, 1985), who also added sand to some works, as did other artists including Braque and Kandinsky. The idea of 'Art brut' or 'raw art' was coined by Jean Dubuffet in the mid 1940s and taken up by artists including Jean Fautrier and Alberto Burri (Cardinal). This rawness was reflected in the materials used, with Dubuffet including sand and grit with oil paint, for example in *Monsieur Plume with Creases in his Trousers (Portrait of Henri Michaux)*, 1947. Burri explored the textures of diverse materials including tar and coarse burlap canvas. Sutherland is also reported to have used raw canvas (Durham, 1985), but it is not known when this was first employed, and whether he or Bacon was first to use this support.

Bacon had probably heard about Picasso's use of household paint Ripolin, which seemed to become well-known and was also adopted by other artists including Ben Nicholson and Patrick Heron (Standeven, 2003). Lucian Freud also experimented with it in *Landscape with Birds*, 1940 (Feaver, 2002). By the 1950s similar commercial paints were also reportedly used by American abstract expressionists such as Jackson Pollock. Bacon appears to have used a household paint in around 1950, but this was not his usual practice and he did not regularly use such materials until the early 1960s. In this early example, the household paint appears to be used as though it were an oil paint, without any obvious exploitation of the different effects possible with this type of paint. Its use therefore may have been due to its availability, rather than any desire to produce specific effects, and this implicit use of material is thought to be common among British artists at this time (Standeven, 2003). The use of household paint in this way is probably more widespread than previously thought as it appears to be largely undocumented.

The use of commercial paints by British artists does not appear to be made explicit until the work of artists such as Richard Hamilton, who used these industrial materials as part of the pop art movement. Using such mass-produced materials tied in with the popular, commercial ideas of pop art. However these materials appear to have been used more often by artists for their aesthetic or functional qualities rather than to communicate any political message (Standeven, 2003). When Bacon begins to use these materials more overtly in the 1960s, it appears that he is also using them primarily for their aesthetic qualities, and he does not discuss their use much, in contrast to his comments made about oil paints. Acrylics are only mentioned in opposition to oils, describing them as more predictable in their behaviour. The term ‘acrylic’ appears to be used here to cover any synthetic medium present in a household paint. From the results of this study, artists’ acrylics appear very little used, if at all.

In contrast, the use of oil paint appears to be more important to Bacon, and he describes wanting to use these traditional materials in a new way (Sylvester, 1993, p107). Oil paint might have been used as a conscious link with the past, in the same way that Bacon referred to the work of artists including Velasquez, Rembrandt and Van Gogh in both his art and conversation, the use of the same essential material might have provided another connection between their work and his own. A preoccupation with oil paint was shared by some contemporaries, with Willem de Kooning’s remark that ‘Flesh was the reason oil paint was invented’, apparently recalled by both Bacon and Lucian Freud (Calvocoressi *et al.*, 1995).

From the 1960s, modern synthetic paints start to be used by Bacon and provide a more modern aesthetic with figures in flat, bright interiors. Many colour field artists at this time were also using expanses of flat colour. Some of these artists appeared to continue to use oil paints in the 1960s, for example Patrick Heron, while others such as Kenneth Noland were using the new acrylics to paint flat blocks of colour. Bridget Riley used household emulsion paints to produce a uniform matt finish and avoid any distractions caused by the paint surface (Crook & Learner, 2000).

The use of household, rather than artists' acrylic paints by Bacon points to his choice being influenced by convenience, as these paints could be used to quickly cover expanses of canvas with brush or roller, and could be bought in ready-mixed shades. The colours chosen often appear like those used in interior decoration, particularly some of the pale lilac shades used in the 1970s. Although they may have been used to replicate the appearance of a painted interior, Bacon did not draw attention to the fact that they were household paints, which might show that this connection was not particularly important to him, unlike Hamilton's car paints, which were used in a conscious way for the image of a car (Crook & Learner, 2000).

In several of the works examined, two layers of household paint appear to be used, possibly to ensure the opacity of the colour, for example orange is used over grey in FB18 and orange over brown in FB05. This may also have helped to fill and smooth the canvas texture, resulting in a very different effect to that achieved with thinned oil paint. In some works where the layer beneath is white, the effect is very similar to that of a priming layer, but applied only over the areas of background, with the unprimed canvas receiving the oil paint for the figure. The household paint would have made it possible for Bacon to change background colours much more readily than would be the case where thinned oil paints were used.

From the 1970s Bacon uses Letraset and spray paints, materials associated more strongly with commercial art and graphic design than with fine art. The 'rawness' associated with earlier works is largely abandoned, although sand is still used in some areas of backgrounds.

Surfaces and textures appear to remain important to Bacon throughout, from the fuzzy texture of the dust in Figure in a Landscape, 1945 to the rugged grey surface of Head II, which might be related to Bacon's wish 'to paint like Velasquez but with the texture of a hippopotamus skin' (Time, 1949). Then the texture of the canvas itself, with paint barely skimming the surface, and the areas of thickly impasted paint with added sand and pressed-in cloth-patterns. Housepaint may be used to imitate its effect on interior walls, to give a smooth matt finish, and may have been chosen to suppress any painterly effects in the background, in order to create a greater contrast with the figure.

Paint was the only medium through which Bacon expressed himself. Although he did reveal an interest in doing sculpture, this was never realised (Sylvester, 2000).

The small number of drawings which survive were rehearsals for the paintings and Bacon evidently did not view these as having artistic merit in their own right. Oil paint in particular seems to have been essential to him in allowing him to depict flesh.

The changes to Bacon's style over the years appear to be inextricably linked to the materials he was using. Although oil paint remained a constant, the way in which it was used and combined with other materials went through several distinct phases. As a largely self-taught artist, he appears to have developed and perfected his own particular methods of using his chosen materials, and appears to have remained very consistent in both the materials and techniques used. Throughout his career he single-mindedly pursued the depiction of the human figure in paint, using methods which were gradually adjusted over time. A variety of effects were achieved through the introduction of different materials, particularly in backgrounds. Different textures are created, which contrast with the painting of figures. However oil paint is still used to 'come across directly onto the nervous system', in Bacon's own words.

7.3 Conservation

Most of the paintings examined appeared to be in a fairly good state of preservation, with any major problems resulting from poor treatment of the paintings such as rolling of the canvas leading to mechanical damage. However, the materials and techniques used by Bacon lead to a number of issues for the conservation of his works. Some potential problems and concerns for the preservation of his works are highlighted in this section.

Adhesion of paint

The adhesion of paint and pastel to the canvas is problematic, particularly in early works before Bacon started to use the reverse (unprimed) side of the canvas, which provides better tooth for dry pastel media. It is reported that the large *Painting* 1946 is too fragile to be moved because of the extensive use of pastel, mixed with oil, over a commercial priming. One of the paintings examined (FB06) also appeared to have a significant pastel component and had suffered problems with flaking in several areas, exacerbated by the canvas having been off its stretcher for some time.

Underbound paint and pastel

The use of dry pigments and pastel means surfaces are often fragile. Paint is applied directly to raw canvas in Bacon's work, with the results that the oil medium is absorbed to some extent, leaving the paint underbound. In several cases it has been reported that pigments are soluble in water or white spirit which might be used for cleaning. According to Tate conservation records, works including *Figure in a Landscape*, 1945; *Study for a Portrait of Van Gogh IV*, 1957 and *Reclining Woman*, 1961 exhibit sensitivity to both solvents in paint passages of several different colours (Tate, 1970; 1971; 1973). It is uncertain whether this is because paint is underbound, or if these are examples of the phenomenon of water-sensitivity in modern oil paints (Burnstock *et al.*, 2008).

Fixatives appear to have been used by Bacon, and there is evidence that *Painting* 1946 was sprayed soon after completion, however this was not sufficient to correct underlying problems. Bacon also mentioned setting the dust he sometimes applied 'as one sets a pastel' (Sylvester, 1993, p.192), again presumably with fixative spray.

Friable/poorly adhered materials

Materials such as dust and sand scattered onto the surface may often be poorly attached and vulnerable to being dislodged. Similarly pastel may be powdery and easily knocked from the surface. Use of Perspex glazing may be a problem due to the static generated, as for any other work in pastel. The use of dust on the surface presents an additional difficulty to conservators, as it might be difficult to tell if this was deliberately added or is dirt built-up over time.

The addition of large quantities of sand can also make paint brittle and weak, as there is a lower proportion of the paint medium holding it together. In the work *Untitled (Figure Crouching)*, c.1950-1, the thick sand-encrusted paint in the central area has been particularly vulnerable to cracking and paint-loss after the canvas was stored rolled-up.

Thick impasto

Many works have areas of very thickly applied paint with high impasto. Sometimes the thickest areas have become flattened on the highest points, which in many cases appears to have occurred fairly soon after completion of the painting, when still-soft paint was leant against a hard surface, for example leant against a wall or put in a glazed frame. The thickly sculptural surfaces often have delicate peaks of high impasto which are vulnerable to being broken. This will also make surface cleaning more complicated and delicate.

Lack of varnish

All of Bacon's works are unvarnished, meaning the paint will be more exposed to dust and environmental conditions in general without this protective layer. However, it is fortunate that Bacon himself favoured the aesthetic of seeing the paintings behind glass, as it gave them a certain distance from the viewer. Therefore the majority of works are glazed, providing an effective barrier, which is particularly important given the problems with cleaning these works that have been outlined.

Mixed media

Where oil and PVAc media are combined in a painting, problems of adhesion may occur between the layers of different media. In most cases oil and PVAc appear to be used in different areas, but this could be a problem where changes in composition have meant one is applied on top of another. If a quick-drying acrylic were used over slow-drying oil paint, this might lead to drying cracks forming, however, this would become apparent fairly quickly, and examples of this have not been observed in Bacon's work. The use of different types of paint in different areas of the composition, for example, acrylic household paints in backgrounds and oil paint in figures, might need to be taken into account when making treatment decisions, such as cleaning.

Poor quality materials

In early works Sundeala board was used, which is soft and easily crumbles at the edges. Stretchers are sometimes made from poor quality wood, and are often relatively flimsy with fewer cross-bars than would be recommended for a large size of painting.

Household paints appear to have been used in many later paintings, which are not designed to be particularly long-lasting in comparison to artists' materials. They contain large amounts of extenders which might lead to chalking or discolouration. The pigments used are also likely to be cheaper than those in artists' paints, due to the volumes needed, and may be more susceptible to fading or discolouration. Household paints are also obviously designed to be used on the rigid surface of a wall, not a flexible support such as canvas, so may be more susceptible to cracking.

Colour changes

The fading of colours in *Painting* 1946 has been documented, possibly due to the use of a fugitive aniline lake pigment. Discolouration has also been noted in some areas of the background of *Three Studies for Figures at the base of a Crucifixion*, possibly associated with the use of vermilion, which can darken in some circumstances.

Analysis has shown relatively few organic pigments have been used in early works, with the reasonably stable cadmium yellows and reds being used more frequently. The most commonly used organic pigments phthalocyanine green and alizarin crimson have good colour-fastness. The pigments used in household paints might pose more of a problem, as these are often organic and the expected lifetime for this type of paint is considerably shorter than for artists' paints. The pigments detected in the works analysed included arylide yellows, which have good lightfastness but show poor resistance to solvents (Herbst & Hunger, 2004). Arylide PY74, found in one orange paint, is reported to be have improved properties compared to PY1 which was found in several other samples. It is likely that further examples of organic pigments are present in housepaints used in other works, which may be less stable.

Darkening of canvas

The areas of exposed canvas will become darker and more yellowed as the canvas ages. Where the raw canvas is used as a colour in the image, this will lead to a change in the colour balance of the image, as the original light oatmeal colour of the new canvas gradually darkens. This may also affect the appearance of thinly painted transparent colours in the images, which will also darken. The use of raw canvas also means that there is a high risk of staining and darkening through liquids applied either accidentally or intentionally, such as water damage, use of consolidants on neighbouring paint areas or ill-advised varnishing.

Use of oil directly on canvas

The sinking of oil into unprimed canvas can lead to increased acidity and darkening, and halos of oil staining where raw canvas is exposed. Occasionally areas of oil staining can be seen, for example where thick blobs of paint are applied (often thrown or squeezed directly from the tube) onto an area of bare canvas. However in many cases the paint has been applied very dry, meaning this effect is not noticeable. The fact that the canvas is primed on the reverse does seem to have provided a degree of protection from environmental factors, and has probably resulted in a better state of preservation that would be the case for a wholly unprimed canvas.

Use of thick/thin paint

Often paintings combine very thick areas of paint with areas with little or no paint. The flexible bare or thinly stained canvas will respond differently, compared to the relatively stiff thick paint layers, to factors such as vibration or changes in temperature and relative humidity. This could lead to tensions between the different areas which may result in cracking or flaking of the thicker areas of paint, or distortion in the canvas. This might be of particular concern during the transportation of paintings.

'Chance'

The nature of Bacon's work makes it sometimes difficult to judge what might be viewed as accidental damage which we might be justified in treating. Bacon was very open to the idea of chance in his paintings, which might be as deliberate as throwing paint directly at the canvas to see where and how it might land, but can also include the accidental drips or scrapes that might have occurred to a painting while in the studio. For example, drips from a leaky skylight roof, drops of paint landed accidentally from his work on a nearby canvas, scratches and scrapes from something leaning against a still-wet painting. Sinclair reports that:

> 'if a passing bedfellow did not know where to go and looked for a window to relieve himself and the golden shower fell on a wet painting, so it stayed, if Bacon liked the effect of the incident on his work in the morning. It was the same if a visitor brushed against a canvas and smudged it' (Sinclair, 1993 p.246)

These occurrences may have happened accidentally, but if Bacon was happy for them to leave the studio in this state they should be judged as part of the original work. On the other hand we might want to remove or retouch drips or scrapes resulting from careless behaviour by others which occurred at a later date. Unless we have good documentary evidence, the difference between these different categories cannot be judged with any certainty. To some extent if Bacon was happy with this kind of 'damage' it could be argued that it doesn't really matter when it occurred, but there may come a point when this becomes enough to be noticeable and distracting from the image.

Other problems noted

In *Portrait of Lucian Freud,*1951 a fatty acid efflorescence was noted over large areas of the black background, resulting in a patchy greyish appearance. This phenomenon has been noted on the work of other artists, but it is uncertain what causes it (Singer *et al.,* 1995; Ordonez & Twilley, 1998). It has been associated particularly with certain pigments, such as carbon black. The efflorescence is not difficult to remove, but has been found to recur after treatment in other cases. Free fatty acids have a plasticizing effect on the paint, therefore the repeated removal of these from the paint film may lead to eventual embrittlement.

Chapter 8 Case Studies

In this chapter some test cases are considered, in which the analysis of recently authenticated or questioned works is described and the results compared to the findings of this study. The strengths and shortcomings of this approach are also described.

8.1 Head 1949 (FBA4)

This previously undocumented painting appeared to be similar to the series of grey 'Head' paintings produced from 1948-1949 (six completed works plus one 'abandoned' work are documented by Alley, 1964). Three similar heads were examined in the study, the results from which can be compared to this work. The paint surface appears similar to that of *Head II*, 1949, with a rugged rippled texture built up from many paint applications. The paint is thickly applied over the majority of the canvas, but some uncovered canvas is left along the bottom edge, a feature which is also seen in *Head II*, and to a lesser extent in *Head (FB01).*

Support

The painting has similar dimensions to both *Head (FB01)* and *Head II* and is on the reverse side of a primed canvas. It is on a strainer with horizontal and vertical crossbars. The only other work examined to have this type of auxiliary support is the similar *Head II*. However, the canvas is not the same type in both works, with this work, FBA4, having a finer weave.

Paint

Lead white and ivory black appear to be the principal colours in the grey paint layers, but a number of other pigments were also identified in grey layers, including vermilion, cadmium yellow, cerulean and cobalt violet. An oil binder was identified in the grey paint.

Lead white was found in all three Head paintings analysed, as a major component. Ivory black was also found in *Head II* & *Head (FB01)*. Some samples in *Head II* appear quite similar to the work examined here, with a large number of different grey and blue paint layers. Grey layers with added coloured particles (vermilion, cadmium yellow and cerulean blue) are also a feature of some layers in *Head II*.

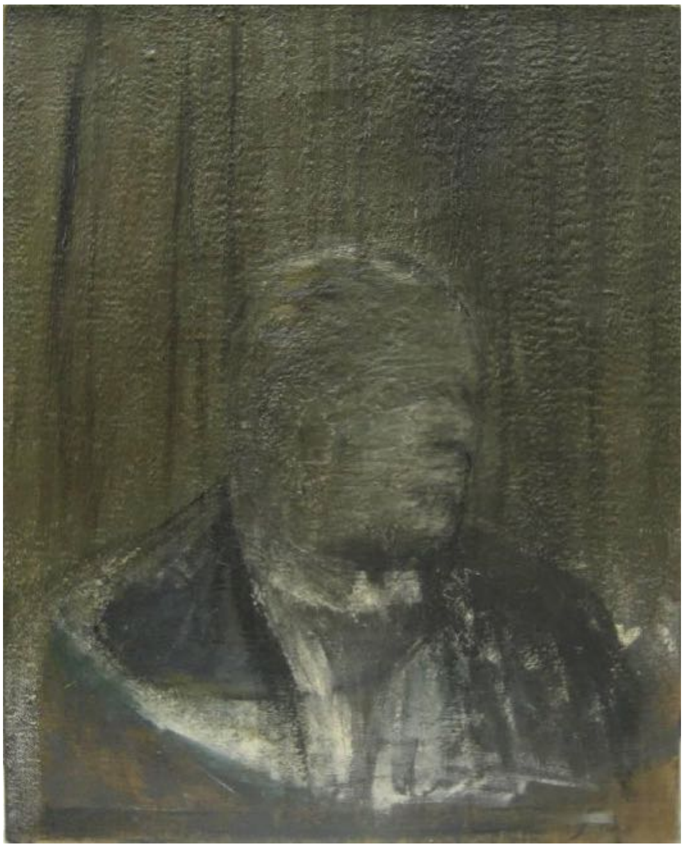

Fig. 8.1 Head, c.1949, 81 x 65 cm (FBA4)

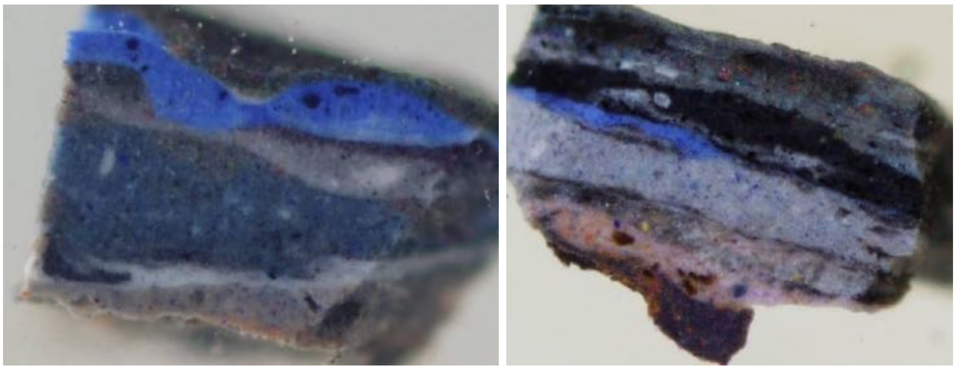

Fig. 8.2 Left, sample from grey background of FBA4. Right, sample from grey background of Head II. Both samples were taken from the top edge of the canvas.

Cross sections taken from the grey background of FBA4 and *Head II* were compared. The bright blue layer in both samples appears to contain barium sulphate with some zinc content, which could be lithopone (barium sulphate with zinc sulphide), or barium sulphate and zinc white. The blue pigment was not easily identified, but in another sample from FBA4 thought to contain the same layer, a copper-containing particle was found, suggesting this could be phthalocyanine blue, a pigment with high tinting strength which might be present at low concentration. The layers in both samples are very similar, providing strong evidence that they were produced by the same hand.

A pale green layer in FBA4 was found to contain a mixture of viridian and cadmium yellow, pigments which have been found in Bacon's works from this time. The same mixture of pigments was found in a green paint sample from *Portrait of Lucian Freud*, 1951, and in another sample (again in an underpaint layer) in *Study for a Portrait of Van Gogh I*, 1956.

As well as the similarity in materials, the way in which they are used appears to be very similar, from comparison of the cross sections.

Conclusions

Although strainers are not common in Bacon's works, the same type of auxiliary support was used for the similar-looking *Head II*, which is interesting. Overall, the materials found tie in very closely to those used in *Head II*, with some specific combinations of pigments found replicated in individual layers in both works.

8.2 Portrait of Mick Tobin (FBA9)

This portrait was said to have been given to the sitter by Bacon, then passed on to a friend, and believed by the current owner to date from the 1980s. The Francis Bacon Authentication Committee do not believe that this could be a genuine work.

Support

The dimensions of the stretcher (14 x 12 inches) and the stretching of the canvas with the white priming layer at the back are consistent with Bacon's methods. However, this exact type of support has not been encountered before in works examined during this study. The stretcher bars are not the same width as other examples of works of this size examined, and the canvas weave not as fine. In addition, the stretcher has been mis-assembled with two stretcher bars placed back-to-front, which is unexpected. The priming layer on the canvas appears to be of a type not encountered before in this research – a mixture of titanium white and chalk with a styrene-acrylic binder. Styrene is sometimes included in acrylic paints as a substitute for more expensive acrylic components (Learner, 2000).

This uniqueness does not preclude its use by Bacon – one other authenticated work investigated has also proved to have a unique stretcher and priming type in comparison to the other works examined (though this is not the same type as the work examined here).

Materials

Prussian blue oil paint was used as an initial staining layer over the background, then covered with a green mixed from Prussian blue and arylide yellow PY1. The pinkish-white used for the shirt was principally zinc white, while ivory black was used for the dark shadows of the collar. Titanium white with an organic red-orange pigment appears to have been used on the face. White, dark blue and green paints had an oil binder.

Prussian blue is very commonly used by Bacon, often as a thin staining layer applied to the canvas, as in this case. The organic arylide yellow PY1 has been found in an oil paint in one painting dating from 1956, and as a component of household paints used in backgrounds in works from c.1971 and c.1982. The same pigment is used in Winsor and Newton's Winsor Yellow, of which examples of both oil paint and dry pigment were found in Bacon's studio.

Zinc white appears to be used as the principal white pigment in the sample taken from the shirt at the bottom edge. Zinc white has been found as a solo white pigment in some earlier works by Bacon, but is much more commonly seen as a component of lead or titanium white paints in his work. No tubes of Zinc white oil paint were observed in the studio, but a jar of zinc white pigment was found. In the flesh paint however, titanium white, with a small amount of zinc white was found, which would be consistent with Bacon's practice in the 1980s. This mixture is used in many Titanium white artists' oil paints, including those made by Winsor & Newton, Daler-Rowney & Royal Talens.

Ivory or bone black (identified through the presence of calcium phosphate) has been found in some early works by Bacon, but in later works (from c.1962 onwards) all blacks tested appear to be wholly carbon-based. In Bacon's studio no examples of paints labelled as ivory or bone black have been found, but tubes of lamp black oil paint are abundant.

The red-orange pigment used on the nose appears to be a chlorinated organic pigment, probably disazopyrazolone PO34. This pigment has not yet been found in Bacon's work or been identified among the studio materials. This pigment has been commercially available since the early 1950s (Herbst & Hunger, 2004) and is used in artists' oil colours – current catalogues from several paint companies list it as the pigment used in certain red/scarlet paints (Old Holland; Royal Talens; Daler-Rowney, 2010). A bright red is used in many of Bacon's portraits of this size (particularly those from the 1960s), usually applied on a textured cloth over a white paint layer. In one small portrait dating from c.1967, this red has been identified as vermilion. Other than this, alizarin crimson, cadmium red and cadmium orange are the red/orange pigments most commonly used by Bacon and many examples of these have been found in the studio. The organic pigments Winsor Red and Winsor Orange have also been found in the studio. Where tested, these have been found to contain different pigments to that found in this work, although changes in formulation do occur in colours such as these based on organic pigments which have an unspecific name.

Both oil paint and household paint have been found in the backgrounds of other small portraits examined from the 1970s and 80s. Titanium white was found in flesh paint in works from the 1980s, with lead white used in the 1970s.

Use of materials

The use of the reverse side of the canvas is typical of Bacon's method, and the roughening of the canvas creating fibres on the surface is also often seen in his work. It appears that a thin blue paint was applied to the canvas over the background, and to sketch out parts of the composition. This might have been used to delineate the entire composition before going to work with thicker oil paints. This method was used by Bacon, at least on larger canvases, as discussed in chapter 6, where a sketch in thinned oil paint would be made first to mark out the composition on the canvas.

The face is painted mainly in white, with touches of bright red and powdery pink pigment on top. Bacon is known to have used pastel and dry pigments which might give this sort of powdery surface. His use of bright red over white on faces has also been noted, however in this case the red does not appear to have been applied using a textured cloth, which would be more usual. Areas of bare and painted canvas appear to be quite distinct in this painting – often in Bacon's work areas of partially exposed canvas are seen, where a stroke of dry paint has been dragged across the canvas texture.

The green background appears to have been applied towards the end of the process, after the face was completed, which would be consistent with Bacon's practice.

Conclusions

While the support is superficially similar to those used by Bacon, it could not be matched to other examples of his work examined. No other primings with an acrylic-styrene binder have yet been identified in Bacon's work. The construction of the painting seems to follow Bacon's general procedure, but some details appear to be unusual.

Some pigments were found which were regularly used by Bacon, e.g. Prussian blue and titanium white. However several others appear which are less typical alternatives to colours in his regular palette at this time, e.g. zinc white, ivory black and pyrazolone orange. Despite this, all of the pigments found could have been available to Bacon.

8.3 Items from Francis Bacon's studio

Three canvases were sampled which had recently been auctioned as part of a collection of items from Francis Bacon's studio. These were analysed to discover if the materials present were consistent with Bacon's technique.

Only one of the items was an intact canvas, but was said to be unfinished. The other two are slashed portraits with the main part of the face cut out, similar to canvases sampled from Dublin City Gallery The Hugh Lane.

Study of a Head (FBA5)

This painting was thought to date from the period when Bacon was in St Ives and then in his Battersea studio, and used a bright green stain for the background of many canvases, along with thickly painted flesh composed of reds and pinks (late 1959 to mid-1960). The 1960 *Head of a Woman (FB14)* is an example of a documented work from this period. The materials in the two works can be compared to discover if materials are consistent with an attribution to Bacon and the proposed date.

Support

The auxiliary support could not be fully investigated due to the presence of a backboard and lining. The canvas appeared to have been cut down at both sides, but it is not known when this occurred. Several of Bacon's works from late 1959 to 1960 appear to be on relatively unusual sizes of canvas, although none are reported to be cut down, and all are larger than the work in question (Alley & Rothenstein, 1964). The priming was found to consist of chalk and lead white in oil, applied in two layers with a higher proportion of lead white in the upper layer. The same type of priming has been found on many of Bacon's works from the 1950s and early 60s. The canvas weave, 15 by 16 threads per cm^2 is similar to that found on four paintings sampled from 1959-60 (14/15 by 15 threads per cm^2)

Pigments

The pigment in the green background is phthalocyanine green, the same pigment that was painted over the whole canvas in *Head of a Woman*, 1960 and also in *Two Figures in a Room*, 1959. A lead white based oil paint layer, with a little zinc white, is used to form the white shirt, which again matches the paint used in *Head of a Woman* for the similar white top.

The flesh paint was again lead white-based, with barium chromate and probably rose madder. Barium chromate has been found in several flesh paint samples in Bacon's work from a range of dates. Rose madder has not been identified in works of this date but is seen in later paintings from the 1980s, and was found among the studio materials. The flesh paint could not be sampled in FB14, but an accretion of pink-white paint was found stuck to the edge of the canvas, which contained cadmium red and lead white. Cadmium red was also found in FBA5, used in the pink stripe framing the portrait.

Use of Materials

The use of phthalocyanine green paint, thinned and applied as a stain over the whole canvas is a common practice of Bacon's, particularly from 1959-60. The use of a thin black layer over the green surrounding the figure, and a white layer for clothing are also features of works at this date. The flesh-paint in *Head of a Woman* is more muted in colour than the flesh in the work examined here, but more vivid tones can be seen in some other works from this period, such as *Miss Muriel Belcher*, 1959, also on a green ground.

Conclusions

There are many points of similarity between materials used in this work and those found in paintings from 1959-60. All of the materials found appear to have been used regularly by Bacon.

Fig. 8.3 Study of a Head (FBA5), 37 x 28.5 cm

Fig. 8.4 Sketch for Portrait, (FBA7), 35.5 x 30.5 cm

Figure 8.5 Study of a Dog, (FBA8), 35.5 x 30.5 cm

Untitled (Sketch for a Portrait) (FBA7)

This work uses a thin green stain in the background, like FBA5, but is thought to be of later date, from c.1967. Several examples are seen at this date of small portraits of this size, often presented as triptychs. The backgrounds are generally formed of thin stains of colour – green, red and black are commonly used.

Support

This size of canvas was used in a few works in the 1950s but didn't become common in Bacon's work until 1961, when it was used for a series of heads (Alley & Rothenstein, 1964). Unfortunately the stretcher could not be fully examined, but the canvas weave type was very similar to many examples examined from the 1960s and 70s. The priming was similar to that found on many works from the 1950s, but has not been found on works later than 1962-3.

Paint

Phthalocyanine green was used in the background, in common with other works using a green stained ground, including *Study for Figure VI,* 1956-7 and *Three Studies for a Portrait of Isabel Rawsthorne,* 1965. Lead white with cadmium red was found in the flesh paint. Both pigments were used by Bacon, and were found in flesh paint in F41, c.1962-3 and F54, c.1964 (though vermilion is generally more commonly found in flesh paint). This mixture was also found in a pink paint on the edge of FB14, though it is not known whether this was the same paint as that used for the flesh.

Conclusions

The pigments found were all consistent with those used by Bacon. The painting could not be linked so closely with a known work in the study as was the case for FBA4 and FBA5, making it more difficult to draw parallels and tie it convincingly to a particular date.

Study of a Dog (FBA8)

The painting is one of two similar small paintings which have recently come to light, believed to have been completed c.1967, inspired by a photograph by Peter Beard (Daniels, 2009). This work is apparently unfinished.

Support

The stretcher appears to match that found on several works from 1965-73 of the same size, with narrow stretcher bars and mitred corners. The alkyd priming is the same as that found on three works from c.1971-73.

Paint

The yellow-green background is an oil paint, with lead white, viridian and probably cadmium yellow. These pigments were all commonly used by Bacon, although viridian was used more often in works from the 1950s. However it was also found on a work from c.1967.

No other paint colours could be sampled from the front of the painting, but several paint splashes on the back were analysed. Alizarin crimson, phthalocyanine green and Prussian blue were identified on the back, all pigments commonly used by Bacon. Two of the splashes proved to be from household paints, both including the same acrylic binder as the Dulux household paints analysed from the studio.

Conclusions

This painting is unusual in its subject matter at this time, and its use of a landscape format, and no comparable paintings were analysed in this study. However, all the materials found appear to have been commonly used by Bacon and the support appears to exactly match that found on a work from c.1973 (F245:8). A date of 1967 has been proposed for this work.   This priming type was found on works from the early 1970s, but might also have been used before this, as no paintings from between c.1967 and c.1971 were analysed in this study.

8.4 Conclusions

The examination of these pictures highlights some of the benefits and drawbacks to this approach. For FBA4, very strong evidence was found to relate this work to *Head II*, through the combinations of pigments found, and the way in which they were used. This in turn provides good evidence for this painting being a genuine Bacon work, and of a similar date to *Head II*. However, identifying this close similarity was reliant on having the data from the *Head II* painting specifically. For example, *Head II* was the only work examined on a strainer, and also appears to be relatively unusual in its extremely thick paint layers and repeated reworking, compared to other works by Bacon. This shows the importance of having information about relevant related works to be able to compare and determine similarity.

In FBA5 also, the similarities to other works examined in the study allowed for the close comparison of materials and techniques. FBA8 was not similar in composition to any other works studied, but the support could be matched to those in other works to help provide date evidence. The study of supports from a larger number of works would add to this information and might allow a more accurate date to be estimated. The materials found in FBA9 showed less consistency with Bacon's usual palette, which might lead us to question it, but this information alone is not enough to absolutely disprove authenticity.

There is a great deal of consistency in the materials used by Bacon, but small variations can be seen, and a preference for certain materials at particular times, which allow us to construct a framework to help place paintings of uncertain date. However, it is always possible that there may be discrepancies, meaning caution is needed. The data collected on priming and canvas types seems to show quite a strong correlation with date, but there is no reason why Bacon should not pick up an old unused canvas many years after it was bought to begin work. Therefore a canvas that does not match the overall pattern should not be immediately assumed to be wrongly dated. From the evidence of the studio we can see that Bacon hoarded materials over long periods, and also kept many of his discarded works for many years even after they had been cut to pieces.

Materials analysis alone cannot give a certain answer to questions of authenticity. Most of the materials used by Bacon were readily available and commonly used by many artists. It is only by piecing together many small pieces of information about these materials that we can get an idea of whether these combinations are consistent with Bacon's practice. Even then, it is unlikely that we will get a definite answer, the best that can be achieved is a measure of likelihood of the work being genuine or not. Only if a pigment is identified which would not have been available to Bacon, due to its date of discovery, can we say a work could not have been produced by him. In this case, the possibility of retouching paint would also have to be ruled out. To be most effective, the information gathered from the scientific analysis of materials should be used in combination with stylistic evidence from the study of an artists' oeuvre.

Chapter 9: Conclusions

In this final chapter, conclusions are drawn from the different areas of the study. Firstly from the analysis of synthetic organic pigments and secondly from the analysis of Bacon's materials. The application of this information to the examination of questioned works is considered, and potential areas for further study are highlighted.

9.1 Conclusions from identification of synthetic organic pigments

A large collection of synthetic organic pigments have been subjected to analysis using FTIR and PyGCMS to produce a collection of reference data for the identification of these materials in works of art. From the results, a wide range of pigments used by modern artists can be identified, particularly where both techniques are used together.

FTIR spectra have been recorded of many different synthetic pigments, which show sharp distinct peaks. Common features were identified among the different types of pigments analysed, allowing many of the key pigment groups to be distinguished.

Pyrolysis GCMS has previously been shown to be a very useful technique for the identification of synthetic organic pigments and has been extended to include a greater range of pigments in this study. Pyrolysis products have been reported from several pigment groups not previously studied, widening its field of application to phthalocyanine, diketopyrrolo-pyrrole, perylene and isoindolinone pigments. Products from the pyrolysis of a greater range of azo pigments are also reported, which should provide useful reference data. While the techniques were applied here to the identification of pigments in works of art, they also have great potential for use in the examination of paint in forensic studies.

9.2 Conclusions from the analysis of Bacon's materials

Paintings have been examined spanning the period from c.1945 to c.1989. Pigments and binders have been successfully identified in nearly all of the samples taken, giving us a good indication of the materials typically used by Bacon. The examination of the studio materials has revealed further information about the range of materials used by Bacon, and analysis of some of these materials has been used to assist in the interpretation of results from samples from paintings. Some materials found in the studio closely match samples taken from paintings, providing evidence that these materials were indeed used by Bacon to create his paintings.

The majority of the paintings examined used a fairly narrow range of materials. Some pigments were found repeatedly over a considerable period, such as cobalt violet, Prussian blue, vermilion and cadmium colours. These pigments were usually found in an oil binder. Most pigments were found repeatedly, and certain colours appear to be used consistently associated with particular features, such as Prussian blue used for dark blue couches and phthalocyanine green PG7 used for green backgrounds.

A few paintings exhibited unusual characteristics compared to the main body of paintings examined, containing different media or pigments or being on an unusual support. Most of these paintings appear to be those which were not accepted by Bacon as complete, approved works, as they were either not listed in the Alley & Rothenstein Catalogue Raisonné, or only occur in the list of 'Abandoned' works. Some appear to have been left behind as supports for other artists to re-use. Later in his career, Bacon realised that many works which he had rejected were finding their way on to the market, which probably led him to destroy later canvases so decisively, by cutting out the main elements of the composition so that they could not be salvaged.

From the pattern of materials found it is apparent that Bacon had a small number of trusted paint colours which he came to rely on in much of his work. However, he might also experiment with other materials, possibly prompted by their availability or by a desire to try new effects. Evidently, some such experimentation was successful, leading to his introduction of household emulsion, spray paint and Letraset throughout the 1960s and 70s. In the studio, many of the more unusual items – the acrylic medium, oil 'paintstik', powder paints and retouching varnish appear to have been used very little, if at all, as containers were full and some did not appear to have been opened.

In household paints the pigments used might be more variable as these are more likely to contain cheaper organic pigments rather than the more toxic or expensive colours like cadmium orange or vermilion. The colour is picked as a shade from a chart and pigment type is not specified, meaning the manufacturers might vary the composition without warning. The large number of different organic pigments available means that similar shades made by different companies might contain completely different pigment combinations.

Bacon found it difficult to work when abroad, though did establish a studio in Paris in the 1970s. Relatively few works are known to have been completed here, and none of those examined in this study. We might expect that materials would have been bought locally in Paris, which might differ from those Bacon was able to get in London. When the apartment was sold in 1984 remaining materials and canvases from the studio might have been moved back to London, or simply discarded. Some materials in the Reece Mews Studio appear to be French in origin, for example the 'vernis à retoucher' and 'peinture orange' spray paint. Some pigments are made by French company Lefranc and Bourgeois, but most are labelled in English so were probably bought in London.

9.3 Fakes, forgeries and authentication

Bacon's paintings have in recent years become some of the most expensive pieces of post-war art ever sold, so it is easy to see how his works might become a target for forgers. In one case in the 1970s a group of Italian students produced a number of forgeries which entered the art market and fooled some dealers (BBC, 1976). At this time Bacon himself was able to state that these were not his own work, but after the Artist's death, the distinction between genuine unknown, unfinished or abandoned works and those produced by another hand can be difficult to determine. Such fraudulent works can profoundly damage the true understanding of an artist's work, by giving a false impression of his practice. This dilemma is illustrated by the debate over the Barry Joule archive material, the authenticity of which has been disputed over for some time. Those who believe this material to be genuine argue that this sheds new light on Bacon's practice (Sladen, 2001), while others remain unconvinced (Harrison, 2005). Therefore the resolution of this dispute will have important implications for how Bacon's work is viewed.

As part of the preparation of the Catalogue Raisonné of Bacon's work, owners are invited to submit works thought to be by Bacon for examination by the Authentication Committee. Several paintings which are obviously not authentic Bacon works have been seen by the Committee, while others are more difficult to judge. These may not necessarily be made or presented with any intention to deceive, as Bacon's work has been very influential on younger artists and may be imitated, for example by art school students. The authentication process has also thrown up several paintings thought to be genuine works, not previously documented, which have proved to be of particular interest, some as rare survivors from an early period.

In chapter 8 the findings from the research were used to examine a series of works, to illustrate how the information gathered can be applied to help answer questions of authenticity. Strong similarities to genuine documented works were found in some cases, providing a convincing argument for the work in question being genuine, as well as providing evidence for their proposed date. However, some of the limitations of this approach were also illustrated.

9.4 Further work

This is the first study to examine Bacon's materials and techniques in detail and there is scope for more research to be carried out into this subject. Only a small sample of works by Bacon have been examined in this study, meaning it is possible that important elements of his practice are not represented in these findings. As with any study of this kind, we cannot investigate every single painting, and it is always possible that isolated examples exist which fall outside the usual pattern. However, more paintings could be investigated to reinforce our confidence in these results, in particular completed works form the 1970s and 80s, which have been somewhat under-represented here. It would also be of particular relevance to investigate works completed in Bacon's Paris studio, or in other locations away from London, where materials are likely to have been obtained locally so may be significantly different to those identified here.

This work has focussed principally on Bacon's paintings and has not examined any of the small number of works on paper (although the studio materials might be expected to apply to both). From the results of analysis of some sketches carried out by Tate, materials appear to be very similar to those found in paintings. The sketches and 'working documents' which have been manipulated through the use of paint could be an area for further investigation, especially in order to compare with materials whose authenticity has been called into question (Harrison, 2006; Finke, 2009a). An investigation of the materials used in such manipulations might add more information to a recent study in which the types of documents and style of manipulation were compared (Finke, 2009a).

The materials in the studio could also be investigated in more depth, as only a small fraction of the materials present were sampled and examined in detail. Although many duplicate items exist, there is still a substantial amount of material which has not yet been looked at. An attempt could be made to date many of the materials more precisely, from manufacturers' records, to clarify when different items might have entered the studio and could have been used. The serial numbers on the tubes of Winsor and Newton paint were used to give an approximate date to the different colours in chapter 5, but these tubes should also have a batch number which would allow for more precise dating.[67] However, in many cases this code may not be visible due to accretions of paint on the tubes.

The design of cans of Carsons and Dulux paint found in the studio could be researched to find out when different tins are likely to have been produced. The ingredients used in the formulation of these paints may have been changed at different times, which could also be used to give a more precise date. The tools in the studio have not yet been investigated in great detail and there may be more information here yet to be uncovered.

It would also be interesting to compare the materials used by Bacon with those of other related artists. Little work has been done to examine materials used by contemporary British artists, particularly those with whom Bacon has been closely linked. More work is needed to investigate the effect of new materials on the work of twentieth century artists. This interesting period of development in the paint industry would be a particularly fruitful area for the investigation of the relationship between artists and their materials.

[67] This code is represented either by nicks in the paper label or a serial number stamped on the tube crimp (Paul Robinson, Winsor & Newton, Personal Communication)

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A Study of the Materials and Techniques of Francis Bacon (1909-1992)

Joanna Elizabeth Russell

Volume 2 of 2

PhD

2010

Appendix A. Details of Pigment Samples

Code	Name	Class	Supplier[68]	Date
PR1	Para red	Azo, β-naphthol pigment	Acros	nd
PR2	Heuco Rot 300202	Azo, Naphthol AS	Heubach GmbH	2002 (Tate)
PR3	Toluidine red/ Monolite scarlet RN	Azo, β-naphthol pigment	ICI	Pre-1984
PR4	Hansa red R	Azo, β-naphthol pigment	Clariant	2007
PR5	Monolite Red CB	Azo, Naphthol AS	ICI	2002 (Tate)
PR6	1085	Azo, β-naphthol pigment	Engelhard	2003 (Tate)
PR8	3149 Fast Red F4R-B Blue shade	Azo, Naphthol AS	HY Pigments	2002 (Tate)
PR9	Permanent red FRLL	Azo, Naphthol AS	Kremer	2007
PR12	Permanent bordeaux FRR	Azo, Naphthol AS	Clariant	2007
PR14	Permanent bordeaux FGR	Azo, Naphthol AS	Clariant	2007
PR17	Sunbrite Red 17	Azo, Naphthol AS	Sun Chemical	2002 (Tate)
PR21	3132 Fast Red 2R	Azo, Naphthol AS	HY Pigments	2002 (Tate)
PR22	Sunbrite Red 22	Azo, Naphthol AS	Sun Chemical	2002 (Tate)
PR23	1523 Naphthol Red 23	Azo, Naphthol AS	Lansco Colors	2002 (Tate)
PR24	Waxoline Red O	?	Keegan Brico Tetley Chemicals	1978 (Tate)
PR31	Symuler Fast Red 4085	Azo, Naphthol AS	Dainippon	2002 (Tate)
PR32	Suimei Fast Rubine BN	Azo, Naphthol AS	Sansui	2003 (Tate)
PR38	Sunbrite Red 38	Disazopyrazolone	Sun Chemical	2002 (Tate)
PR41	Suimei Dianisidine Red	Disazopyrazolone	Sansui Pigment	2003 (Tate)
PR42	Cinquasia Magenta RT-355-D	?	Ciba Speciality chemicals	nd (Tate)
PR47	OC220	?	Dominion	2005 (Tate)
PR48:1	Sunbrite Red 48:1	Azo, Pigment lake, BONA, Ba	Sun Chemical	2002 (Tate)
PR48:2	Rubine Toner 2BO	Azo, Pigment lake, BONA, Ca	Avecia	2002 (Tate)
PR48:3	1403B 2B Red	Azo, Pigment lake, BONA, Sr	Lansco	2002 (Tate)
PR48:4	Irgalite Red FBL	Azo, Pigment lake, BONA, Mn	Ciba	2002 (Tate)
PR49:1	Sunbrite Red 49:1	Azo Pigment lake, β-Naphthol, Ba	Sun Chemical	2002 (Tate)
PR49:2	Sunbrite Red 49:2	Azo Pigment lake, β-Naphthol, Ca	Sun Chemical	2002 (Tate)
PR52:1	Sunbrite Red 52:1	Azo, Pigment lake, BONA, Ca	Sun Chemical	2002 (Tate)
PR52:2	BR-522 Bon Maroon	Azo, Pigment lake, BONA, Mn	Lansco	2002 (Tate)
PR53:1	Permanent Lake red LCLL	Azo Pigment lake, β-Naphthol, Ba	Clariant	2007
PR57:1	Sunbrite Red 57:1	Azo, Pigment lake, BONA, Ca	Sun Chemical	2002 (Tate)

[68] Abbreviations used in table: HY Pigments = Hangzhou Yingshanhua Pigment Chemicals, Dainippon = Dainippon Ink & Chemicals Incorporated, Sansui = Sansui Pigment Ind. Co. Ltd., W&N = Winsor & Newton

PR58:4	Suimei Maroon L	Azo, Pigment lake, BONA, Mn	Sansui	2003 (Tate)
PR60	1060	Azo Pigment Lake, Naphthalene Sulfonic Acid	Engelhard	2003 (Tate)
PR60:1	Sunbrite Red 60:1	Azo Pigment Lake, Naphthalene Sulfonic Acid	Sun Chemical	2002 (Tate)
PR63:1	Sunbrite Red 63:1	Azo, Pigment lake, BONA, Ca	Sun Chemical	2002 (Tate)
PR63:2	Suimei Bordeaux BB	Azo, Pigment lake, BONA, Mn	Sansui	2003 (Tate)
PR81	Fast Pink Lake G	Dye salt with complex anion	HY pigments	2002 (Tate)
PR81:2	Sunbrite Red 81:2	Dye salt with complex anion	Sun Chemical	2002 (Tate)
PR83	Alizarin crimson	Anthraquinone		nd
PR88	Thioindigoid red	Quinacridone	Kremer	2007
PR112	Alizarin Crimson Light	Azo, Naphthol AS	Kremer	2008
PR122	Magenta	Quinacridone	Kremer	2007
PR122	Monolite Rubine 3B	Quinacridone	ICI	Pre-1984
PR123	CI Pigment Red 123 CI 71145	Perylene	Bayer Corporation	2002 (Tate)
PR144	CPT-Red (Medici red)	Azo, Disazo	Kremer	2007
PR146	1146 Naphthol Red 146	Azo, Naphthol AS	Lansco Colors	2002 (Tate)
PR147	Permanent Pink F3B	Azo, Naphthol AS	Clariant	2002 (Tate)
PR149	Fast Red B	Perylene	Clariant	2002 (Tate)
PR150	Suimei Fast Carmine R	Azo, Naphthol AS	Sansui	2003 (Tate)
PR166	CPT-Scarlet	Azo, Disazo	Kremer	2007
PR168	Monolite red 2Y	Anthraquinone	ICI	Pre-1984
PR170	Permanent red B	Azo, Naphthol AS	Kremer	2007
PR172	Erythrosine Al lake	Aluminium pigment lake	S (Chinese)	2003 (Tate)
PR173	3293 Fast Rose Lake B	?	HY Pigments	2002 (Tate)
PR175	Purple Red (brownish, Urbino red)	Azo, Benzimidazolone	Kremer	2007
PR176	Novoperm carmine HF3C	Azo, Benzimidazolone	Clariant	2007
PR177	Cromophtal Red A2B	Aminoanthraquinone	Ciba	2002 (Tate)
PR178	Paliogen Rot Light 3880 HD	Perylene	BASF	2002 (Tate)
PR179	Paliogen maroon	Perylene	Kremer	2007
PR185	Novoperm carmine HF4C	Azo, Benzimidazolone	Clariant	2007
PR187	Novoperm Red HF4B	Azo, Naphthol AS	Clariant	2002 (Tate)
PR188	Novoperm red HF3S	Azo, Naphthol AS	Clariant	2007
PR190	CI Pigment Red 190 CI 71140	Perylene	Bayer	2002 (Tate)
PR194	Permanent red dark	Perinone	Kremer	2007
PR202	Cinquasia magenta RT-343-D	Quinacridone	Ciba	2002 (Tate)
PR206	Cinquasia Chestnut brown	Quinacridone	Kremer	2008
PR208	Novoperm Red HF2B 01	Azo, Benzimidazolone	Clariant (Hoechst)	2002 (Tate)
PR209	Hostaperm red EG transp.	Quinacridone	Clariant	2007

PR210	Permanent Red P-FK	Azo, Naphthol AS	Clariant	2002 (Tate)
PR214	Novoperm Red BN	Disazo condensation	Clariant	2002 (Tate)
PR221	Cromophtal Red 2B	Disazo condensation	Ciba	2002 (Tate)
PR224	CI Pigment Red 224 CI 71127	Perylene	Bayer	2002 (Tate)
PR254	Irgazine Red DPP BO	Diketopyrropyrrole	Kremer	2007
PR255	Irgazine scarlet DPP EK	Diketopyrropyrrole	Kremer	2007
PR264	Irgazine Ruby DPP TR	Diketopyrropyrrole	Kremer	2007
PR266	Naphthol Red Medium	Azo, Naphthol AS	Magruder	2002 (Tate)
PO5	Hansa Red GG	Azo, β-naphthol pigment	Clariant	2002 (Tate)
PO13	Monolite orange G	Azo, disazo pyrazolone	ICI	Pre-1984
PO16	2316 Diarylide Orange 16	Azo, diarylide	Lansco	2002 (Tate)
PO34	Sunbrite Orange 34	Disazo, pyrazolone	Sun Chemical	2002 (Tate)
PO36	Novoperm orange HL	Azo, Benzimidazolone	Clariant	2007
PO38	Novoperm Red HFG	Azo, Napthol AS	Clariant	2002 (Tate)
PO43	Hostaperm Orange GR	Perinone	Clariant	2007
PO46	Sunbrite Orange 46	Azo pigment lake β-Naphthol, Ba	Sun Chemical	2002 (Tate)
PO48	Cinquasia gold, red-gold	Quinacridone	Kremer	2007
PO49	Cinquasia gold, brown-gold	Quinacridone	Kremer	2007
PO51	Paliogen orange	Pyranthrone	Kremer	2007
PO59	Paliotol orange	Nickel complex	Kremer	2007
PO61	Isoindolor orange	Isoindolinone	Kremer	2007
PO62	Novoperm orange H5G70	Azo, Benzimidazolone	Clariant	2007
PO67	Paliotol orange L2930 HD	Pyrazolo-quinazolone	BASF	2002 (Tate)
PO69	Pyranthrone orange	Isoindoline	Kremer	2007
PO73	Irgazine orange DPP RTR	Diketopyrropyrrole	Kremer	2007
PO73	Irgazine orange DPP RA	Diketopyrropyrrole	Kremer	2007
PY1	Monolite yellow GN	Azo, Arylide yellow	ICI	Pre-1984
PY1	Winsor yellow	Azo, Arylide yellow	W&N	nd
PY1	Hansa yellow G 02	Azo, Arylide yellow	Clariant	2002 (Tate)
PY1:1	Monolite yellow 2R Mini grains	Azo, Arylide yellow	Avecia	2002 (Tate)
PY2	Suimei Fast Yellow	Azo, Arylide yellow	Sansui	2003 (Tate)
PY3	Winsor lemon	Azo, Arylide yellow	W&N	nd
PY3	Hansa Yellow 10G	Azo, Arylide yellow	Clariant	2002 (Tate)
PY6	Permanent Yellow HKA	Azo, Arylide yellow	Kremer	2002 (Tate)
PY12	Sunbrite Yellow 12	Azo, diarylide	Sun Chemical	2002 (Tate)
PY13	Irgalite yellow BAW	Azo, diarylide	Ciba	2002 (Tate)
PY14	Sunbrite yellow 14	Azo, diarylide	Sun Chemical	2002 (Tate)
PY16	Permanent Yellow NCG	Bisacetoacetarylide	Clariant	2002 (Tate)
PY17	Sunbrite yellow 17	Azo, diarylide	Sun Chemical	2002 (Tate)
PY24	Monolite yellow FR	Flavanthrone	ICI	Pre-1984

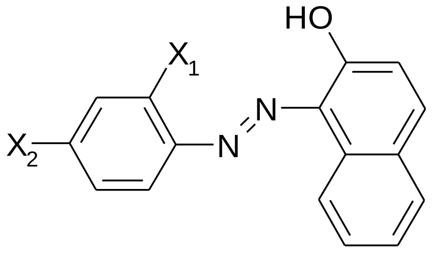
PY55	Kenalake Yellow BG55	Azo, diarylide	Albion Colours	2002 (Tate)
PY62:1	Heuco Gelb 106200	Monoazo pigment lake, Ca	Heubach GmbH	2002 (Tate)
PY65	Sunbrite yellow 65	Azo, Arylide yellow	Sun Chemical	2002 (Tate)
PY73	Hansa brilliant yellow 4GX	Azo, Arylide yellow	Clariant	2007
PY74	Brilliant yellow	Azo, Arylide yellow	Kremer	2007
PY75	1275 Yellow 75	Azo, Arylide yellow	Lansco	2002 (Tate)
PY81	Novoperm yellow H10G01	Azo, diarylide	Clariant	2007
PY83	Sunbrite yellow 83	Azo, diarylide	Sun Chemical	2002 (Tate)
PY87	Indian Yellow Imitation	Azo, diarylide	Cornelissen	2008
PY97	Novoperm Yellow FGL	Azo, Arylide yellow	Clariant	2002 (Tate)
PY100	Indian yellow (tartrazine lake)	Pyrazolone lake	Cornelissen	2008
PY108	Pyramid-yellow medium	Anthraquinone	Kremer	2007
PY109	Isoindolinone (aminoketone)	Isoindolinone (aminoketone)	Kremer	2007
PY110	Irgazine yellow 2 RLT	Isoindolinone (aminoketone)	Kremer	2007
PY120	Novoperm yellow H2G	Azo, Benzimidazolone	Clariant	2002 (Tate)
PY126	Permanent yellow DGR	Azo, diarylide	Clariant	2002 (Tate)
PY127	2127 Diarylide Yellow 127	Azo, diarylide	Lansco Colors	2002 (Tate)
PY128	Cromophtal yellow 8GN	Disazo condensation	Ciba	2002 (Tate)
PY129	Irgazine yellow, greenish	Azomethine metal complex	Kremer	2007
PY138	Paliotol Gelb D0960	Quinophthalone	BASF	2002 (Tate)
PY139	Paliotol yellow-orange	Isoindoline	Kremer	2007
PY150	Nickel azo yellow	Nickel azo		Nd
PY151	Permanent yellow light	Azo, Benzimidazolone	Kremer	2007
PY154	Permanent yellow medium	Azo, Benzimidazolone	Kremer	2007
PY168	Bricofor yellow 8GP	Monoazo pigment lake, Ca	Albion Colours	2002 (Tate)
PY173	Isoindolinon yellow	Isoindolinone	Kremer	2007
PY175	Hostaperm yellow H6G	Azo, Benzimidazolone	Clariant	2007
PY180	Novoperm Yellow P-HG	Disazo, Benzimidazolone	Clariant	2002 (Tate)
PY194	Novoperm yellow F2G	Azo, Benzimidazolone	Clariant	2002 (Tate)
PG7	Phthalocyanine green, dark	Phthalocyanine, Cl	Kremer	2007
PG8	Bricofor Green L5837	Nitroso green	Hays Colours	2002 (Tate)
PG10(?)	Indian yellow imitation	Nickel azo	Kremer	Nd
PG36	Phthalocyanine green, yellowish	Phthalocyanine, Br	Kremer	2007
PB14	Pigment blue 14	Triarylcarbonium	Dominion	2005 (Tate)
PB15	Winsor blue	Phthalocyanine	W&N	Nd
PB15:3	Phthalocyanine blue, royal blue	Phthalocyanine	Kremer	2007
PB15:6	Phthalocyanine blue, reddish	Phthalocyanine	Kremer	2007
PB16	Heliogen blau D7490	Metal-free phthalocyanine	BASF	2002 (Tate)

PB17	4230 Fast sky blue lake	?	HY pigments	2002 (Tate)
PB60	Indanthrone blue Monolite blue 3R	Anthraquinone	ICI	Pre-1984
PB63	Indigo Carmine Aluminium Lake	Aluminium indigo lake	S (Chinese)	2003 (Tate)
PB76	Fastogen Blue 10GN	?	Dianippon	2002 (Tate)
PV1	RA527	Triarylcarbonium	Dominion	2005 (Tate)
PV3	1903 Methyl Violet 23	Triarylcarbonium	Lansco Colors	2002 (Tate)
PV5	Alizarin violet	Anthraquinone	Kremer	2007
PV19	Monolite violet 4R	Quinacridone	ICI	Pre-1984
PV23	Monolite violet RN	Dioxazine	ICI	Pre-1984
PV29	CI Pigment Violet 29 CI 71129	Perylene	Bayer	2002 (Tate)
PV29	Sunfast Violet 24	Perylene	Sun Chemical	2002 (Tate)
PV32	Novoperm Bordeaux HF3R	Azo, Benzimidazolone	Clariant	2002 (Tate)
PV37	Cromophtal Violet B	Dioxazine	Ciba	2002 (Tate)
PBr23	Gubbio Red	Disazo condensation	Kremer	2008
PBr25	Hostaperm Brown HFR 01	Azo, Benzimidazolone	Clariant	2002 (Tate)
PBr41	PV Fast Brown RL	Disazo condensation	Clariant	2002 (Tate)

Pigment manufacturers
Clariant (Leeds, UK); Acros Organics (Geel, Belgium); Heubach GmbH (Langelsheim, Germany); ICI Paints (Slough, UK); BASF (Ludwigshafen, Germany); Hangzhou Yingshanhua Pigment Chemical Co. Ltd. (Hangzhou, China); Kremer Pigmente (Aichstetten, Germany); Sun Chemical (Parsippany, USA); Lansco Colors (Pearl River, USA); Dainippon Ink & Chemicals (Tokyo, Japan); Bayer Corporation (Pittsburgh, USA); Sansui Pigment Ind. Co. Ltd. (Osaka, Japan); Albion Colours (Halifax, UK); L. Cornelissen & Son (London, UK)

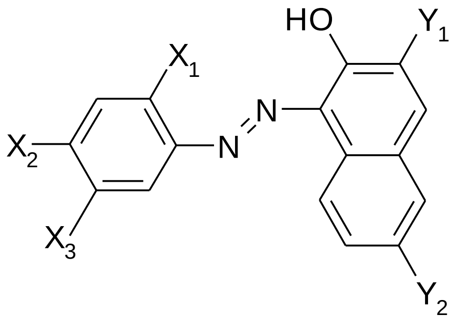
Appendix B. Pigment structures

Beta-naphthol

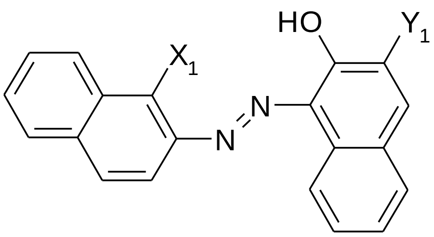


C.I. Name	*X_1*	*X_2*
PR1	H	NO_2
PR3	NO_2	CH_3
PR4	Cl	NO_2
PR6	NO_2	Cl
PO5	NO_2	NO_2

Beta-napthol salts

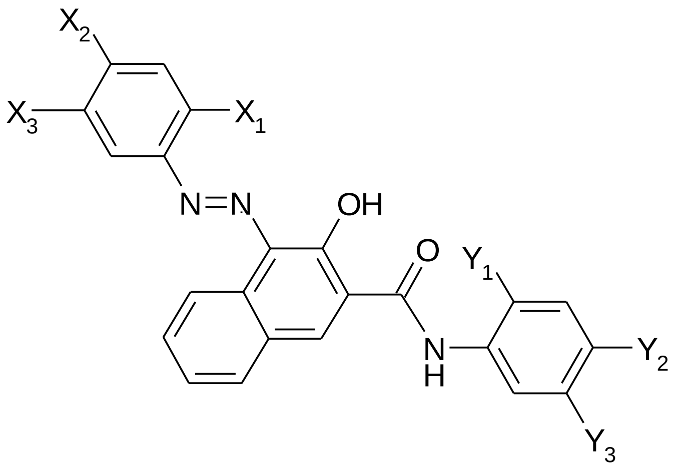


C.I. Name	*X_1*	*X_2*	*X_3*	*Y_1*	*Y_2*	
PR48	SO_3^-	CH_3	Cl	COO^-	H	1 Ba, 2 Ca, 3 Sr, 4 Mn, 5 Mg
PR52	SO_3^-	Cl	CH_3	COO^-	H	1 Ca, 2 Mn
PR53	SO_3^-	Cl	CH_3	H	H	Na, 1 Ba, 2 Ca, 3 Sr
PR57	SO_3^-	CH_3	H	COO^-	H	1 Ca
PR58	H	Cl	SO_3^-	COO^-	H	4 Mn
PR60	COO^-	H	H	SO_3^-	SO_3^-	1 Ba
PO46	SO_3^-	Cl	C_2H_5	H	H	Ba



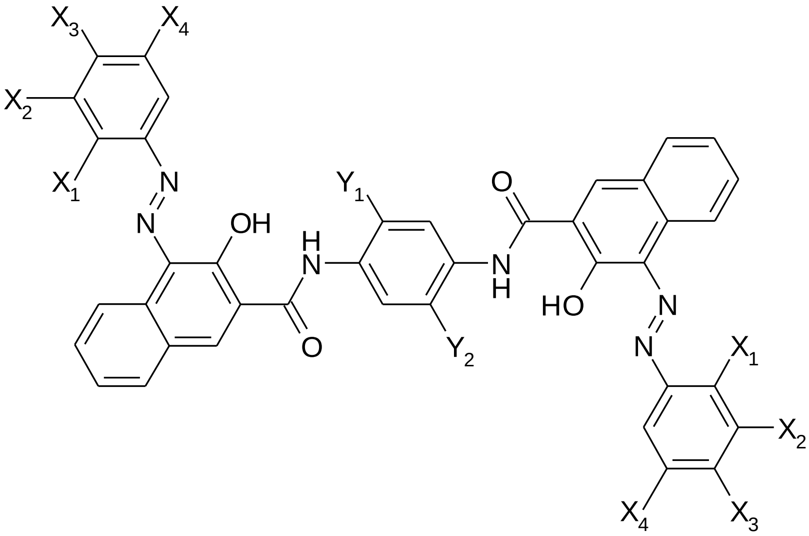
C.I. Name	*X_1*	*Y_1*	
PR49	SO_3^-	H	Na, 1 Ba, 2 Ca
PR63	SO_3^-	COO^-	1 Ca, 2 Mn

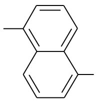
Naphthol AS



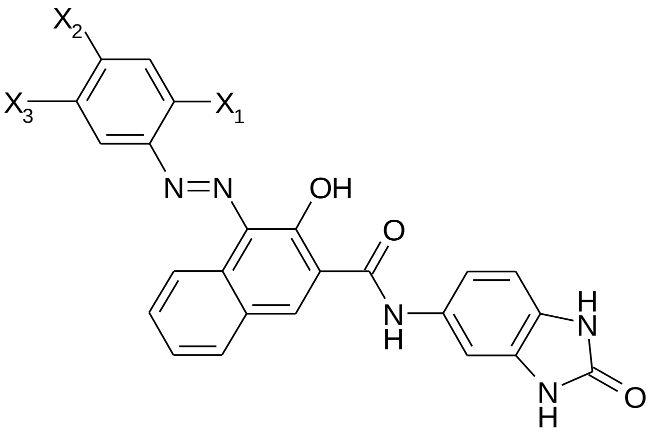
C.I. name	Substituents					
	X_1	*X_2*	*X_3*	*Y_1*	*Y_2*	*Y_3*
PR2	Cl	H	Cl	H	H	H
PR5	OCH_3	H	$SO_2N(C_2H_5)_2$	OCH_3	OCH_3	Cl
PR8	CH_3	H	NO_2	H	Cl	H
PR9	Cl	H	Cl	OCH_3	H	H
PR12	CH_3	NO_2	H	CH_3	H	H
PR14	NO_2	Cl	H	CH_3	H	H
PR17	CH_3	H	NO_2	CH_3	H	H
PR21	Cl	H	H	H	H	H
PR22	CH_3	H	NO_2	H	H	H
PR23	OCH_3	H	NO_2	H	H	NO_2
PR31	OCH_3	H	$CONHC_6H_5$	H	H	NO_2
PR112	Cl	Cl	Cl	CH_3	H	H
PR147	OCH_3	H	$CONHC_6H_5$	CH_3	H	Cl
PR170	H	$CONH_2$	H	OC_2H_5	H	H
PR187	OCH_3	H	$CONHC_6H_4CONH_2$	OCH_3	OCH_3	Cl
PR188	$COOCH_3$	H	$CONHC_6H_3Cl_2$	OCH_3	H	H
PR210	H H	$CONH_2$ $CONH_2$	H H	OC_2H_5 OCH_3	H H	H H
PR266	H	$CONH_2$	H	OCH_3	H	H

Disazo condensation



C.I. Name	*Substituents*					
	X_1	*X_2*	*X_3*	*X_4*	*Y_1*	*Y_2*
PR144	Cl	H	H	Cl	Cl	H
PR166	Cl	H	H	Cl	H	H
PR214	Cl	H	H	Cl	Cl	Cl
PR221	Cl	H	H	$COOC_3H_7$	Cl	Cl
PBr23	NO_2	H	Cl	H	Cl	H
PBr41	Cl	Cl	H	H		

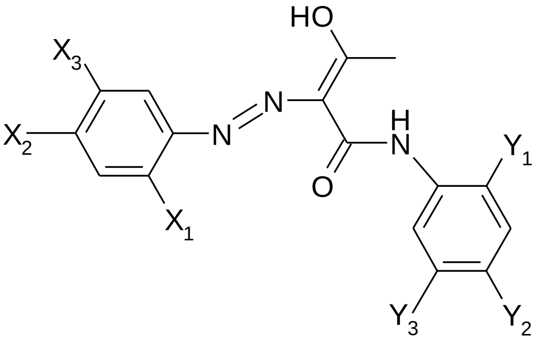
Benzimidazolone (naphthol AS)



C.I. name	*Substituents*		
	X_1	*X_2*	*X_3*
PR175	$COOCH_3$	H	H
PR176	OCH_3	H	$CONHC_6H_5$
PR185	OCH_3	SO_2NHCH_3	CH_3
PR208	$COOC_4H_9$(n)	H	H
PV32	OCH_3	SO_2NHCH_3	OCH_3
PBr25	Cl	H	Cl

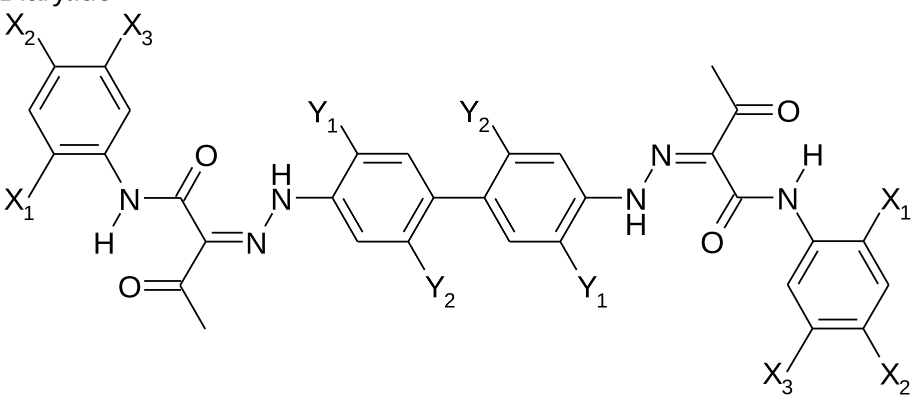
Appendix B

Arylide pigments



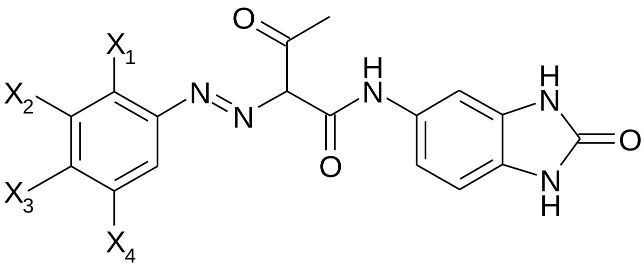
C.I. Name	*Substituents*					
	X_1	*X_2*	*X_3*	*Y_1*	*Y_2*	*Y_3*
PY1	NO_2	CH_3	H	H	H	H
PY2	NO_2	Cl	H	CH_3	CH_3	H
PY3	NO_2	Cl	H	Cl	H	H
PY6	NO_2	Cl	H	H	H	H
PY65	NO_2	OCH_3	H	OCH_3	H	H
PY73	NO_2	Cl	H	OCH_3	H	H
PY74	OCH_3	NO_2	H	OCH_3	H	H
PY75	NO_2	Cl	H	H	OC_2H_5	H
PY97	OCH_3	$SO_2NHC_6H_5$	OCH_3	OCH_3	Cl	OCH_3

Diarylide



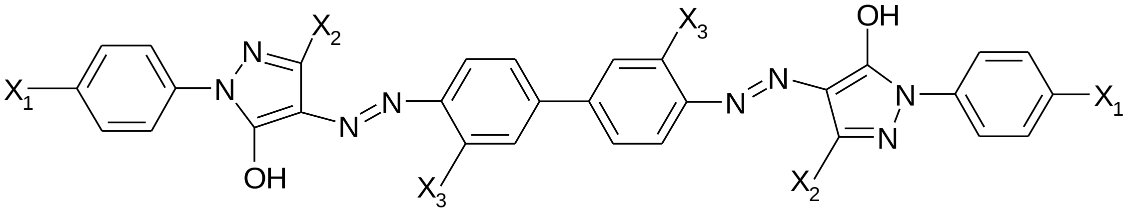
C.I. Name	*Substituents*				
	X_1	*X_2*	*X_3*	*Y_1*	*Y_2*
PY12	H	H	H	Cl	H
PY13	CH_3	CH_3	H	Cl	H
PY14	CH_3	H	H	Cl	H
PY17	OCH_3	H	H	Cl	H
PY55	H	CH_3	H	Cl	H
PY81	CH_3	CH_3	H	Cl	Cl
PY83	OCH_3	Cl	OCH_3	Cl	H
PY87	OCH_3	H	OCH_3	Cl	H
PY126	H H	H OCH_3	H H	Cl	H
PY127	CH_3 OCH_3	CH_3 H	H H	Cl	H
PO16	H	H	H	OCH_3	H

Benzimidazolone (arylide)



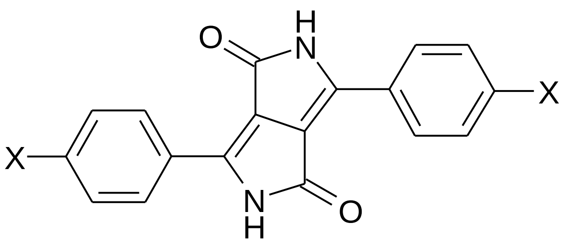
C.I. name	*Substituents*			
	X_1	X_2	X_3	X_4
PY120	H	$COOCH_3$	H	$COOCH_3$
PY151	COOH	H	H	H
PY154	CF_3	H	H	H
PY175	$COOCH_3$	H	H	$COOCH_3$
PO36	NO_2	H	Cl	H
PO62	H	H	NO_2	H

Disazopyrazolone



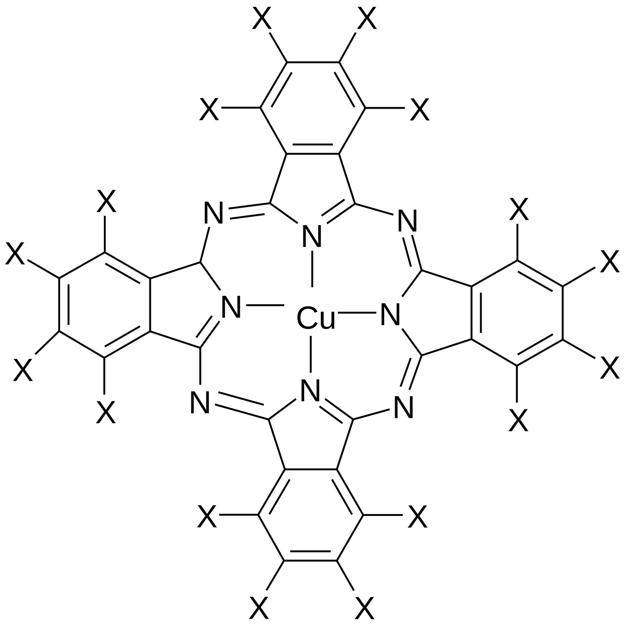
C.I. name	*Substituents*		
	X_1	X_2	X_3
PR38	H	$COOC_2H_5$	Cl
PR41	H	H	OCH_3
PO13	H	CH_3	Cl
PO34	CH_3	CH_3	Cl

Diketopyrrolo-pyrrole



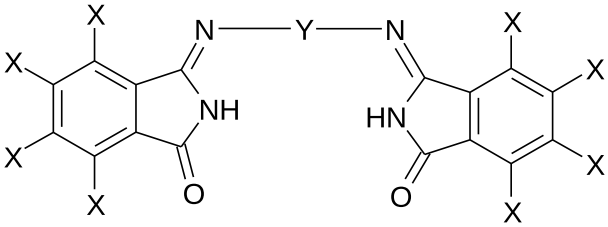
C.I. Name	*X*
PR254	-Cl
PR255	-H
PR264	$-C_6H_5$
PO73	$-C(CH_3)_3$

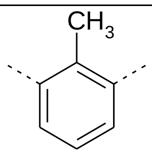
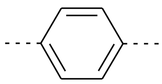
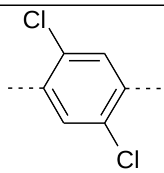
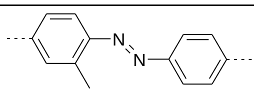
Phthalocyanine



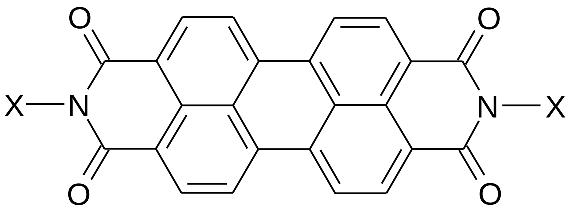
C.I. name	*X*
PB15:6	H
PG7	14- 15 Cl
PG36	4-9 Br, 8-2 Cl

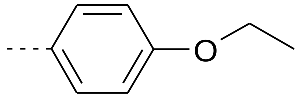
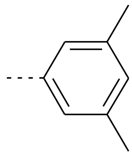
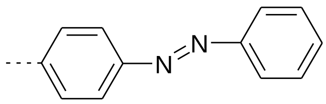
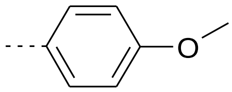
Isoindolinone



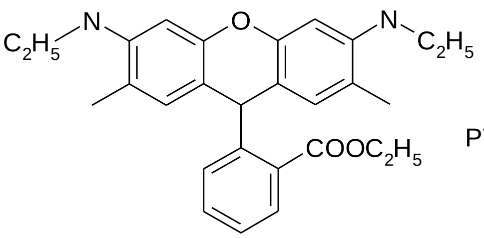
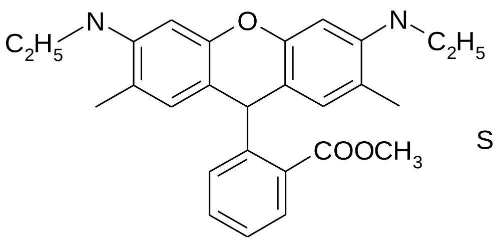
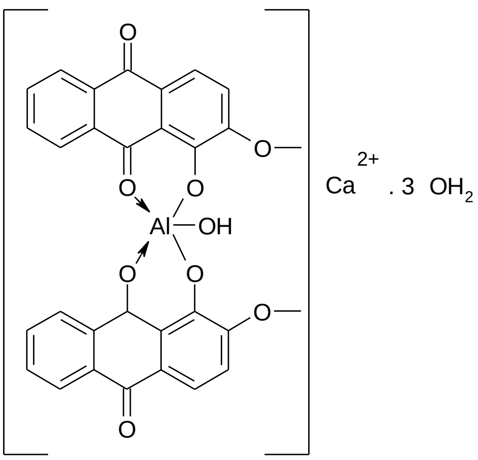
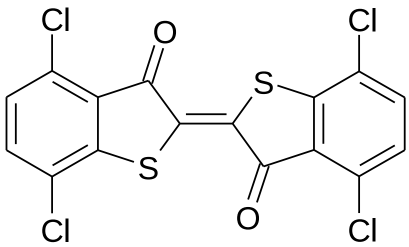
C.I. name	*X*	*Y*
PY109	Cl	
PY110	Cl	
PY173	H	
PO61	Cl	

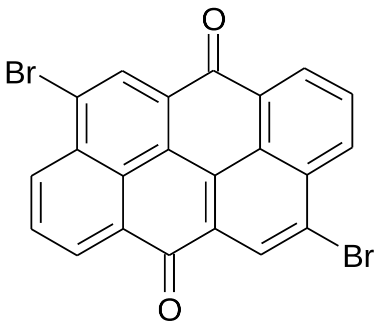
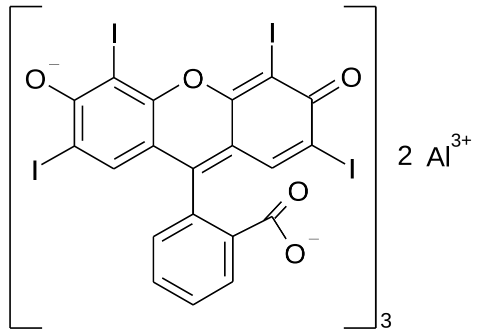
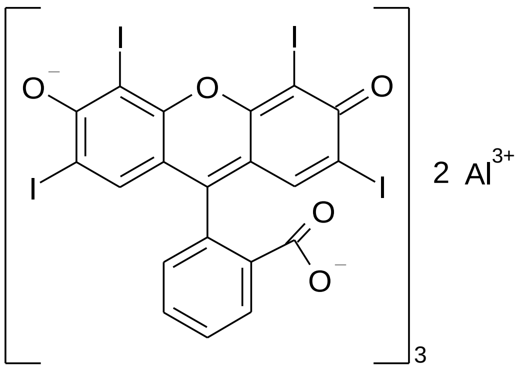
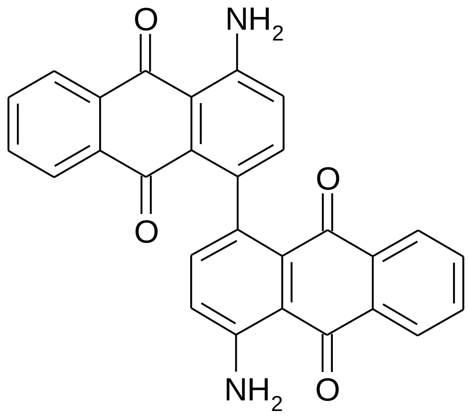
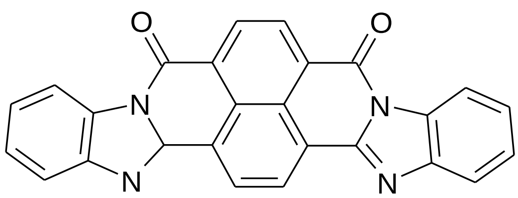
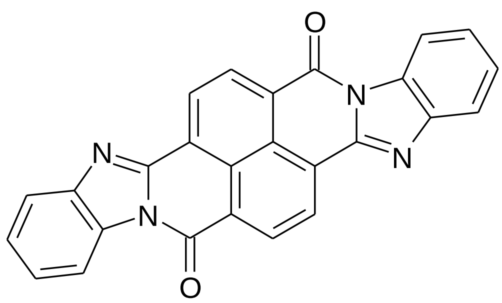
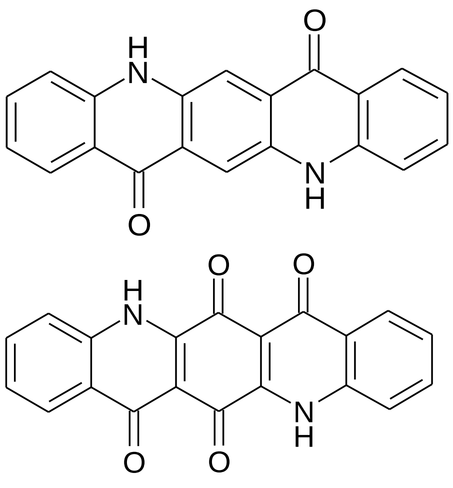
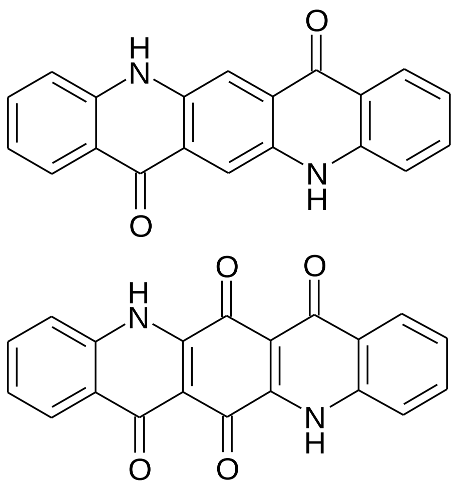
Perylene



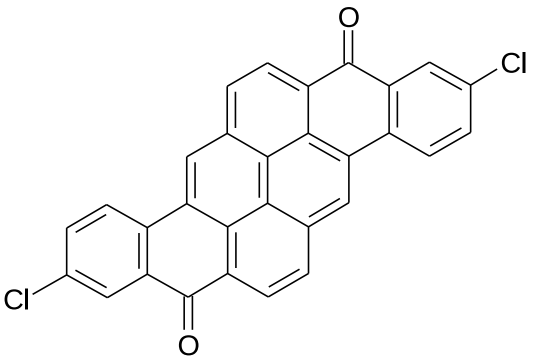
C.I. name	*-X*
PR123	
PR149	
PR178	
PR179	- - - CH_3
PR190	
PV29	- - H

Other pigment structures

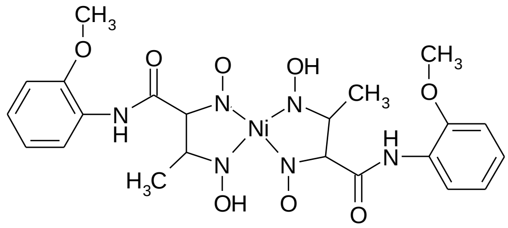
PR81	PR81:2
 PTM- PTM = phosphotunstomolybdic acid	 SM- SM = silicomolybdic acid
PR83 Alizarin crimson 	PR88 Thioindigo 

PR168 	PR172 
PR173 	PR177 
PR194 	PO43 
PO48 	PO49 

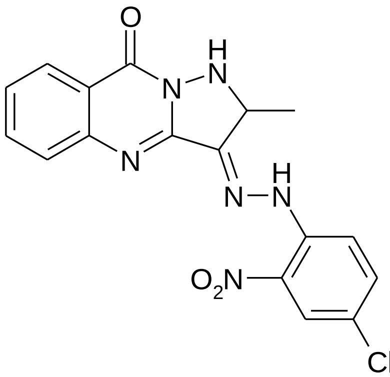
PO51



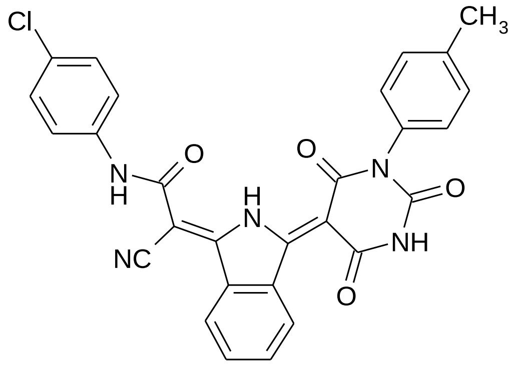
PO59



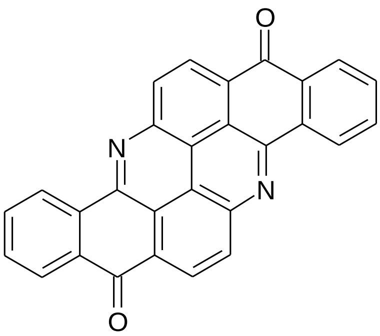
PO67



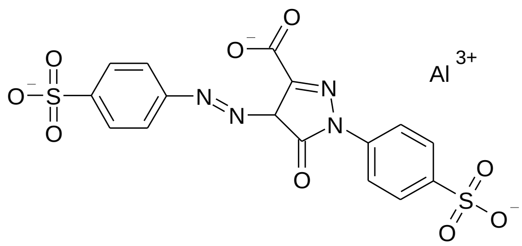
PO69



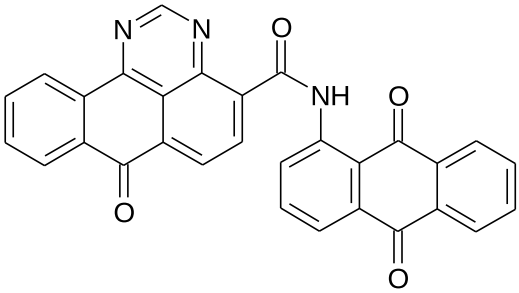
PY24



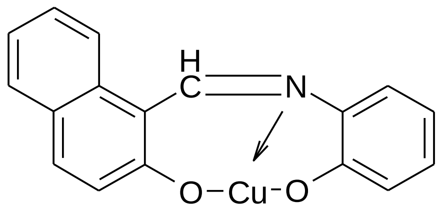
PY100



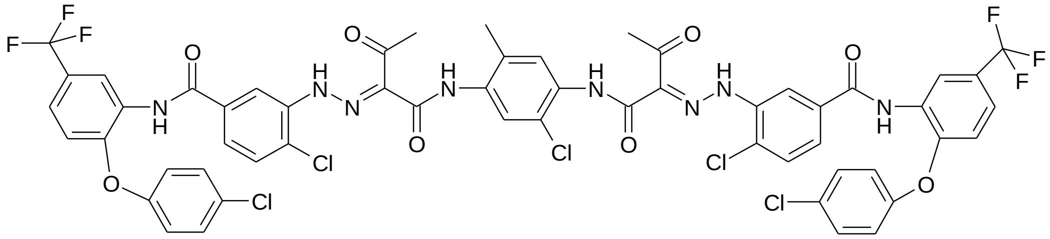
PY108

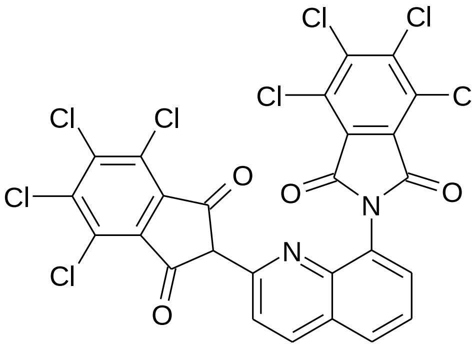
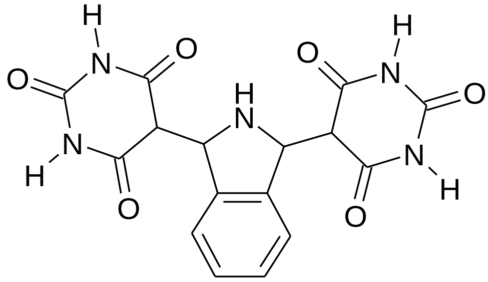
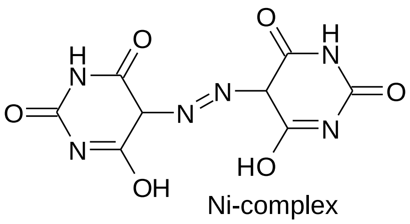
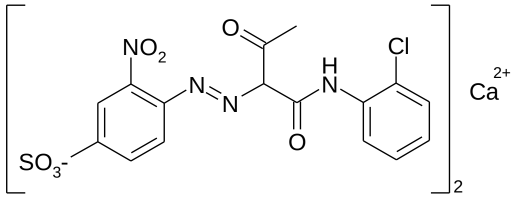
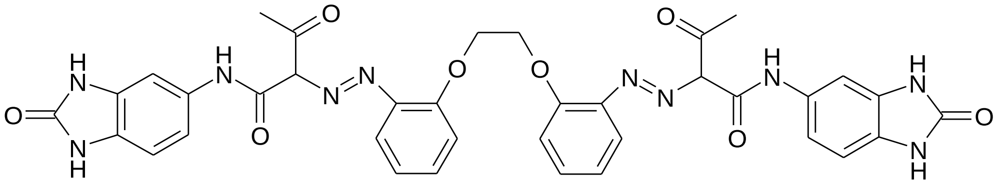
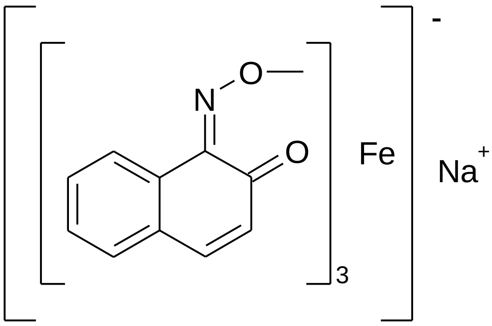
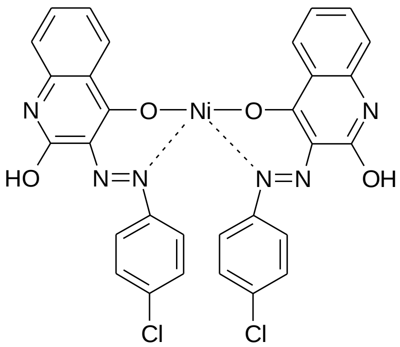
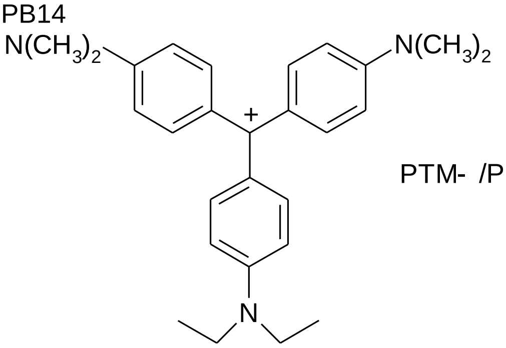
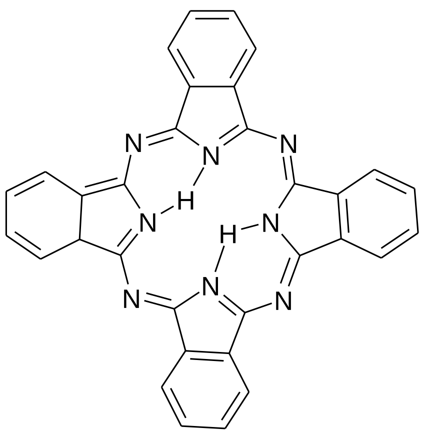


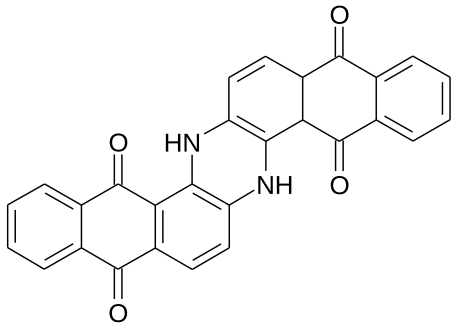
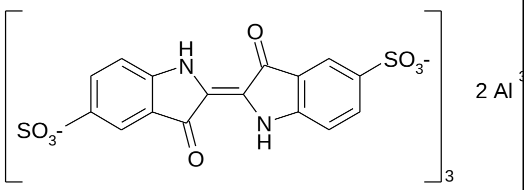
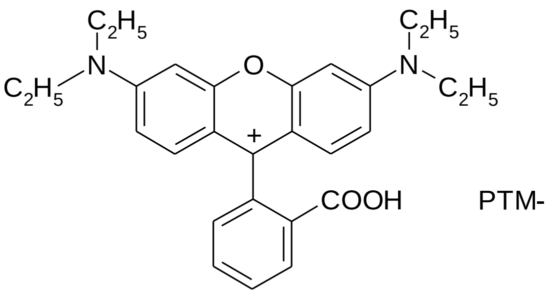
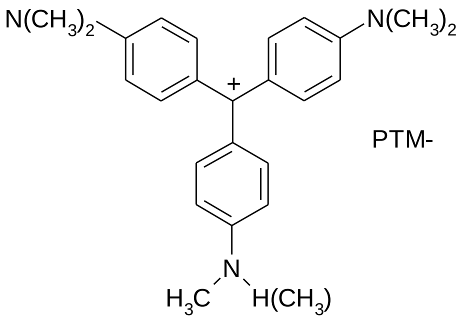
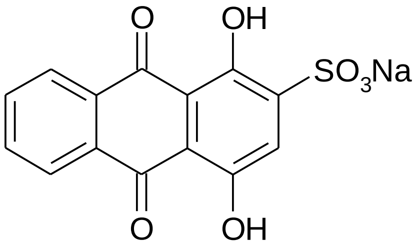
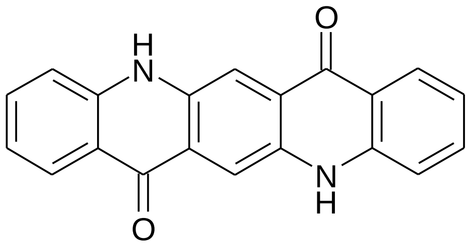
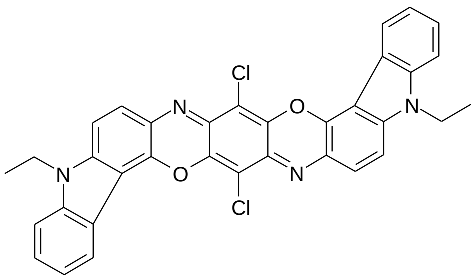
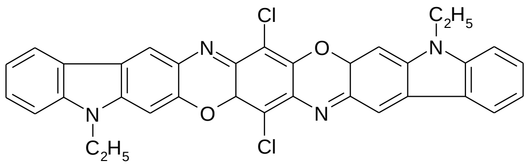
PY129



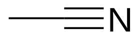
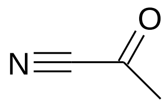
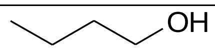
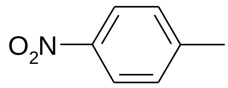
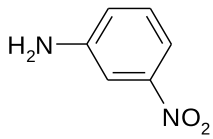
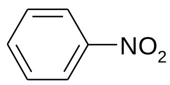
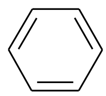
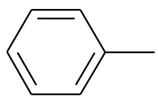
PY128



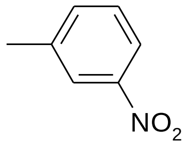
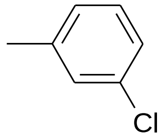
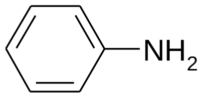
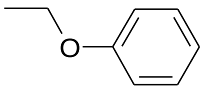
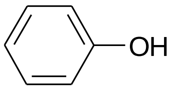
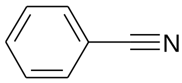
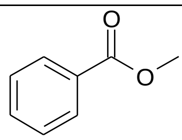
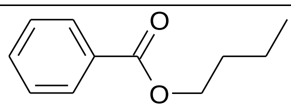
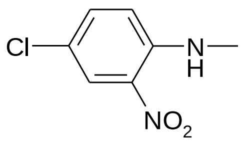
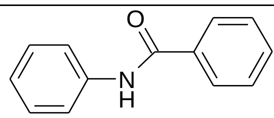
PY138 	PY139 
PY150  Ni-complex	PY168 
PY180 	
PG8 	PG10 
PB14  PTM- /PM- PTM = phosphotunstomolybdic acid PM = phosphomolybdic acid	PB16 

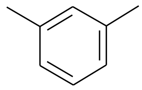
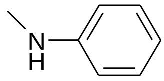
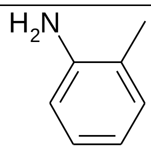
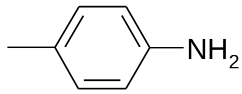
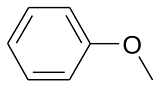
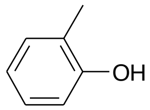
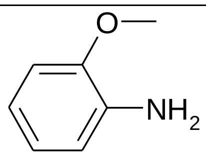
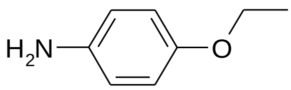
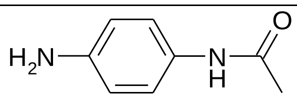
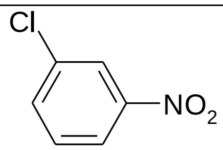
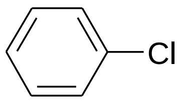
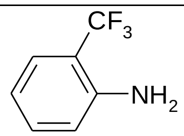
PB60 	PB63 
PV1  PTM = phosphotunstomolybdic acid	PV3  PTM = phosphotunstomolybdic acid
PV5:1 	PV19 
PV23 	PV37 

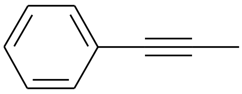
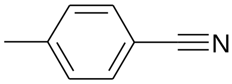
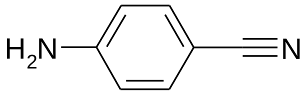
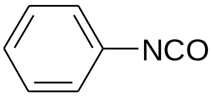
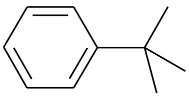
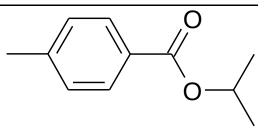
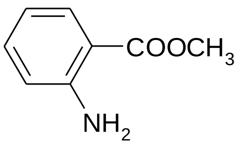
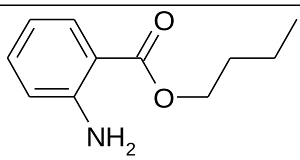
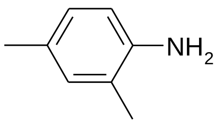
Appendix C. Tables of Products from Pyrolysis of Pigments

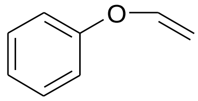
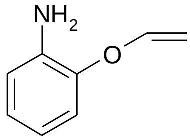
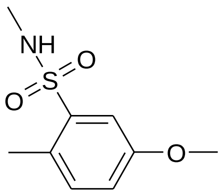
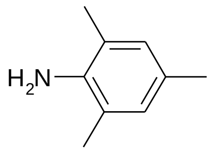
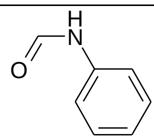
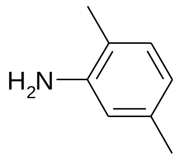
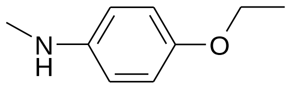
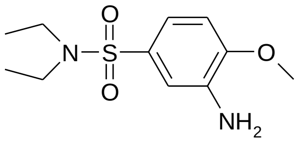
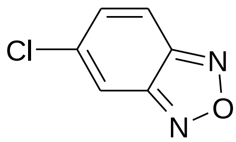
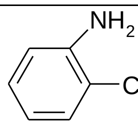
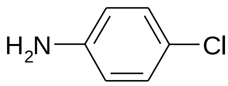
Pigment	*A*[69]	*Mass peak*	*Base peak*	*Other peaks in mass spectrum*	*Identity*
PO13 PO34	++ +	41	41	40(50)	
All arylide, diarylide & arylide benzimid-azolone pigments PO69 PY16		69	43	69 (50), 54(35)	
PO61	+	50	50	52(30)	
PR208	+		56	41(80)	 ?
PR48:1 PR52:1 PR53:1 PR57:1 PR58:4 PO46	++ + + + ++ +	64	64	48(30)	SO_2
PR8 PR17 PR22	++ ++ ++	137	65	137 (95), 91(80)	
PR23 PR31	++ ++	138	65	138 (98), 92(65), 108(25)	
PO62	+	123	77	123 (60), 51(50), 107(25), 93(20)	
PR21 PR32 PR38 PR146 PR150 PR175 PR178 PR190 PR208 PR255 PR264 PO13 PY151 PV23	+++ ++ ++ + + + +++ + + ++ ++ ++ + ++	78	78	77(30)	
PR57:1 PR190 PO34 PO61	+ + + +	92	91	92 (80), 65(20)	

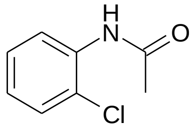
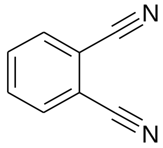
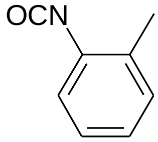
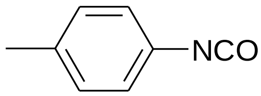
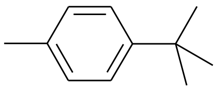
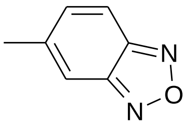
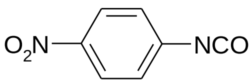
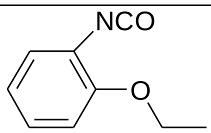
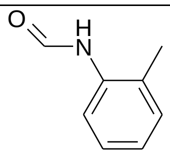
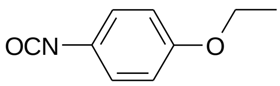
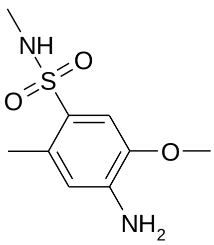
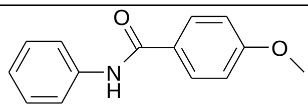
69 Abundance of product in pyrogram, +++ = 60-100% abundance, ++ = 15-60%, + = less than 15% but at least 3 times the height of the noise.

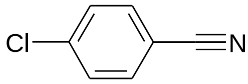
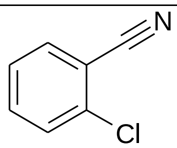
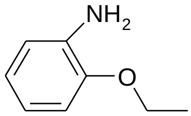
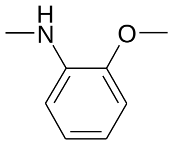
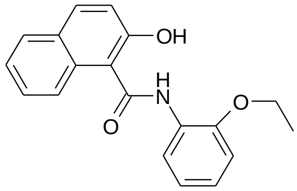
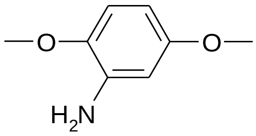
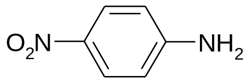
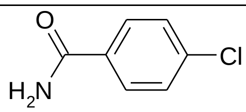
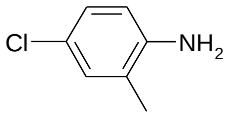
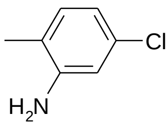
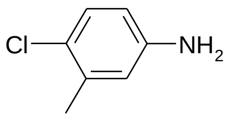
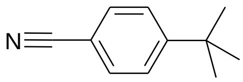
PR3 PR12 PY1	+ ++ +	137	91	137 (60), 65(50)	
(PR7)		126	91	126	
PR2 PR21 PR22 PR31 PR32 PR41 PR146 PR150 PR176 PR178 PO16 PY1 PY6 PY12 PY97 PY126 PY127 PY151	+ +++ +++ + +++ + ++ + +++ +++ +++ ++ +++ +++ + +++ +++ +	93	93	66(50)	
PR266	+		93	121(85), 108(90), 123(70), 65(50)	
PR123	++	122	94	122(60), 66(25)	
PR123 PR190 PY180	+++ ++ ++	94	94	66(50)	
PR210 PR255	+ ++	103	103	76(10), 50(10)	
PR175 PY108	++ +	136	105	77(40), 136 (35), 51(15)	
PR208	++	178	105	123(50), 77(25), 178 (2)	
PY75	++		105	186(35), 152(35), 111(38)	?
PY73	+	186	105	186 (80), 111(35), 153(30), 75(30), 139(30), 188(25), 77(25)	
PR150	+	197	105	197 (35), 77(30)	

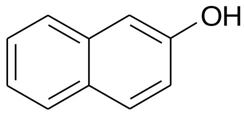
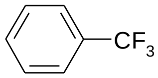
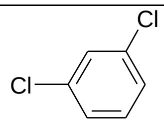
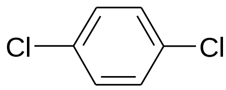
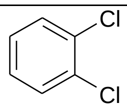
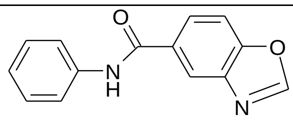
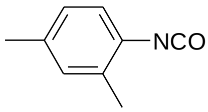
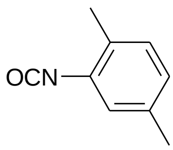
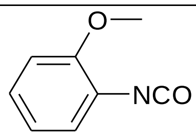
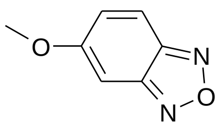
PR149 PG7	++ ++	106	106	91(95), 105(40)	
PR176 PY1	++ +	107	106	107 (70), 93(50), 77(30)	
PR12 PR14 PR17 PR112 PY14	+++ +++ ++ +	107	106	107(68), 77(12)	
PR57:1 PO34 PY6 PY55 PY126 PY127	+ + + +++ + +	107	106	107(65), 77(10)	
PR123	+	122	107	122(50), 77(20)	
PR190 PY194	+++ ++	108	108	65(45), 78(35)	
PR190	+	108	108	79(25), 90(15)	 ?
PR9 PR188 PR210 PR266 PO59 PY17 PY65 PY73 PY74 PY194	+ +++ ++ ++ + +++ +++ +++ +++ ++	123	108	123 (80), 80(60), 65(10)	
PY75	+++	137	108	109(60), 137 (45), 80(25)	
PO38	++	150	108	150 (70), 80(20)	
PR4 PR6 PR14 PO36 PO67 PY75 PBr23	+ ++ ++ + ++ + +	157	111	157 (65), 75(65), 113(30), 99(25)	
PR254 PO67 PY3 PY128 PG36	++ + + + ++	112	112	114 (30), 77(40)	
PY154	++	161	114	141(95), 161 (90), 142(25)	

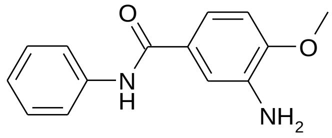
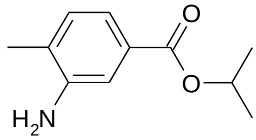
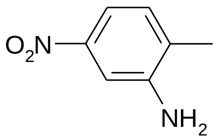
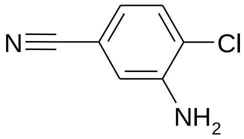
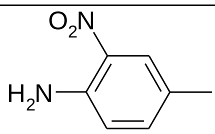
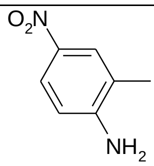
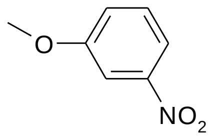
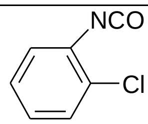
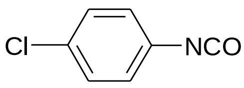
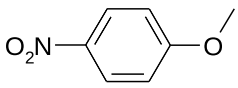
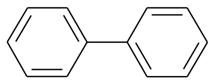
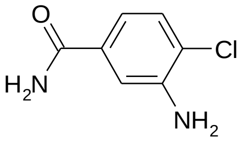
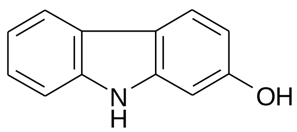
PR150	+	116	115	116 (80)	
PR176	++		115	130(80), 102(20) 65(20)	
PO34	+		117	116(70), 90(35)	 ?
PY151	+		118	160(20), 91(10), 63(10)	
PR187 PR210 PR266	++ + +	118	118	91(25)	
PR2 PR21 PR22 PR31 PR32 PR38 PR41 PR146 PR150 PR176 PO13 PO16 PO62 PY1 PY6 PY12 PY126 PY127 PY151	+ ++ ++ + ++ +++ ++ ++ + ++ +++ +++ + +++ ++ ++ ++ +++ +	119	119	91(40), 64(30)	
PO73	+	134	119	91(40), 134 (20), 77(10)	
PR221	++		119	136(40), 91(30)	 ?
PR175	+++	151	119	151 (80), 92(55), 65(25)	
PR208	++	193	119	193 (40), 137(25), 92(20), 65(20)	
PY13 PY81	++ +++	121	120	121 (95), 106(70), 77(10)	

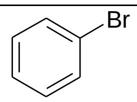
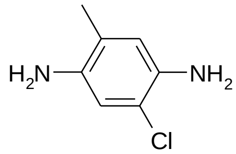
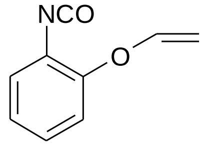
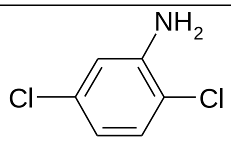
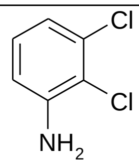
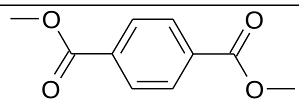
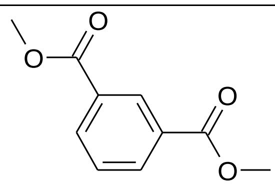
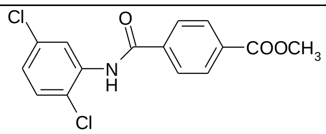
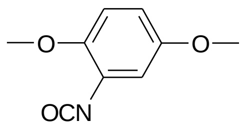
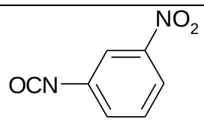
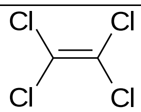
PY180	++	120	120	91(95), 94(30)	
PY180	+++	135	120	135(80), 108(35), 80(40)	
PR185	++	215	120	121(28), 150(18), 215(18), 91(21), 77(15)	
PY2	+	135	120	135 (95), 120, 134(70)	 ?
PR210 PY73	+ +	121	121	93(95), 66(70), 65(65)	 ?
PY2	++	121	121	120(95), 106 (90), 77(20)	
PY75	++	151	122	151 (70), 94(15)	 ?
PR5	+++	258	122	258 (60), 186(40), 72(30)	
PR6 PO36 PO67 PO69 PY2 PY3 PY6 PY73 PY75 PBr23	+ ++ + + ++ + + ++ ++ +	154	124	154 (80), 126(30), 156(25)	
PY150	++		126	85(22), 68(18), 43(28)	
PY3 PY168	+++ +++	127	127	129(30), 65(30)	
PR8 PO69	+++ ++	127	127	129(25), 65(25)	

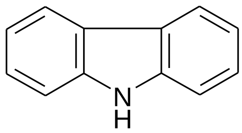
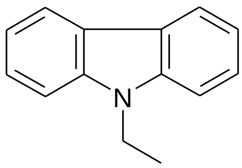
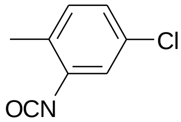
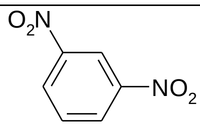
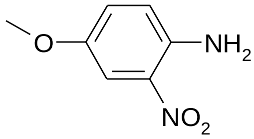
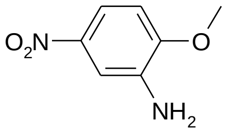
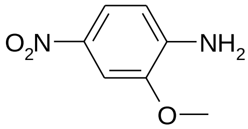
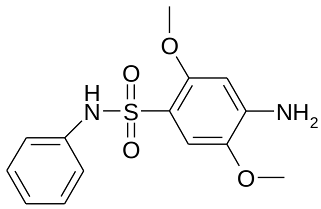
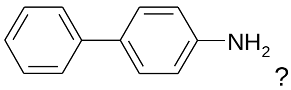
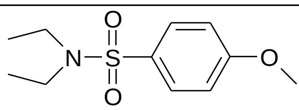
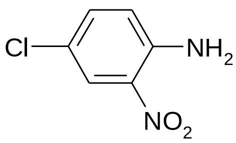
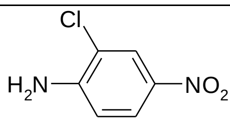
PY168	+	169	127	134(30), 129(30), 169(20)	
PB15	+	128	128	101(40), 75	
PR266	+		129	130(90), 115(70)	
PR12 PR14 PR17 PR112 PY14	++ +++ +++ ++ ++	133	133	104(60), 105(30), 78(20)	
PO34 PO69 PY55	++ ++ ++	133	133	104(70), 132(50), 78(20)	
PO73	+	148	133	148 (40), 105(40)	
PY1	+	134	134	77(60), 105(40)	
PO62	+	164	134	164 (70)	
PR170 PR210	++ ++	163	135	163 (50), 79(30), 91(15), 106(8)	
PY73	+	135	135	106(89), 77(28), 91(20)	 ??
PY75	++	163	135	163 (70), 79(10)	
PR185	+++	230	135	230(80), 152(40), 136(52), 121(45), 93(22)	
PR31 PR32 PR146 PR147 PR150 PR176	+ ++ ++ + + ++	227	135	227 (20), 92(10), 77(10)	

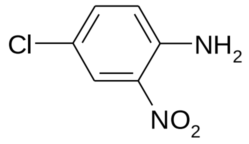
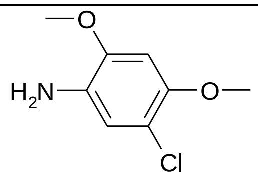
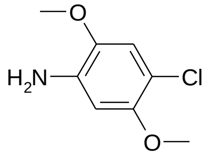
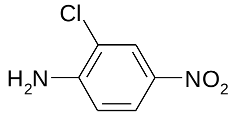
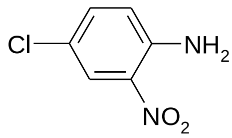
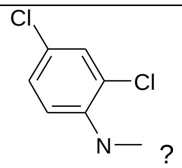
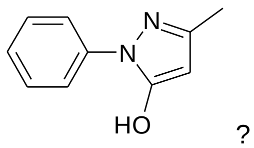
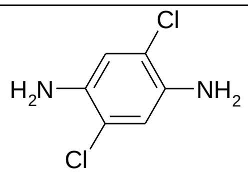
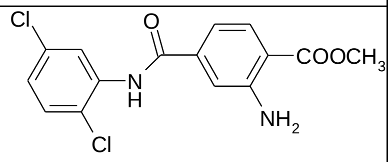
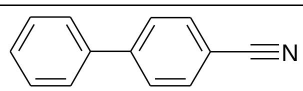
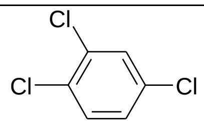
PR254	++	137	137	139(30), 102(40)	
PY168	+	137	137	139(35), 102(30)	 ?
PR170 PR210	+++ ++	137	137	108(95), 109(55), 80(68)	
PY73	+	137	137	122(84), 94(58), 77(22), 65(15)	
PR170	++	307	137	171(70), 307 (55), 115	
PY87	+++	153	138	153 (50), 110(30), 95(20)	
PO62	+	138	138	65(90), 108(70), 92(20)	
PO38	+	155	139	155 (50), 111(35), 141(30)	
PY3	+	141	140	141 (70), 77(15), 142(40)	 ?
PR147 (PR7)	+++	141	141	143(35), 106(98), 77(20)	
PR52:1	+	141	141	106(95), 77(35)	
PO34	+		143	115	
PR1	+++	293	143	293 (65), 115(60)	PR1
PR3	+++	307	143	307, 275(90), 246(40), 115(45)	PR3
PR4	+++	327	143	327 (70), 329(20), 115(60)	PR4
PO73	+++	159	144	116(35), 104(10), 159 (10)	

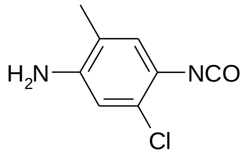
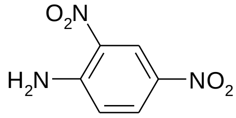
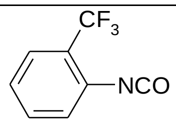
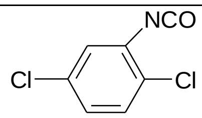
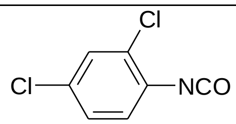
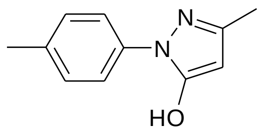
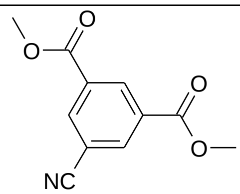
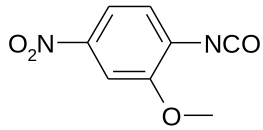
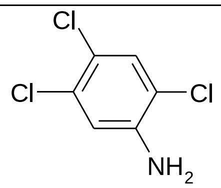
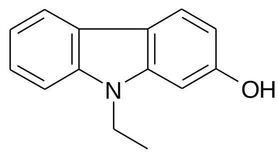
PR1 PR3 PR4 PR49:2 PR53:1 PR58:4 PR266 PO5 PO38 PO46	+ + + + + + + ++ + ++	144	144	115(40)	
PY154	++	146	146	145(60), 127(30), 96(20)	
PY16	+	146	146	148(70), 111(25)	
PR2 PR9 PR144 PR166 PR214 PO61 PY173 PV23 PBr25	++ ++ + ++ + +++ +++ + +	146	146	148(60), 111(30)	
PY109 PBr23 PBr41	++++ + +	146	146	148(50), 111(20), 75(10)	
PR32 PR146 PR150	++ ++ +		146	238(25), 118(15)	 ?
PY13 PY81	++ +	147	147	132(30), 118(30)	
PY2	++	147	147	132(30), 118 (20)	
PR9 PR188 PR210 PR266 PO59 PY17 PY65 PY73 PY74 PY194	++ ++ ++ ++ +++ ++ ++ ++ ++ +++	149	149	134(40), 106(40), 120(30)	
PY65	++	150	150	120(20), 77(10)	

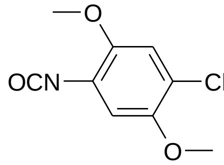
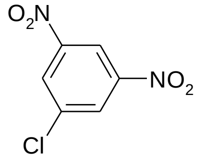
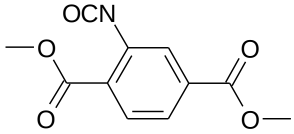
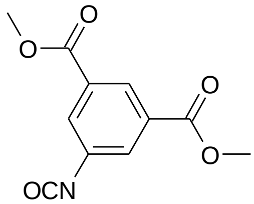
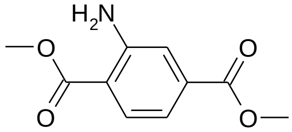
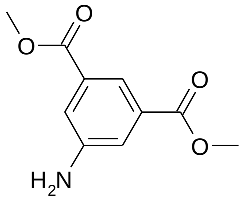
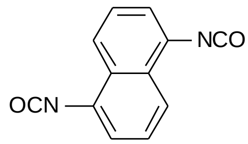
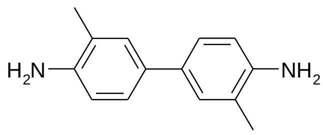
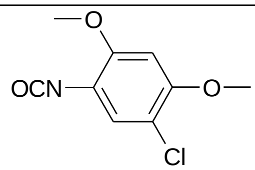
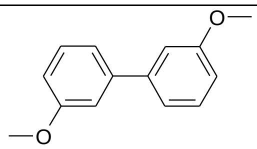
PR31 PR32 PR146 PR147 PR150 PR176	+++ ++ +++ ++ + +++	242	150	242 (30), 122(15), 107(5)	
PR221	+++	193	151	106(50), 193 (40), 134(25)	
PR8 PR17 PR21? PR22	++ ++ ++ +++	152	152	106(55), 77(30), 79(20)	
PO38	++	152	152	154(30)	
PR3	+	152	152	106(50), 77(25)	
PR12	++	152	152	136 (24), 122(85), 93(30), 77(45)	
PY65	++	153	153	107	
PY3 PY168	++ ++	153	153	155(30), 125(35), 127(20), 90(15), 63(12)	
PR8 PO69	++ +++	153	153	125(35), 155(30), 90(20)	
PR23	+	153	153	122(65), 92(45), 64(35)	
PR178 PR264	++ ++	154	154	153(40), 152(30), 155(20),	
PO38	+++	170	154	170 (80), 126(40), 156(30)	
PV23	++	183	154	183(95), 155(40), 127(20)	

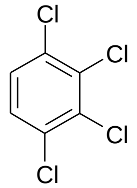
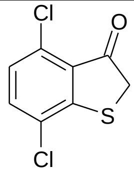
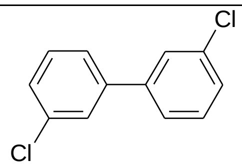
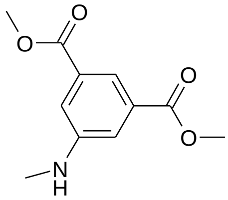
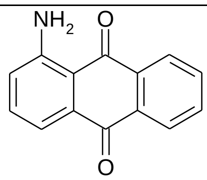
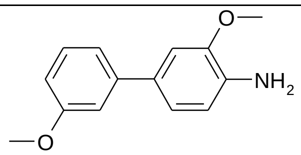
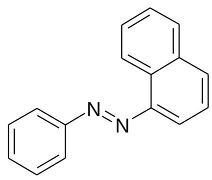
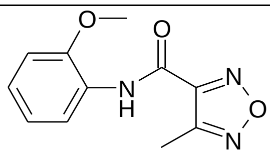
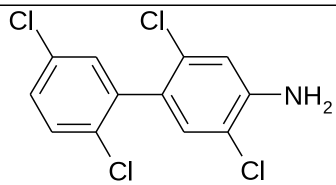
PG36	+	156	156	158(80), 77(70)	
PY128	+++	156	156	155, 158, 121	
PY151	++		160	145(40), 118(40), 89(40)	
PY180	++	161	161	132(25), 79(20)	
PR2 PR9 PR144 PR166 PR188 PR214 PY16 PBr25	+++ +++ +++ +++ ++ +++ ++ +++	161	161	163(60)	
PBr41	+++	161	161	163(60), 126(10), 90(10)	
PY175	+	194	163	194 (35), 135(30), 103(20), 120(20)	
PY120	++	194	163	194 (25), 135(20), 76(10)	
PO62	+++	205?	163	133(20), 117(25), 105(20)	
PR188	+++	323	163	288 (40), 135(15), 290(10), 323 (5)	
PY87	++	179	164	179 (40), 136(30), 108(10), 93(10)	
PR23	+	164	164		
PR206		164	166	164 (75), 129(50)	

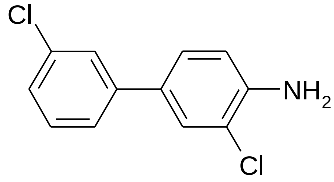
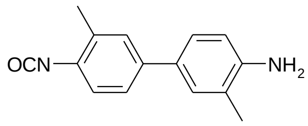
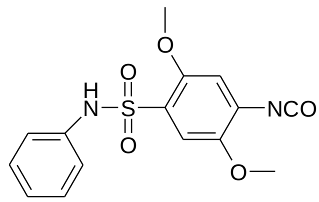
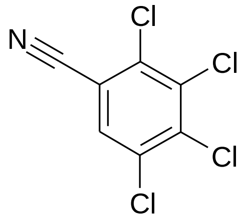
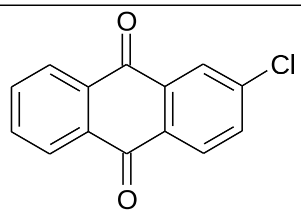
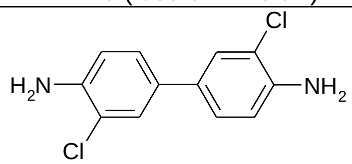
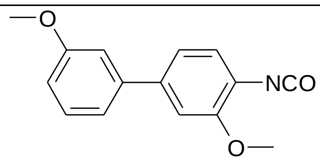
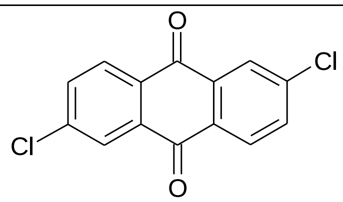
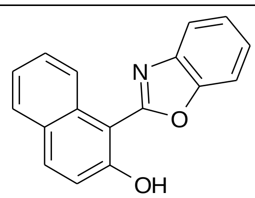
PV23	++	167	167	166(35), 139(20), 140(15)	
PV23	+	195	167	180(25), 166(30), 164(10), 139(30), 195 (25)	
PR147 (PR7)	++	167	167	169(30), 138(60), 132(60), 104(20)	
PR178	+		167	139(15), 83(6)	
PO5	+	168	168	76(60), 122(40)	
PY65	+	168	168	153(50), 122(35), 107(25), 79(20)	
PR23	+++	168	168	153 (40), 122(20), 95(18)	
PY74	+	168	168	153(30),	
PY97	+	308	168	308 (50), 122(35)	
PR178	++	169	169	168(70), 167(40), 77(15), 83(15)	
PR5	+++	243	171	228(60), 107(35), 243 (20)	
PO36 PBr23	+++ +++	172	172	126(60), 99(30), 90(20)	
PR6	+++	172	172	126(60), 99(45), 174(25), 63(30)	

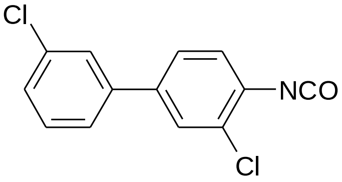
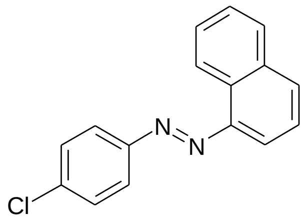
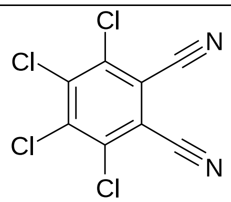
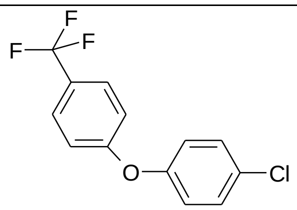
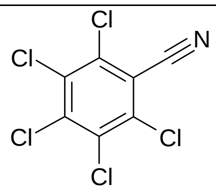
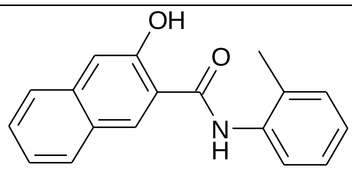
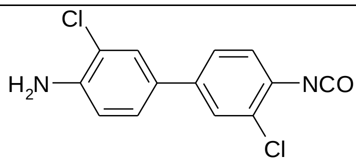
PR14 PO67 PY73 PY75	++ ++ + ++	172	172	126(65), 99(36), 174(30)	
PR5 PR187	+ +++	187	172	187 (50), 144(40), 129(25)	
PR146 PY83 PY97	+++ +++ +++	187	172	187 (40), 144(25), 129(20)	
PR4	++	172	172	142(85), 90(65), 174(32), 63(31)	
PY6	+	172	172	126(40), 63(60)	
PY16	+		174	175(80), 176(55), 177(45)	
PR41	+++	174	174	105, 91	
PR221	++	176	176	178(60), 141(20), 114(15)	
PR188	+++	338	178	303(40), 150(25), 338 (20), 135(20)	
PR264	+++	179	179	178(30), 151(22)	
PR112	++	180	182	184(30), 145(55), 109(30)	

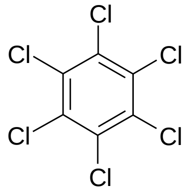
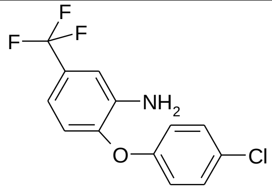
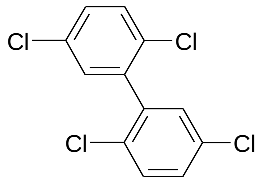
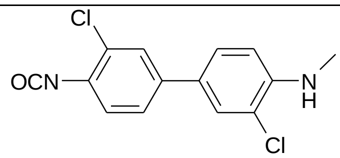
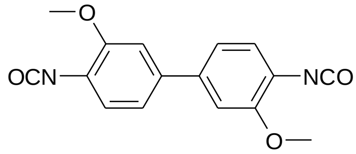
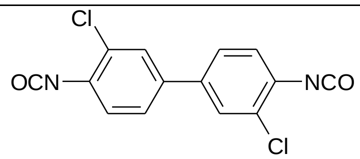
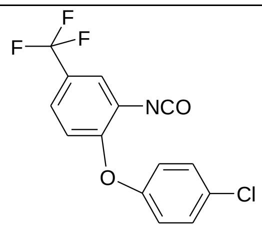
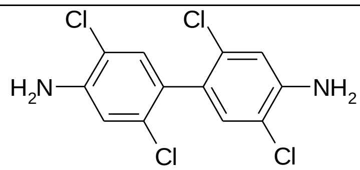
PY128	++	182	182	153(65), 119(50), 184(25)	
PY128	++		182	119(55), 184(35), 154(20)	
PO5	++	183	183	153(90), 91(45)	
PY154	+++		186	166(40), 138(30), 228(15)	
PY154	++		186	166(40), 138(25), 228(10)	
PY16	++		186	188(60), 124(15)	
PY154	+++	187	187	168(20), 145(18)	
PR188 PR214	+ +	187	187	189(55), 124(50), 159(15)	
PY16	+++	187	187	189(65), 124(70), 159(40)	
PO34	+	188	188	105(75), 91(60)	
PY120	+	219	188	219 (30), 160 (30)	
PY74	+		193	147(35), 164(20)	
PY74	+++		194	164(25), 136(20), 77(25)	 ?
PR32	++		195	288(50), 231(35)	
PR112	+++	195	195	197(85), 199(25), 124(30), 97(12)	
PV23	+++	211	196	211 (65), 183(20), 154(25), 127(12)	

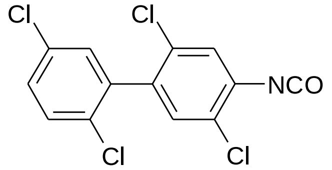
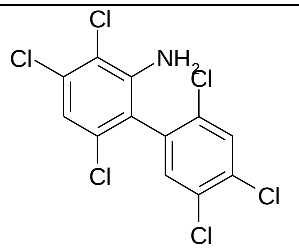
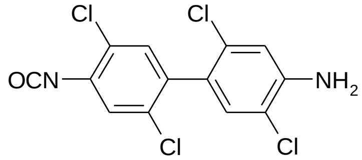
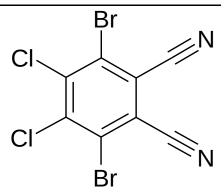
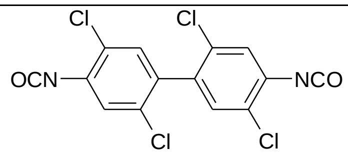
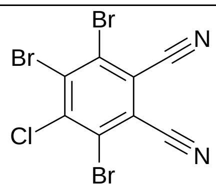
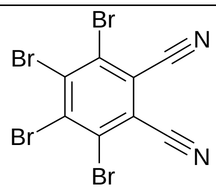
PR146 PY83 PY97	++ ++ +++	213	198	213 (65), 215(20), 170(15)	
PO5	+	202	202	204(35), 110(55), 75(75)	
PY175	++	235	204	235 (40), 144(10), 120(10)	
PY120	+	235	204	235 (35), 161(25), 176(15)	
PY175	++	209	209	177(60), 150(25), 119(25)	
PY120	+++	209	209	178(50), 150(40), 122(20)	
PBr41	+	210	210	154(30), 127(10)	 ?
PY16	+	212	212	106(15)	
PR5 PR187	+ ++	213	213	215(35), 198(50), 172(80), 187(40)	
PR41	+++	214	214	171(15)	

PO61 PY109 PY110	+ + +	214	216	214 (80), 218(50), 143(15), 108(20)	
PR88	++	218	218	220(60), 189(50)	
PR38 PO13 PO34 PY55	++ ++ ++ +	222	222	224(60), 152(60)	
PY120	+	223	223	192(30), 164(25), 136(10)	
PY108	+++	223	223	195(20), 167(20), 139(20)	
PR41	+	229	229	214(50), 186(35)	
PR57:1	+++		232	231(60), 202(25)	
PO59	+	233	233	149(50), 106(30), 176(25)	
PY175	+++		234	203(70), 176(20), 143(20), 245 (20)	
PY120	++		234	203(99), 276(20)	
PR2 PR9 PR144 PR166 PR214 PY81 PBr25 PBr41	+ + ++ ++ ++ + + +	305	235	270(88), 272(80), 237(60), 307(50), 305 (40)	

PR38 PO13 PO34 PY12 PY13 PY17 PY87 PY126	++ ++ +++ + + + + +	237	237	239(60), 167(20), 139(20)	
PY16	+	238	238	195(10), 239(20)	
PY97	++	334	239	334 (50), 148(50), 194(30), 163(30)	
PO61 PY109 PY110	++ + +++	239	241	239 (70), 243(50), 204(20), 99(15)	
PO51	+++	242	242	214(55), 151(40), 186(35), 244(35)	
PR255	++		245	216(20), 189(10)	m.w. - 43 (loss of HNCO?)
PR6 PR38 PO13 PO34	++ + + ++	252	252	254(30), 189(15)	
PO16	+	255	255	212(30)	
PO51	++	256	256	258(30), 193(30), 165(25)	
PR3	++		260	231(65), 202(50)	
PY129	+++	261	261	260(50), 233(20), 204(10)	

PR38 PY12 PY13 PY14 PY17 PY55 PY87 PY126 PY127	+ + + + + + + ++ ++	263	263	265(70), 200(50), 164(20)	
PO46	+++	265	265	280(90), 202(20), 282(30)	
PR1	+		265	189(40), 218(25)	PR1 minus CO?
PR48:1 PR52:1 PR53:1 PO46	++ +++ +++ +	266	266	268(30), 231(25), 202(20)	
PG7	+++	264	266	264 (70), 268(40), 229(10), 194(10)	
PR49:2	+++		268	239(20), 134(10)	
PY128	+	272	270	272(30), 251(20)	
PR3	++		275	246(35), 129(20)	
PG7	+	273	275	277(60), 279(20), 240(20)	
PR112	+	277	277	171(65), 142(50), 115(65), 107(75)	
PY12 PY14 PY17 PY55 PY83 PY126 PY127	+ ++ + + + ++ ++	278	278	280(60), 215(30)	

PY110	+	282	284	286(90), 249(30), 142(30), 288(30)	
PY128	+++	287	287	289(35), 252(15), 148(25)	
PO5			290	244(30)	
PO5			291	189(95), 217(60), 187(55)	
PR9 PR144 PR166 PR214	+ + + +	290	292	294(70), 255(20), 220(65)	
PY126 PY127	++ ++		292	294(60), 278(30)	 ?
PO16	++	296	296	253(50). 210(10)	
PY14 PY83 PY126 PY127	++ + ++ +++	304	304	306(60), 241(40)	
PR144 PR166 PR214 PBr25 PBr41	+ + + + +		307	305(90), 235(40)	
PY128	+		313	315(55), 234(45)	
PR254	++		313	315(60), 317(10), 250(30), 214(20)	m.w. - 43 (loss of HNCO?)
PY173	+	320	322	320 (70), 281(50), 324(40), 250(20)	

PY81	+	331	333	331 (70), 335(50), 261(30), 198(25)	
PR112	+	373	340	305(80), 268(40)	
PY81 PY173	+ +	346	348	346 (80), 350(40), 276(15), 213(15)	
PG36	++	352	354	356(80), 352 (40), 358(25), 276(15), 194(15)	
PR58:4	++		357	358(85), 339(20), 145(30), 187(15)	
PY81	+	372	374		
PG36	+++	396	400	398(80), 402(50), 396 (30), 240(20), 124(20)	
PG36	+++	440	444	442(60), 446(60), 440 (20), 448(15), 365(15) 284(20), 124(25)	

Appendix D. Details of Samples taken from Studio

	Database no.	Name	Further details	Sample description	Location
S1	RM98F205:32	Carsons orange	Paint tin. Carsons Sunway Colours vinyl matt yellow tint	Dried fragments of bright orange paint	Floor to back right of main easel
S2	RM98F131:110	Dulux white	Paint tin. Dulux Trade Vinyl Matt Emulsion. The Professional Choice	Dried fragment from inside tin	Main group of tins on floor
S3	RM98F131:181	Dulux pale blue	Paint tin, Dulux Trade Vinyl Matt Emulsion Colourdimensions light base	Pale blue fragments	Main group of tins on floor
S4	RM98F131:49	Dulux orange	Paint tin. ICI Dulux Trade Vinyl Matt Emulsion The Professional Choice Colour Dimensions Extra Deep Base	Orange scraping from under lid	Main group of tins on floor
S5	RM98F19:73(?)	Winsor orange pigment	Jar. Winsor & Newton Dry Ground Artists' Pigment Winsor Orange (Napthalene Carboxyic Acid)	Dry pigment	Top shelf opposite door
S6	RM98F19:1	Peinture aerosol, orange	Spray paint can. Peinture Aerosol Orange Brillant secage instantane	Dried drip from nozzle	Top shelf opposite door
S7	RM98F19:35	U-spray red	Spray paint can. U - Spray Trade Mark Gloss Paint Pillar Box Red	Dried fragment from nozzle	Top shelf opposite door
S8	RM98F19:28	L&B cadmium red-orange	Jar of pigment. Lefranc & Bourgeois Artist Pigment Cadmium Red Orange (Cadmium Sulphide)	Dry pigment from jar	Top shelf opposite door
S9	RM98F19:27	L&B cadmium yellow-orange	Tin of pigment. Lefranc & Bourgeois Artist Pigment Cadmium Yellow (Cadmium Sulphide)	Dry pigment from tin	Top shelf opposite door
S10	RM98F19:90	U-spray blue	U-Spray Gloss Paint Mid Blue	Dried fragment from nozzle	Top shelf opposite door
S11	RM98F19:92	Winsor yellow pigment	Glass jar of Winsor & Newton Artist's Pigment. Dry Ground Winsor Yellow	Dry pigment from jar	Top shelf opposite door
S12	(small table)	Rembrandt pastel, blue	Talens Rembrandt Pastel, blue	Fragments scraped from stick	Small table to left of entrance
S13	(small table)	Rembrandt pastel, chrome green	Talens Rembrandt Pastel, Chrome green	Fragments scraped from stick	Small table to left of entrance
S14	(small table)	Flesh-coloured chalk/pastel	Unlabelled	Fragments scraped from stick	Small table to left of entrance
S15	(small table)	Universal stainer, red	Paint tube. Universal Stainer, Permanent Scarlet	Wet scraping from inside cap	Small table to left of entrance

S16	(small table)	Roberson viridian	Paint tube. C. Roberson & Co. oil colour, viridian	Wet paint from inside tube	Small table to left of entrance
S17	RM98F18:3	W&N oil colour, Winsor red 173	Paint tube (unused?). Winsor & Newton artists' oil colour, Winsor Red, 173, 37ml	Wet paint from inside tube	Wooden bowl on floor
S18	RM98F7A:77(?)	W&N permanent rose(?)	Paint tube. Winsor & Newton oil paint, probably permanent rose, details obscured by paint accretions	Dried paint at nozzle of tube	Table at left side in front of back shelves
S19	RM98F12:110	Liquitex acrylic modeling paste	Plastic container, Liquitex, Acrylic, Modeling Paste	Dried fragment from inside jar	Low table to left of shelves opposite door
S20	RM98F7C:4:1	W&N oil colour, Alizarin crimson	Paint tube. Winsor & Newton Artists' Oil Colour Alizarin Crimson 142, 37ml	Semi-dry paint from tube	Table at left side in front of back shelves
S21	RM98F7C:12:5	W&N oil colour, Jaune brillant	Paint tube. Winsor & Newton Artists' Oil Colour Jaune Brillant 118 SL Series 1, 37ml	Dried paint at nozzle of tube	Table at left side in front of back shelves
S22	RM98DOOR	Door, white paint,	Thick blob on central spar of door	White fragments	Studio door, outer side
S23	RM98DOOR	Door, red paint	Crust on central spar of door	Red fragments	Studio door, outer side
S24	RM98DOOR	Door, pink-white	Pink-white paint from upper left panel of door	Pink/white fragments	Studio door, outer side
S25	RM98DOOR	Door, blue-white paint	Blue-white paint on upper part of central spar of door	Blue/white fragments	Studio door, outer side
S26	RM98F7A:11	Pink paint from corduroy rag	Cut fragment from brown corduroy trousers, with accretions of pink, black & pale blue paint	Paint scraping	Table at left side in front of back shelves
S27	RM98F7A:11	Light blue paint from corduroy rag	Cut fragment from brown corduroy trousers, with accretions of pink, black & pale blue paint	Paint scraping	Table at left side in front of back shelves
S28	RM98F7A:1	Pale pink paint from dish	Glazed rectangular ceramic dish used for mixing paints, with pale pink and light brown paint accretions.	Pink fragments	Table at left side in front of back shelves
S29	RM98F7A:1:3	W&N oil paint, Cobalt violet	Paint tube. Winsor & Newton Artists' Oil Colour Cobalt Violet 229, inside dish (RM98F7A:1)	Dried paint from nozzle	Table at left side in front of back shelves
S30	RM98F7C:79	W&N oil paint, Titanium white	Paint tube. Winsor & Newton Artists' Oil Colour Titanium White 644 (244)	Dried paint from nozzle	Table at left side in front of back shelves
S31	RM98F7C:34:2	W&N oil paint, Winsor red 173	Paint tube. Winsor & Newton Artists' Oil Colour Winsor Red 173 Series 2, 37ml	Dried paint from nozzle	Table at left side in front of back shelves
S32	RM98F7C:1:5	W&N oil paint, green	Paint tube. Winsor and Newton Artists' Oil Colour, green (details obscured)	Dried paint from nozzle	Table at left side in front of back shelves

S33	RM98F7C:12:4	Pink powder from dish	Pink powder in metal top from cooking pot	Powder	Table at left side in front of back shelves
S34	RM98F7D:2 (?)	Yellow powder/ paint over orange	Tin tray with mainly orange/yellow paint accretions	Yellow powder + orange flake	Table at left side in front of back shelves
S35	RM98F7D:2 (?)	Orange pigment/ paint	Plastic bucket with orange paint/pigment	Orange fragments	Table at left side in front of back shelves
S36		Dust from edge of tin on shelf		Grey fibres	Top back shelf
S37	RM98F7C:134	W&N oil paint, green	Half paint tube. Winsor and Newton Artists' Oil Colour, green (details obscured)	Fragments from cut edge	Table at left side in front of back shelves
S38		W&N oil paint, Winsor orange	Paint tube. Winsor & Newton Artists' Oil Colour Winsor Orange 172, 37ml	Dried paint from nozzle	Table at left side in front of back shelves
S39	RM98F7B:22	Rowney cadmium yellow	Rowney Cryla Colour, Cadmium Yellow, Pale 611 Series C	Dried paint from nozzle	Table at left side in front of back shelves
S40	RM98F7B:23	W&N oil paint, Flake white	Winsor & Newton Artist's Oil Colour Flake White, No. 2. 239	Dried paint from nozzle	Table at left side in front of back shelves
S41	RM98F105:122D (?)	Orange paint from cloth	Fine-knit cream-coloured cloth with orange and blue paint accretions	Paint scraping	Floor in front of back shelves
S42	RM98F7B:96	Yellow pigment on table	Pigment on corner of table at left side in front of back shelves	Powder	Table at left side in front of back shelves
S43	RM98F139:6	Dark pink powder over light pink	Enamel plate with accretions of paint, mainly pink, white & orange	Powder + pink flake	Top back shelf, far left
S44	RM98F139:6	Orange paint on plate	Enamel plate with accretions of paint, mainly pink, white & orange	Orange scraping	Top back shelf, far left
S45	RM98F139:6	Dark red blob on plate	Enamel plate with accretions of paint, mainly pink, white & orange	Red scraping	Top back shelf, far left
S46	RM98F7C:7	Red paint on plate	White enamelled metal bowl used as artist's palette	Red scraping	Table at left side in front of back shelves
S47	RM98F7C:7	Orange paint on plate	White enamelled metal bowl used as artist's palette	Orange scraping	Table at left side in front of back shelves
S48	RM98F7C:34:3	Rowney oil color, crimson alizarin,	Rowney Crimson Alizarin oil paint 515	Semi-dry paint from nozzle	Table at left side in front of back shelves
S49	RM98F7C:1:3	Orange paint on cloth	Fine-knit beige cloth (dishcloth?) with white, yellow and orange paint accretions	Orange scraping	Table at left side in front of back shelves
S50	RM98F7C:1:3	Yellow paint on fine knit beige cloth	Fine-knit beige cloth (dishcloth?) with white, yellow and orange paint accretions	Yellow scraping	Table at left side in front of back shelves

S51	RM98W5	Orange-red patch on wall	Orange-red patch of paint on wall to right of false door, above radiator	Orange scraping	Wall section immediately to right of false door
S52	RM98W5	Red ring on wall	Red ring of paint on wall to right of false door, above radiator	Red scraping	Wall section immediately to right of false door
S53	RM98W5	Purple paint on wall, with wall paint	Purple patch of textured paint on wall to right of false door, above radiator	Purple layer and masonry paint	Wall section immediately to right of false door
S54	RM98W5	White/red patch on wall	White-red patch of paint on wall to right of false door, above radiator	White scraping	Wall section immediately to right of false door
S55	RM98W5	Deep red paint with fibrous material on wall	Deep red paint with white fibrous material on wall to right of false door, above radiator	Red fragment + white fibres	Wall section immediately to right of false door
S56	RM98W5	Green-yellow paint on wall	Green-yellow patch of paint on wall to right of false door, above radiator	Green and yellow fragments	Wall section immediately to right of false door
S57		Pink dust on easel	Dust from horizontal of easel to left of entrance, between radiators	Pink powder & fibres	Easel to left of entrance
S58	RM98W5	Green-white paint on wall	Green-white patch of paint on wall to right of false door, above radiator	Green/white scraping	Wall section immediately to right of false door
S59	RM98W7	Black over pink, from wall	Very thick paint application with black surface on wall above table	Paint chip with black over pink	Wall section to left of back wall, above table
S60	RM98W7	Orange over white from wall	Paint on wall above table	Paint chip with orange & white layers	Wall section to left of back wall, above table
S61	RM98F12:55	W&N Fixative	Spray can of Winsor & Newton Aerosol Fixative	Scraping from nozzle	Low table to left of shelves opposite door
S62	RM98W8	Pale pink over dark pink by mirror	Pale pink over dark pink paint on wall to left of mirror	Paint chip with pink layers	Back wall to left of mirror
S63	RM98W8	White by mirror	White patch of paint on wall to left of mirror	White scraping	Back wall to left of mirror
S64	RM98F12:28	Orange pigment in tray	Paint roller tray covered in orange pigment particles	Powder	Low table to left of shelves opposite door
S65	RM98F12:21	U-spray matt white	Spray can. U - Spray Matt Finish White	Scraping from nozzle	Low table to left of shelves opposite door
S66	RM98F162:50	Kingston Universal Stainer, red	Paint tube. Kingston Universal Stainer	Semi-dry material from nozzle	In wooden box in space behind main easel
S67	RM98F131:4	Blue paint from green food tin	Green tin with blue paint inside, Split Green Olives in Brine And Aromatic Herbs Fontvieille France	Drip outside tin	Main group of tins on floor

S68	RM98F225:2	Carsons pink-purple	Paint tin. Carsons Sunway Colours Vinyl Matt “Pale” masonry paint	Scraping from lid (+rust?)	Third shelf down opposite door
S69	RM98F251:23	Carsons purple	Paint tin. Carsons Vinyl Matt Pale, Carson Hadfields Mitcham, Surrey	Fragment from inside can	Floor beneath shelves opposite door
S70	RM98F223:1	Carsons tan	Paint tin. Carsons Sunway Colours Vinyl Matt Deep Tint, Bestobell Paints Ltd. Mitcham, Sry.	Scraping from drips outside can	Shelf opposite door
S71	RM98F131:207 ? or 84?	Carsons vinyl matt, vibrant, green	Paint tin. Carsons Sunway Colours Vinyl Matt Vibrant Tint	Scraping from drips outside can	Main group of tins on floor
S72	RM98F221:19A	Sand from bowl	Fine light coloured grains of sand, possibly the same as that in nearby white paper bag: BMS Blanchards Builders Sand	Sand particles	Second shelf down opposite door
S73	RM98F19:100	Rose madder gen, pigment, Cornelissens	White paper packet of pink pigment. Rose Madder - Gen 350 6 M Cornelissen & Son 105 Great Russell Street, WC10	Dry pigment	Top shelf opposite door
S74	RM98F162:19	Rowney acrylic, cobalt blue	Paint tube. Rowney Cryla Acrylic Standard Formula Cobalt Blue 109 Series B	Wet paint from tube	In wooden box in space behind main easel
S75	RM98F162:7	Universal stainer, permanent green.	Paint tube. Universal Stainer Permanent Green. Carson Paripan Ltd	Semi-dry material from tube	In wooden box in space behind main easel
S76	RM98F209:24	L&B Alizarin crimson	Pigment jar. Lefranc & Bourgeois Artist Pigment Alizarin Crimson (Alizarin On Aluminium Oxide)	Dry pigment	Top back shelf
S77	RM98F209:2:6	W&N Rose madder genuine	Pigment jar. Winsor & Newton Rose Madder Genuine pigment	Dry pigment	Top back shelf
S78	RM98F209:2:2	W&N Chrome lemon	Pigment jar. Winsor & Newton Chrome Lemon dry pigment.	Dry pigment	Top back shelf
S79	RM98F209:22:1	Parris Marble medium	Parris’s Marble Medium for Oil Painting where the surface is required to appear flat or dead. Roberson & Co Ltd, 71 Parkway, London	Scraping from nozzle	Top back shelf
S80	RM98F19:117	Chalkboard paint	Chalkboard Paint Black, Thos. S. Jackson & Sons Ltd., Jasonite Works. Mitcham, Surrey	Drip from outside of tin	Top shelf opposite door
S81	RM98F19:4	U-spray gloss, deep green	Spray paint can. U - Spray Gloss Paint Deep Green	Scraping from nozzle	Top shelf opposite door
S82	RM98F19:3	Humbrol Krylon spray, white	Spray paint can, Humbrol Krylon Spray Paint for interior and exterior use	Scraping from nozzle	Top shelf opposite door
S83	RM98F251:18	Carsons orange	Carsons Sunway Colours Vinyl Matt Yellow Tint, Bestobell Paints Ltd. Mitcham, Surrey	Drip from outside of tin	Floor beneath shelves opposite door

S84	RM98F251:26	Du-lite emulsion, mushroom tint	Paint tin. ICI Du-lite Emulsion Paint Mushroom Tint 1572. Paints Division Slough Bucks	Dried fragment from inside tin	Floor beneath shelves opposite door
S85	RM98F87:37	Blackboard black	Paint tin, Blackboard Black (details obscured)	Dried black + liquid oil	Floor beneath small table
S86	RM98F87:30	Armitages Talk bird sand	Cardboard box, Armitage’s Talk Bird Sand, coarse yellowish particles.	Sand particles	Floor beneath small table
S87	RM98F131:61	Carsons full gloss vibrant	Paint tin. Carsons Full Gloss Vibrant	rubbery skin + olive green paint	Main group of tins on floor
S88	RM98F12:7	Markal paintstik, azo orange	Markal Artists Paintstik. Permanent Oil Colors in Stick Form	Scraping from paint stick	Low table to left of shelves opposite door
S89	RM98F12:7	Markal paintstik, napthol red	Markal Artists Paintstik. Permanent Oil Colors in Stick Form	Scraping from paint stick	Low table to left of shelves opposite door
S90	RM98F87:2	Ronseal polyurethane varnish	Tin. Ronseal Original Hardglaze Polyurethane Wood Seal Varnish. Clear Gloss Finish	Liquid sample	Floor beneath small table
S91	RM98F88:2	Carsons vibrant, dark green	Paint tin. Carsons Sunway Colours Vinyl Matt (Vibrant Tint), dark green masonry paint	Dried fragments from inside tin	Floor beneath small table
S92	RM98F88:2	Carsons vibrant, red drips	Paint tin. Carsons Sunway Colours Vinyl Matt (Vibrant Tint), dark green masonry paint	Drips from outside of tin	Floor beneath small table
S93	RM98F19:9	L&B Vernis à retoucher	Glass bottle. Vernis A Retoucher. Retouching Varnish Retuschierfirniss J. G. Vibert Lefranc Made in France (unused?)	Liquid sample	Top shelf opposite door
S94	RM98F7B:39	W&N oil colour, Permanent rose	Paint tube. Winsor & Newton Artists’ Oil Colour Permanent Rose 210 SL Series 3, 37ml	Scraping from nozzle	Table at left side in front of back shelves
S95	RM98F7B:11	W&N oil colour, Raw umber	Paint tube. Winsor & Newton Artist’s Oil Colour Raw Umber 129, 37 ml	Scraping from nozzle	Table at left side in front of back shelves
S96	RM98F251:29A	Carsons yellow-orange	Paint tin. Carsons Colours Emulsion Vibrant Tint. Bestobell Paints Ltd. Mitcham, Surrey	Drip from outside of tin	Floor beneath shelves opposite door
S97	RM98F19:17	U-spray black gloss	Spray can. U - Spray Gloss Paint Black	Scraping from nozzle	Top shelf opposite door
S98	RM98F19:38	U-spray matt black	Spray paint can. U - Spray Matt Finish Black	Scraping from nozzle	Top shelf opposite door
S99	RM98F162:35	W&N oil colour, Winsor red	Paint tube. Winsor & Newton Artists’ Oil Colour Winsor Red	Scraping from nozzle	In wooden box in space behind main easel
S100	RM98F162:21	W&N oil colour, Winsor yellow	Paint tube. Winsor & Newton Artists’ Oil Colour Winsor Yellow 175	Wet paint from tube	In wooden box in space behind main easel

Results of Analysis of Studio Materials

	Name	Analysis	Medium	Pigments	Extenders
S1	Carsons orange	FTIR, PyGCMS, EDX	PVAc (+ a little VeoVa?) [70]	Titanium white, PY1(PY3) & PR144/PR166/PR214?	Kaolin, chalk
S2	Dulux white	FTIR, PyGCMS	Acrylic (MMA, 2-EHA)	Titanium white	Kaolin
S3	Dulux pale blue	FTIR, PyGCMS	Acrylic (MMA, 2-EHA)	Titanium white	Kaolin, chalk
S4	Dulux orange	FTIR, PyGCMS, EDX	Acrylic (MMA, 2-EHA)	PY74, unidentified organic red/orange	Kaolin, chalk
S5	Winsor orange pigment	FTIR	-	PO43	-
S6	Peinture aerosol, orange	FTIR, PyGCMS, EDX	Alkyd-nitrocellulose. Dioctylphthalate plasticser	Iron oxide? (only trace of Fe in EDX)	
S7	U-spray red	FTIR PyGCMS	Methyl-styrene (Py product)	Organic red, napthol AS	
S8	L&B cadmium red-orange	FTIR, EDX	-	Cadmium sulphide-selenide	Barium sulphate
S9	L&B cadmium yellow-orange	FTIR, EDX	-	Cd sulphide-selenide (less Se than S8)	Barium sulphate
S10	U-spray blue	FTIR, EDX	Methyl-styrene (Py product)	Titanium white, organic blue?	
S11	Winsor yellow pigment	FTIR, PyGCMS	-	PY1	-
S12	Rembrandt pastel, blue	FTIR, PLM, EDX	?	Ultramarine, viridian?	Kaolin, barium sulphate
S13	Rembrandt pastel, chrome green	FTIR, PLM, EDX	?	Prussian blue & Chrome yellow	Kaolin, barium sulphate
S14	Flesh-coloured chalk/pastel	FTIR, EDX	?	Iron oxide red/yellow, zinc white	Kaolin, chalk, Barium sulphate
S15	Universal stainer, red	FTIR, PyGCMS	Oil, p/s = 1.72	Organic red PR144 or PR166	Chalk
S16	Roberson viridian	FTIR, EDX	Oil	Viridian	
S17	W&N oil colour, Winsor red 173	FTIR, PyGCMS	Oil, p/s = 1.42	PR188	Magnesium carbonate

[70] Vinyl versatate resin, a mixture of highly branched C_9 and C_{10} vinyl esters added as an internal plasticiser (Learner, 2004)

S18	W&N permanent rose(?)	FTIR, EDX, GCMS	Oil, p/s = 4.70	Unidentified. Al from lake base?	Magnesium carbonate
S19	Liquitex acrylic modeling paste	FTIR, PyGCMS	Acrylic (EA, MMA)	-	Chalk
S20	W&N oil colour, Alizarin crimson	FTIR, EDX, GCMS	Oil, p/s = 2.75	Alizarin crimson	Barium sulphate
S21	W&N oil colour, Jaune brillant	FTIR, EDX	Oil	Lead white, zinc white, Cadmium yellow/red	
S22	Door, white paint,	FTIR, GCMS	Oil, p/s = 2.65	Titanium white	Barium sulphate, magnesium carbonate
S23	Door, red paint	FTIR, GCMS, EDX	Oil, p/s = 1.63	Vermilion	Magnesium carbonate
S24	Door, pink-white	FTIR, EDX	Oil	Titanium white, Al from pink lake base?	Magnesium carbonate, barium sulphate?
S25	Door, blue-white paint	FTIR, EDX	Oil	Titanium white, zinc white, Prussian blue	Barium sulphate, magnesium carbonate?
S26	Pink paint from corduroy rag	FTIR, GCMS, EDX	Oil, p/s = 3.42	Titanium white, Al from pink lake base?	Magnesium carbonate, barium sulphate
S27	Light blue paint from corduroy rag	FTIR, EDX	Oil	Titanium white, Prussian blue	Barium sulphate, magnesium carbonate
S28	Pale pink paint from dish	FTIR, EDX	Oil	Titanium white, zinc white, Al from pink lake base?	Barium sulphate, Magnesium carbonate?
S29	W&N oil paint, Cobalt violet	FTIR, EDX, GCMS	Oil, p/s = 2.25	Ammonium cobalt phosphate hydrate	
S30	W&N oil paint, Titanium white	FTIR, EDX, GCMS	Oil, p/s = 2.59	Titanium white, zinc white	Barium sulphate, magnesium carbonate?
S31	W&N oil paint, Winsor red 173	FTIR, GCMS	Oil, p/s = 1.60	PR188	Magnesium carbonate
S32	W&N oil paint, green	FTIR, EDX, GCMS	Oil, p/s = 1.33	Phthalocyanine green PG7	Barium sulphate
S33	Pink powder from dish	FTIR, EDX	-	? Al & S from EDX	-
S34	Yellow powder/ paint over orange	FTIR, EDX	Oil?	Cadmium orange/ yellow, organic yellow?	Barium sulphate, chalk
S35	Orange pigment/ paint	FTIR, EDX	-	Cadmium orange	Barium sulphate

S36	Dust from edge of tin on shelf	FTIR, EDX	-	-	Gypsum, alumina
S37	W&N oil paint, green	FTIR, EDX, GCMS	Oil, p/s = 2.68	cobalt green/blue, zinc white	Magnesium carbonate
S38	W&N oil paint, Winsor orange	FTIR, EDX GCMS, PyGCMS	Oil, p/s = 3.00	Arylide PY1, Naphthol AS PR188	Barium sulphate
S39	Rowney cadmium yellow	FTIR, PyGCMS, EDX	Acrylic (EA, MMA)	Cadmium yellow	Barium sulphate
S40	W&N oil paint, Flake white	FTIR, GCMS, EDX	Oil, p/s = 2.50	Lead white, zinc white	
S41	Orange paint from cloth	FTIR, EDX	Oil?	Cadmium sulphide-selenide	Barium sulphate
S42	Yellow pigment on table	FTIR, EDX	-	Cadmium sulphide, zinc white?	
S43	Dark pink powder over light pink	FTIR, EDX	Oil	Titanium white, alizarin crimson	Barium sulphate, Magnesium carbonate
S44	Orange paint on plate	FTIR, EDX	Oil	Titanium white, cadmium sulphide-selenide	Barium sulphate, Magnesium carbonate
S45	Dark red blob on plate	FTIR	Oil	Titanium white	Magnesium carbonate
S46	Red paint on plate	FTIR, EDX, PyGCMS	Oil	Chrlorinated organic red – PR188	Magnesium carbonate
S47	Orange paint on plate	FTIR, EDX	Oil	Cadmium sulphide-selenide	Barium sulphate, Magnesium carbonate
S48	Rowney oil color, crimson alizarin,	FTIR, EDX	Oil	Alizarin crimson	
S49	Orange paint on cloth	FTIR, EDX		Titanium white, PO43 (Winsor orange), cadmium sulphide-selenide	Kaolin
S50	Yellow paint on fine knit beige cloth	FTIR, PyGCMS		Titanium white, Arylide yellow PY1 &PY3	Kaolin
S51	Orange-red patch on wall	FTIR, EDX	Oil	Vermilion	Magnesium carbonate
S52	Red ring on wall	FTIR, EDX	Oil	Cadmium sulphide-selenide	Magnesium carbonate, Barium sulphate

S53	Purple paint on wall	FTIR, EDX	Oil	Lead white, Cobalt phosphate/arsenate, zinc white	
	wall paint	FTIR			Chalk, kaolin
S54	White/red patch on wall	FTIR, EDX	Oil	Lead white, zinc white	
S55	Deep red paint with fibrous material on wall	FTIR, EDX	Oil	Al lake base?	Magnesium carbonate
S56	Green-yellow paint on wall	FTIR, EDX, GCMS	Oil, p/s = 3.73	Cadmium sulphide, (zinc)	Magnesium carbonate Barium sulphate
S57	Pink dust on easel	FTIR, EDX		Titanium white, Al lake base / alizarin?	Gypsum, silica
S58	Green-white paint on wall	FTIR, EDX	Oil	Lead white, zinc white, phthalocyanine green?	
S59	Black over pink, from wall	FTIR, Xsec, EDX	Oil	Titanium white, cobalt phosphate	Magnesium carbonate, Barium sulphate
S60	Orange paint	FTIR	Nitrocellulose spraypaint?	Beta-naphthol PO5?	
	White flake	FTIR	Oil	Titanium white	Magnesium carbonate, Barium sulphate
S61	Winsor & Newton Fixative	FTIR, PyGCMS	PVAc		
S62	Pale pink over dark pink by mirror	Xsec, EDX		Lead white, zinc white, vermilion, cadmium red, ivory black, iron oxide, titanium white	
S63	White by mirror	FTIR, EDX	Oil	Lead white, zinc white	
S64	Orange pigment in tray	FTIR, EDX	-	Cadmium sulphide-selenide	Barium sulphate
S65	U-spray matt white	FTIR, PyGCMS, EDX	Methyl-styrene (Py product)	Titanium white	Chalk, silica
S66	Kingston Universal Stainer, red	FTIR, PyGCMS, EDX	Oil	Naphthol AS PR7/PR11	
S67	Blue paint from green food tin	FTIR, PyGCMS, EDX	Acrylic (MMA, 2-EHA)	Titanium white	Kaolin
S68	Carsons pink-purple	FTIR, PyGCMS, EDX	PVAc, phthalate plasticiser	Titanium white, iron oxide	Chalk, kaolin

S69	Carsons purple	FTIR, PyGCMS, EDX	PVAc, VeoVa	Titanium white	Kaolin
S70	Carsons tan	FTIR, PyGCMS, EDX	PVAc	Iron oxide, titanium white	Chalk, kaolin
S71	Carsons vinyl matt, green	FTIR, PyGCMS, EDX	PVAc	Arylide yellow, probably PY65, PY73 or PY74	Chalk
S72	Sand from bowl	FTIR	-	Silica	
S73	Rose madder gen, pigment, Cornelissens	FTIR, EDX	-	Alumina lake base	
S74	Rowney acrylic, cobalt blue	FTIR, PyGCMS, EDX	Acrylic (EA, MMA)	Cobalt aluminium oxide	Barium sulphate
S75	Universal stainer, permanent green.	FTIR, PyGCMS, EDX	Oil	PG7	Chalk
S76	L&B Alizarin crimson	FTIR, EDX	-	Alizarin crimson	-
S77	W&N Rose madder genuine	FTIR, EDX	-	Alizarin crimson	Alumina base
S78	W&N Chrome lemon	FTIR, EDX	-	Lead chromate	Lead sulphate
S79	Parris Marble medium	FTIR, GCMS	Beeswax, oil	-	
S80	Chalkboard paint	FTIR, GCMS, EDX	Oil, p/s = 3.04	Carbon black?	Chalk, dolomite/ magnesium carbonate?
S81	U-spray gloss, deep green	FTIR, PyGCMS, EDX	Methyl-styrene (Py product)	Prussian blue, phthalo green?	
S82	Humbrol Krylon spray, white	FTIR, PyGCMS, EDX	MMA-BMA	Titanium white	Kaolin
S83	Carsons orange	FTIR, PyGCMS, EDX	PVAc (+ little BA & VeoVa)	PY1, PY166/144/214, titanium white	Chalk, kaolin
S84	Du-lite emulsion, mushroom tint	FTIR, PyGCMS, EDX	PVAc	Iron oxide	Chalk, kaolin
S85	Blackboard black	FTIR, GCMS	Ortho-phthalate alkyd, p/s = 4.00	Carbon black?	Chalk
S86	Armitages Talk bird sand	FTIR, EDX	-	-	Sand (silica, with some iron)
S87	Carsons full gloss vibrant	FTIR, GCMS, EDX	Ortho-phthalate alkyd, p/s =0.98	Titanium white, PG7?, iron oxide?	

S88	Markal paintstik, azo orange	FTIR, PyGCMS, GCMS	Oil (az/p = 5.04, p/s = 1.86)	PO36	Chalk
S89	Markal paintstik, napthol red	FTIR, PyGCMS, GCMS	Oil (az/p = 6.06, p/s = 2.60)	PR170	Chalk
S90	Ronseal polyurethane varnish	FTIR, PyGCMS	Polyurethane-oil	-	-
S91	Carsons vibrant, dark green	FTIR, PyGCMS, EDX	PVAc, phthalate plasticiser	Titanium white, iron oxide	Chalk, kaolin
S92	Carsons vibrant, red drips	FTIR, PyGCMS, EDX	Oil	Alizarin crimson	Kaolin
S93	L&B Vernis à retoucher	FTIR, PyGCMS	Hydrocarbon?		
S94	W&N oil colour, Permanent rose	FTIR, EDX	Oil	Al base, PV19?	Magnesium carbonate
S95	W&N oil colour, Raw umber	FTIR, EDX	Oil	iron oxide, manganese oxide	Silica, chalk
S96	Carsons yellow-orange	FTIR, PyGCMS, EDX	PVAc	Iron oxide	Barium sulphate, chalk
S97	U-spray black gloss	FTIR, PyGCMS, EDX	Methyl-styrene (Py product)	Carbon black?	-
S98	U-spray matt black	FTIR, PyGCMS, EDX	Methyl-styrene (Py product)	Carbon black?	Chalk
S99	W&N oil colour, Winsor red	FTIR, PyGCMS	Oil	PR188	Magnesium carbonate
S100	W&N oil colour, Winsor yellow	FTIR, PyGCMS	Oil	PY1/PY3	Barium sulphate

Abbreviations used for media: BA – butyl acrylate; BMA – butyl methacrylate; EA – ethyl acrylate; 2-EHA – 2-ethylhexyl acrylate; MMA – methyl methacrylate; PVAc – Polyvinylacetate; VeoVa – vinyl versatate; p/s – palmitate to stearate ratio; az/p – azelate to palmitate ratio

Appendix E. Examination and Analysis Reports of Paintings

Individual reports from the examination of each painting are included, with details of samples taken and a summary of analytical results.

Reports from the complete works are listed first, placed in numerical order using the project code given to each (FB01, etc.). These are followed by reports from the slashed canvases, ordered by their database numbers in the Hugh Lane Gallery's catalogue.

Abbreviations used in tables: SEM-EDX – Scanning Electron Microscopy with Energy Dispersive X-ray Analysis, GCMS – Gas Chromatography Mass Spectrometry, FTIR – Fourier Transform Infrared Spectroscopy, PLM – Polarised Light Microscopy, PyGCMS – Pyrolysis Gas Chromatography Mass Spectrometry, UVF – Ultraviolet Fluorescence

FB01 Head, 1949

Identification details		
Title: Head		*Date:* 1949
Dimensions (hxwxd): 82 x 66.5 x 2.2 cm	*Location/owner:* Private owner, examined at Faggionato Fine Arts Gallery	

Marks/Inscriptions:

Label on back, black printing on paper: 'La Medusa Studio D'Arte Contemporanea Roma 124 Via deu Babuno N. 528'

Support
Type: <u>Canvas</u> / Board / Paper / <u>Stretcher</u> / Strainer

Description:

Four member softwood stretcher, mitred mortise & tenon, members 2" wide.
Steel (iron?) tacks, rusting. 12-13 cm spacing, tack heads 5 mm diameter.
Linen canvas, thread count 19 x 20 threads/cm^2

Paint and ground
Priming: Off-white commercial priming on reverse of canvas, drips and splashes of paint on top.

Paint description:
White bands of paint along top and left edges under the grey layer could be considered a partial priming layer, elsewhere raw canvas is exposed in patches. This white is quite coarse textured, with clear brushmarks. A black line at the base of the horizontal white strip delineates the edge. Traces of a bright purple are visible under the white at the top and left edges, apparently an earlier layer. This paint has quite a matt appearance.

Vertical strokes of grey cover much of the canvas, smeared with some brownish, black and white paint mixed in. Thicker grey splodges have been used over the white in the top left, and the width of the brush can be clearly seen. A thick drip of more glossy grey paint runs down at top left, with smaller drips of a darker grey. Black lines are used to outline the left shoulder and folds of jacket, collar and head. White/grey impasto is used for the eye-socket and ear on the left side of the face, on top of the grey strokes continuing from the background (figure E.01.1). It's possible that features were also painted on the right before a further grey 'curtain' was painted on top (while the paint was still wet).

Smears of green-blue in several areas, small amounts of smooth and finely dispersed colour. Spots of brighter blue paint near top and at bottom right. A grey-blue drip of watery paint runs down vertically in top right corner.

Surface coatings

None apparent, paint is generally quite matt.

Samples taken

No.	*Colour*	*Location*
1	White (+ grey)	Top edge, fragments, 13.5 cm from left.
2	Purple	Top tacking margin, 12 cm from left
3	Grey	Top edge, drip over tacking edge, 40 cm from left
4	Blue (+grey)	Bottom edge, 4.5 cm from right corner.
5	Grey over purple	Left edge, 20 cm from bottom
6	Grey-brown over black	Right edge, 9 cm from top
7	Green	Left edge, 22 cm from bottom, 1 cm from left.

Notes

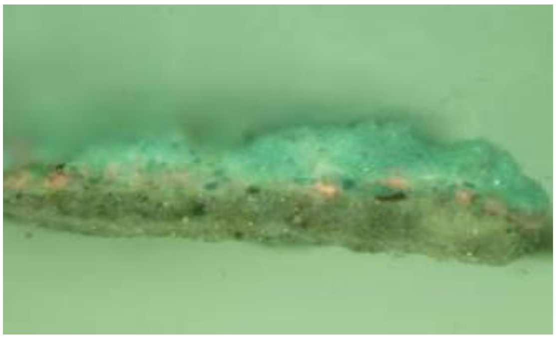
This painting appears in Alley & Rothenstein catalogue as one of 'Abandoned pictures' (A7), dated 1949. It is probably related to the series of six monochrome Head paintings made 1948-9. This is an early example of a work painted on reverse of canvas (first done c. 1948, Monte Carlo).

Figure E.01.1 Detail of ear

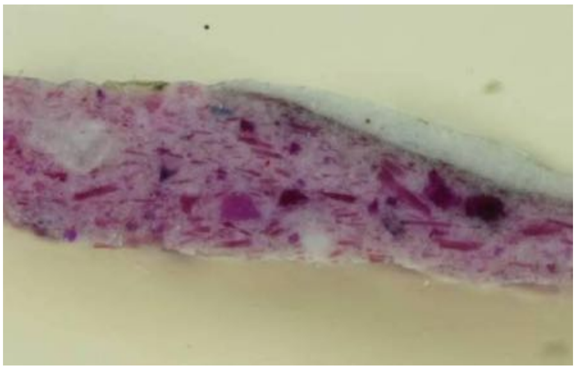
Sample locations

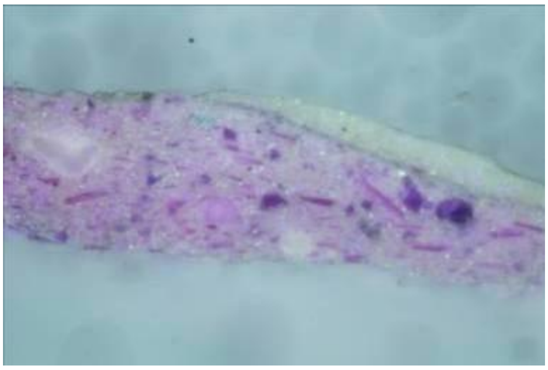
FB01-4 Blue spot over grey, bottom edge


Normal light (taken at x200 magnification)

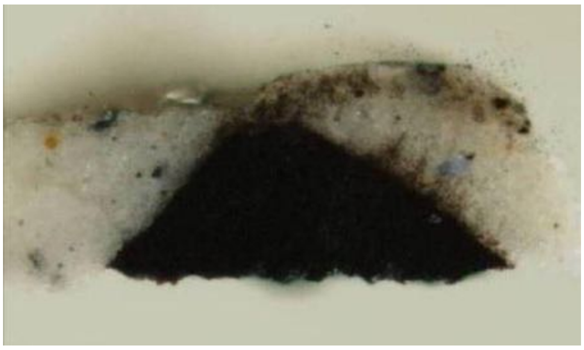

Ultraviolet (x200 magnification)

FB01-5 Purple under white/grey, left edge


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB01-6 Grey-brown over black, right edge


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*[71]	*Materials identified*
White, top edge	1	FTIR, GCMS	Drying oil, maybe poppy (p/s = 2.89, az/p = 0.62)
		FTIR, SEM-EDX, PLM	Lead white
		PLM	Zinc white
Purple under grey	2, 5	PLM, SEM-EDX	Cobalt violet (mainly cobalt phosphate, with a few cobalt arsenate particles)
		PLM, SEM-EDX	Lead white
		SEM-EDX	Zinc white
Grey	3	GCMS	Drying Oil, probably linseed & poppy mixture (p/s = 2.48, az/p = 0.45) + additive?
		FTIR, PLM	Lead white
		PLM	Zinc white
Blue	4	SEM-EDX	Cerulean blue
		SEM-EDX	Lead chromate?
Grey	4	SEM-EDX	Lead white
		SEM-EDX	Raw umber
		SEM-EDX	Silica
Grey	6	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Small amount ivory black?
Black	6	SEM-EDX	Carbon black
		SEM-EDX	Lead white/drier?
Green smear	7	SEM-EDX	Phthalocyanine green

Conclusions

Lead white and zinc white were the main materials identified, with some ivory black. Cobalt violet was present in a layer beneath the white-grey surface, a mixture of cobalt phosphate and arsenate.

Phthalocyanine green was thought to be present in the sparse smears of intense green, which has been applied in very small quantities and appears to have been smeared into the grey on the canvas. Cerulean blue was identified in the small spots of blue near the top and at bottom right. It's possible that these were made accidentally.

[71] SEM-EDX – Scanning Electron Microscopy with Energy Dispersive X-ray Analysis, GCMS – Gas Chromatography Mass Spectrometry, FTIR – Fourier Transform Infrared Spectroscopy, PLM – Polarised Light Microscopy.

Figures in a Landscape, c.1954

Identification details		
Title: Figures in a Landscape		*Date:* c.1954
Dimensions (hxwxd): 66 x 53.2 x 1.8 cm	*Location/owner:* Private, sampled at Redfern Gallery	
Marks/Inscriptions: Stamp on stretcher: 'ER(?) Cat no. 51'		

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
Thick paper/card stuck to canvas. The paper appears yellow/buff where visible in losses to the upper surface. Yellowish glue is visible around the edges. Edges are trimmed (not completely straight), paint extends to very edge. Pinholes through paper at right edge: one 8 cm from top, one 3.5cm from bottom, and at left edge 1.5 cm from bottom.

Canvas is on 5-membered stretcher (1 horizontal cross bar), with square mortise and tenon joints. Steel tacks at 2 " spacing, 5-6 mm diameter.

Paint and ground

Priming:
Uncertain. A pale under-paint layer is visible in the top half of the painting which could be considered a priming layer, but it's unknown whether this covers the whole of the painting.

Paint description:
Pale blue paint is visible underneath the top half of painting (sky). A thin red-purple layer is brushed over this. A darker almost black paint is used in the left hand portion of the sky, with a more opaque pink-red scumbled over. Brush strokes are clearly visible in the black strokes in

the upper left area. White (blue?) shows through abrasion to black in one place at left edge, possibly indicating the brushstrokes originate from a thicker white layer underneath (figure E.02.1). A thin opaque brownish paint is used over the red at the right hand side of the sky. A few narrow drying cracks in the brown at the centre show blue/white paint below. A black line marks the horizon.

A yellow colour is used under the grass, painted over with red toward right and darker red-brown at left. Individual strokes of red, pink and yellow-brown are painted on top to form grass (figure E.02.3). Some more greenish-yellow strokes and darker green paint is mixed in at lower left of centre, with a few green splodges at base. The texture of horizontal brush strokes can be seen from an underpaint layer, with vertical strokes on top. More random texture of strokesfrom underpaint visible in sky and under figures.

Grey figures at centre, with some areas of thicker paint here. Red streaks on top. Black lines used to sketch in outlines of figures.

Fingerprint at centre of left edge (figure E.02.2), and a swirl of fingermarks in top left corner. Clumps of dried paint stuck on in a couple of places, pressed into surface.

Surface coatings/gloss

Slight surface sheen, no coatings apparent.

Samples taken

No.	*Colour*	*Location*
1	Black/red-pink over pale blue	Left edge 8.5 cm from top
2	Pink over white and blue	Right edge, 35.5 cm from bottom.
3	Green	Bottom edge, 15.5 cm from left.
4	Yellow/red/blue	Right edge, 7 cm from bottom.
5	Green and red over texture (white?)	Bottom edge 20.5 cm from left.
6	Red over blue (white underneath?)	Edge of tear, 16.5 cm from left, 1.5 cm from top.
7	Yellow-green over white	Right edge, 10.5 cm from bottom.

Notes

This painting appears in Alley & Rothenstein catalogue as one of ‘Abandoned pictures’ (A13), dated 1954. It is said to be one of three dating from Bacon’s stay at Henley on Thames, probably from the latter part of his time there when staying at 9 Market Place. These three works were given to another painter with the intention of their being reused/destroyed. *Figure with Meat* 1954 (Chicago) is said to be the only surviving work painted at 9 Market Place (Alley, p91). Martin Harrison proposes date of c.1955, based on this entry. He now wonders if the date could be earlier, due to possible similarity with ‘Street Scene’ seen at Authentication Committee Meeting (use of paper/card, painting of grass).

The painting was reportedly lined onto canvas after leaving Bacon’s hands, by the owner. The pin holes imply the paper was pinned to a board while being worked on. The use of paper may indicate Bacon was unable to get hold of his usual materials while working away from London.

X-ray:
Very little detail can be seen, as plates have low contrast, with a gradation of light to dark across each plate making it impossible to get a seamless mosaic of uniform exposure. In the upper left plate diagonal strokes can be seen which appear to correspond to the coarse textured strokes probably in pale blue paint, visible under the black/pink surface layers.

Figure E.02.1. Detail of upper left background, showing coarse brushstrokes of light paint/ground, covered with thin black paint and patchy red

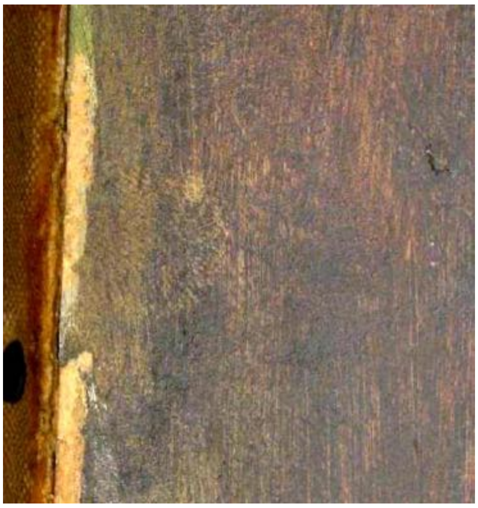
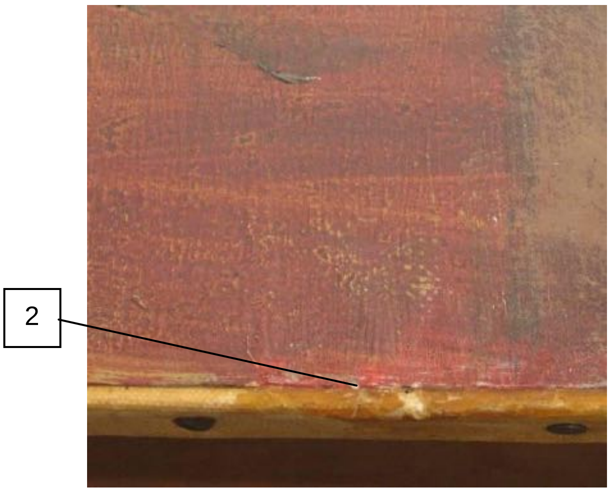
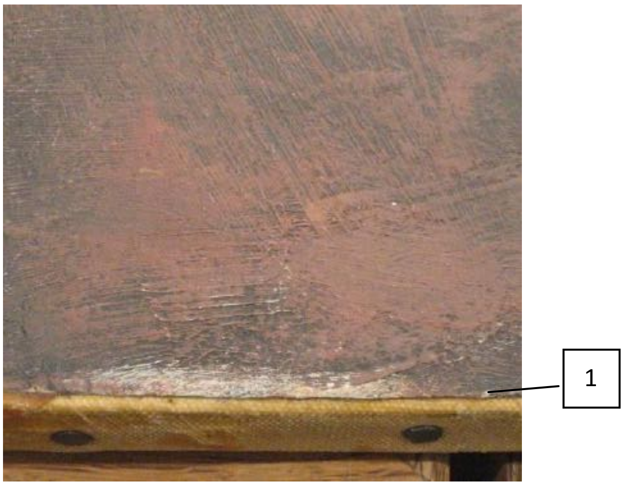


Figure E.02.2. Detail of left side, showing fingerprint in paint

Figure E.02.3. Detail of bottom edge, showing yellow paint layer covered with dark red, with strokes of grass on top of this

Sample sites





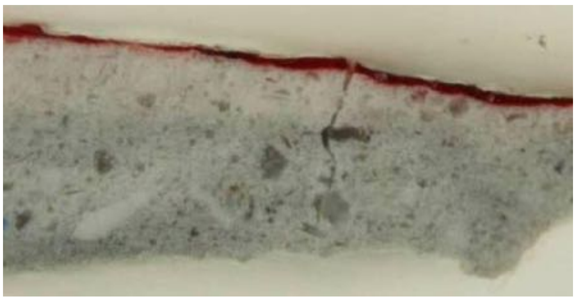
Cross sections

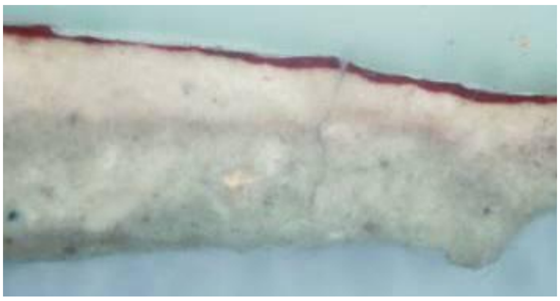
FB02-1 Black/red-pink over pale blue


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

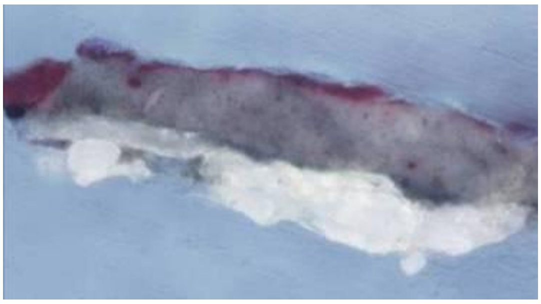
FB02-2 Pink over white and blue


Normal light (taken at x200 magnification)

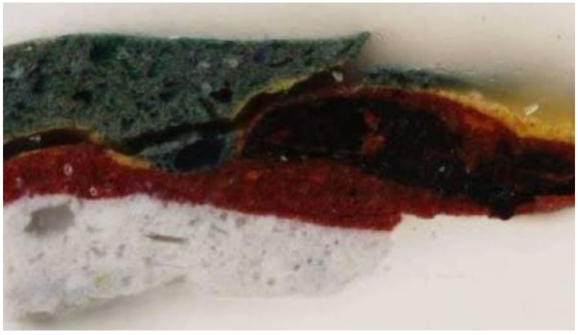

Ultraviolet (x200 magnification)

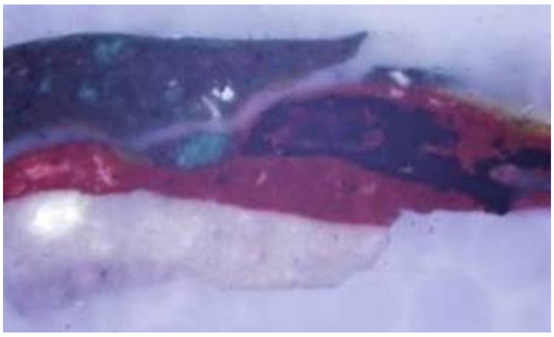
FB02-4 Yellow/red/blue


Normal light (taken at x200 magnification)

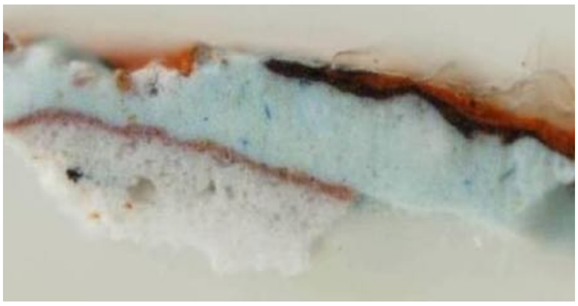

Ultraviolet (x200 magnification)

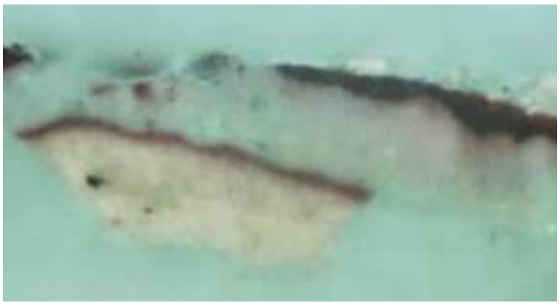
FB02-5 Green and red over texture (white?)


Normal light (taken at x200 magnification)

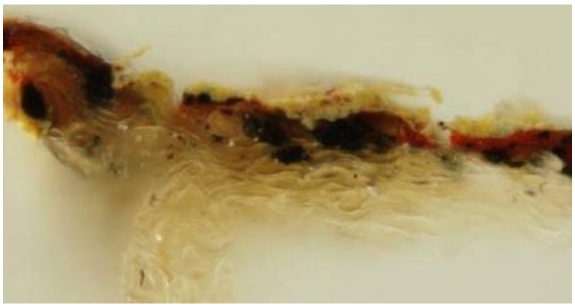

Ultraviolet (x200 magnification)

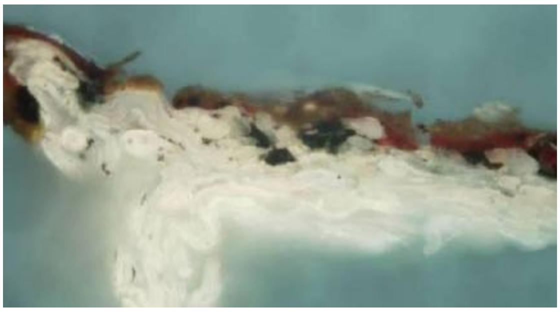
FB02-6 Grey-brown over black, right edge


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB02-7 Yellow-green over white


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Pale blue	1, 6	GCMS, FTIR	Oil (Az/P = 0.88, P/S = 3.44)
		SEM-EDX	Titanium white
		SEM-EDX	Zinc white
		SEM-EDX	Barium sulphate
Pink	1, 6	SEM-EDX	Titanium white
		SEM-EDX	Zinc white
		SEM-EDX	Iron oxide - umber?
		SEM-EDX	Al lake?
Black	1, 6	SEM-EDX	Carbon black (lamp black?)
White /grey ground	2, 5, 6	FTIR	Oil?
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Silica
Red-pink	2, 4	FTIR, SEM-EDX	Alizarin
Green	3	FTIR, GCMS	Oil (Az/P = 0.78, P/S = 2.51)
	3, 5	SEM-EDX	Viridian
	5	SEM-EDX	Titanium white
Blue	4	SEM-EDX	Titanium white
		SEM-EDX	Prussian blue?
		SEM-EDX	Lead white?
Yellow	5, 7	SEM-EDX	Lead chromate
		SEM-EDX	Titanium white

Conclusions

The painting is on paper, stuck to canvas, an unusual support for Bacon, and also unusually appears to have a white ground layer, seen in samples 2, 5 and 6 from areas of the grass and sky. This contains titanium white, chalk and silica. A pale blue paint has been used over this in the sky, but this has then been painted over in black, followed by a patchy opaque red-pink. There appears to be a coarse brushy texture in the pale blue paint. The figures are loosely painted in a pale grey, apparently on top of the black background. Smears of pink paint have been added on top of the left hand figure. A dark underlayer also appears to have been used in some areas of the grass. Strokes of pink, yellow and green have then been used to form the blades of grass.

An oil binder was detected in green paint, and in at least one layer of sample 6 (blue-white). Titanium white was the principal white pigment found in all colours, with lead white thought to be present only in the dark blue in sample 4 (possibly associated with Prussian blue). Viridian and chrome yellow were found in the grass. Alizarin and iron-manganese oxides were thought to be present in red layers, but another red (organic lake) pigment might also be present.

Untitled (Figure Crouching)

Image omitted for copyright reasons

Identification details

Title: Untitled (Figure Crouching)	*Date:* c.1950-1
Dimensions (hxw): 179.5 x 120.6 cm (70.5" x 47.5")	*Location/owner:* Estate of Francis Bacon

Marks/Inscriptions:

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
Unsupported canvas, has been cut from stretcher and rolled. Cut edges, top left corner cut off on diagonal. Thread count 12 x 12 threads/cm^2.

Two long vertical tears to canvas from top and bottom edges. Tear from top edge is 26cm long, 49cm from left. Tear from bottom edge is 26cm long, 55cm from left.

Paint and ground

Priming:
On reverse, off-white

Paint description:
Thin vertical black brushstrokes in top portion of canvas. Grey opaque paint applied in curved strokes on top of this. Some black paint and sand mixed into this paint at the left edge. This grey paint has a slight gloss. Canvas shows through patchily. Dark green shadowy figure in lower right with gritty material mixed in (figure E.03.1).

Paint is very thick in central figure, approx. 3mm layer can be seen where paint is cracked and has raised edges due to rolling, pale pink-grey-brown colour with gritty inclusions (figure E.03.2). A layer of more glossy grey paint is exposed in losses where the thick pink-brown has flaked off. Canvas texture is visible through this grey layer. A pinkish colour exposed in areas of flaking in the head of the figure. There is an area of thicker paint also above the right of the figure's head, painted grey like the background, but a pale grey layer can be seen beneath, revealed through cracking.

White lines form a framework of rails. These are thickly painted in the foreground, the paint is cracking and flaking away. Peaks of stippled texture in some areas of thicker white paint. Splashes of pink-purple in foreground, and black drips. A few glossy green spots on the left shoulder of the figure.

Surface coatings

None apparent. Slight sheen on thicker greys and whites.

Samples taken

No.	Description	Location
1	Grey over pink + pink fragment	Left side of figure's head, edge of loss (43.5 cm from left, 99 cm from bottom)
2	White. Top layer only, white&grey beneath left behind.	Thickly painted white stripe centre left. (27 cm from bottom, 68 cm from left)
3	Grey gritty paint. Top layers only, grey left on canvas beneath	Lower centre of figure, edge of loss (56 cm from left, 67 cm from bottom)
4	Dark grey, gritty	Figure, right of head, edge of loss. (57 cm from left, 80.5 cm from top)
5	Grey, slight gloss. Scraping	Background, left side. (7 cm from left, 95 cm from bottom)
6	Off-white priming	Back of canvas, top right corner.

Notes

Figure reminiscent of that in *Fragment of a Crucifixion,* 1950. Facial features are difficult to distinguish, obscured by cracking. Grisaille – used for series of Heads 1949 & other works 1949-50. The figure perches on a white rail, similar to rails and space-frames in many other works. Shadowy green figure in foreground – shadows/profiles seen in many paintings – one in a similar position in *Study for Portrait*, 1949 (in blue) and in *Portrait of Lucian Freud*, 1951.

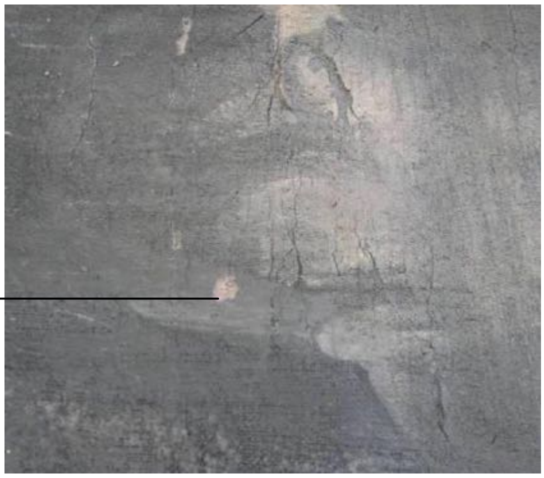
The canvas has a fairly coarse weave, which appears similar to that used in *Study for Crouching Nude*, 1952 and *Pope I*, 1951.

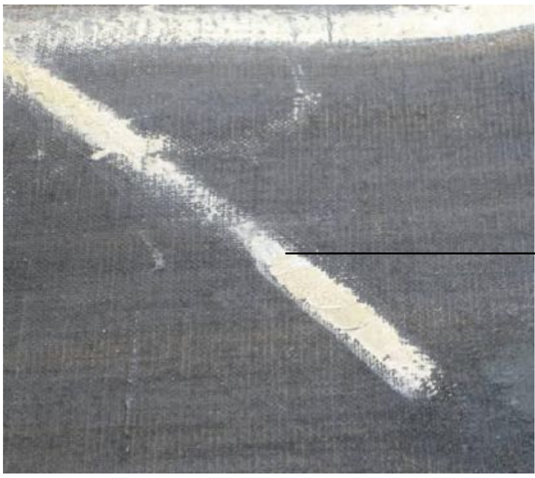
3

Figure E.03.2. Detail of figure showing thick sand-encrusted paint

Figure E.03.1. Detail showing greenish shadowy figure

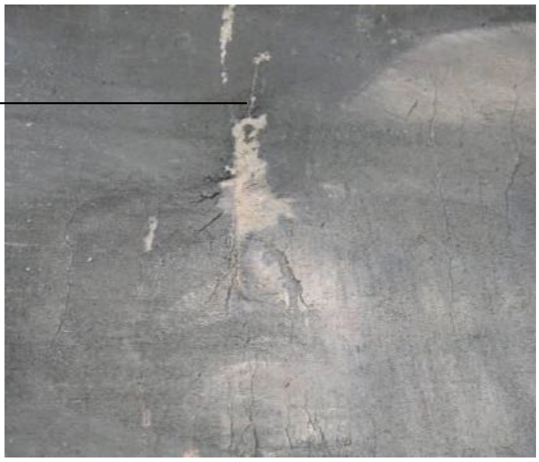
1





2

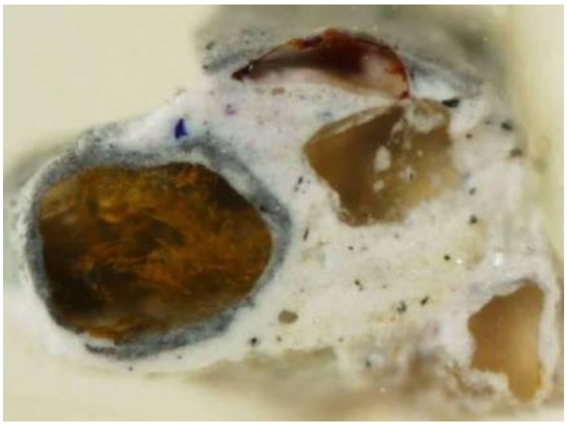
4

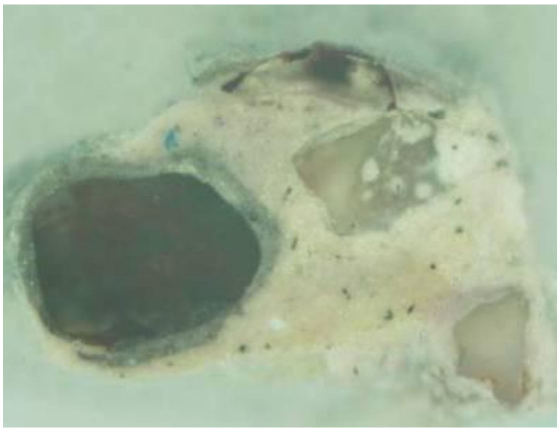


5

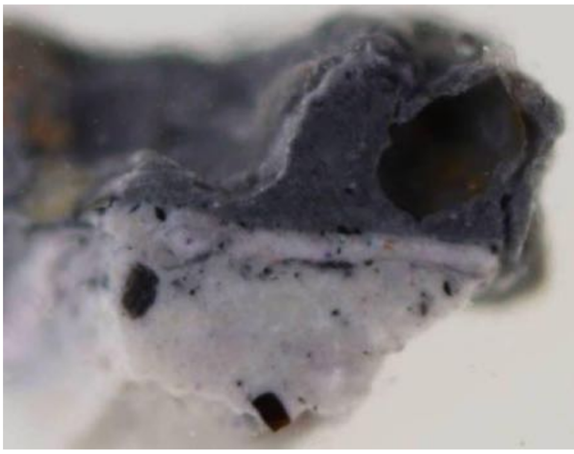
Cross sections

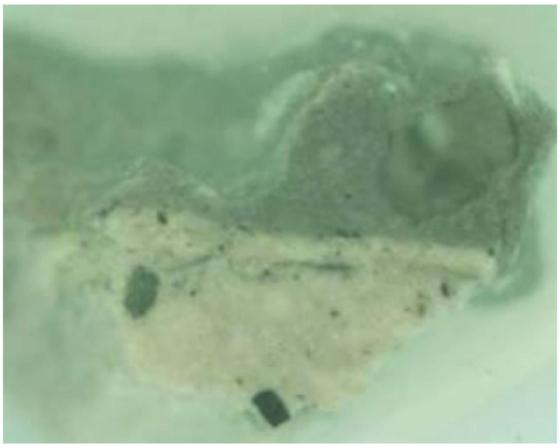
FB03-1 Grey over pink. Left side of figure's head, edge of loss


Normal light (taken at x20 magnification)


Ultraviolet (x20 magnification)

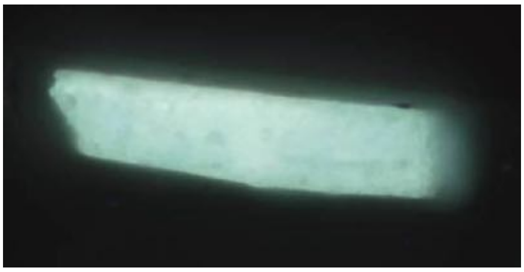
FB03-4 Dark grey, gritty. Right of figure's head, edge of loss.


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB03-6 Priming from back of canvas


Normal light (taken at x20 magnification)


Ultraviolet (x20 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Grey gritty paint	3, 4	GCMS, FTIR	Oil (P/S = 3.52)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Silica (sand)
	4	SEM-EDX	Zinc white
Pale pink	1, 4	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Sand
		SEM-EDX	Cobalt violet (phosphate)
	1	SEM-EDX	Ultramarine
		SEM-EDX	Barium chromate
White stripe	2	FTIR, GCMS	Oil (Az/P = 0.88, P/S = 3.42)
		FTIR	Lead white
Blue grey background	5	GCMS, FTIR	Oil (Az/P = 0.59, P/S = 2.52)
		FTIR	Lead white
Priming	6	FTIR, GCMS	Oil (Az/P = 0.71, P/S = 2.23)
		FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Lead white

Conclusions

An oil medium was found in all samples analysed. Lead white was the principal pigment, with a small amount of zinc white. The flesh paint appears very pale and greyish, but a slightly pinker and lighter paint is visible in losses, from an earlier layer. Analysis showed a mixture of coloured pigments in the lighter paint, but these are sparsely distributed through the white. The black pigment appears to be fine-particled and carbon-based, possibly lamp black.

Large sand grains were found in several samples, some of which appear quite brown and iron was detected in one. One grain in sample 1 was coated with a layer of grey paint, within the white/pink paint, which suggests the sand, white and grey paints were applied in quick succession, while paint was still fluid.

The oil-based priming contains lead white and chalk, and may consist of two layers, as there appeared to be a higher proportion of chalk on one side of the sample, from FTIR.

Figure going through open doorway

Image omitted for copyright reasons

Identification details

Title: Figure going through open doorway	*Date:* c.1972
Dimensions (hxwxd): 198.5 x 148 (78” x 58“)	*Location/owner:* Estate of Francis Bacon, Estate no. 4378 010

Marks/Inscriptions:

Pencil numbers on stretcher bars: ‘58’, ‘39’, ‘78’

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
6-member softwood stretcher, horizontal and vertical cross-bars. Square mortise and tenon joints. Members 2 ¾“ in width (approx. 7 cm).

Linen canvas, with 16 x 24 threads per square cm.
Canvas is held with steel tacks, 6mm diameter, 9-10 cm spacing.

Paint and ground

Priming:
On reverse of canvas, off-white.

Paint description:
The painting appears to be in fairly early stage of completion, with large areas of exposed canvas. Thin green lines are used to sketch out features of the composition – curved edges of the room, doorway, a tasselled rug. It has been suggested these are done with marker pen, but could be thin paint. Curved lines appear more like brushstrokes. Some strokes appear to be in a more liquid, dilute paint (figure E.04.2).

The figure appears to have been outlined in green and started to be filled in, but smears of very thin green around the area of the figure seem to suggest paint has been scrubbed away, probably using some sort of solvent (figure E.04.1). Thin pink and white paint is used over areas of the figure, which have a slight gloss, The white is thinly applied, mainly in texture of canvas. Pink smeared into canvas texture – could be pastel? This paint may also have been partially scrubbed away.

Dark blue strokes forming head of figure and leg. Spray of blue spots at bottom.

Surface coatings/gloss

None

Samples taken

No.	Colour	Location
1	Green	Edge of green line. Left side 58 cm from bottom
2	Pink	Right elbow of figure. 45 cm from right, 70.5 cm from top
3	Off-white priming	Back of canvas
4	Red smear	Back of canvas, left stretcher-bar turnover

Notes

Very difficult to sample due to thinness of paint. Very small scrapings only.
Figure in curved room. Outlines drawn with very thin green paint, lines of door and curve probably drawn using mechanical aid, though no specific evidence. Figure started to be filled in then abandoned? Signs that paint may have been scrubbed away.

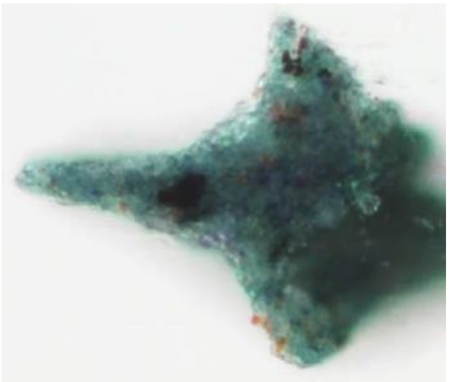
Figure E.04.1. Detail of figure showing green smearing around head, green outlining and stroke of white on arm.

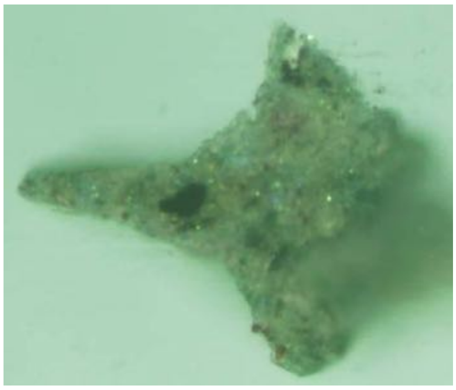
Figure E.04.2. Detail of thin lines in very dry green paint

Sample sites

Cross sections

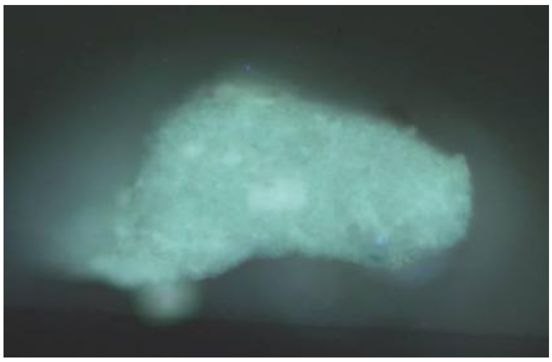
FB04-1 Green stroke


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB04-3 Priming


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Green line	1	SEM-EDX	Lead white
		SEM-EDX	Phthalocyanine green?
		SEM-EDX	Zinc white
		SEM-EDX	Barium chromate?
		SEM-EDX	Prussian blue
Pink	2	SEM-EDX	Lead white
		SEM-EDX	Zinc white
Red on back	4	GCMS	Oil (Az/P = 0.42, P/S = 5.97)
		SEM-EDX	Cadmium red
		FTIR, SEM-EDX	Magnesium carbonate
		FTIR, SEM-EDX	Barium sulphate
Priming	3	FTIR, GCMS	Ortho-phthalate alkyd (Az/P=1.48, P/S = 1.86)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Kaolin
		SEM-EDX	Titanium white

Conclusions

Thin green lines have been used to mark out a curved area, doorway, rug and box around the figure. The area of greenish stained canvas around the figure suggests paint has been removed from this area, possibly scrubbed at with solvent. The figure is also outlined in green, with thin pale green and pink paint filling in shape.

The paint medium used in the image could not be identified, due to the difficulty of taking a large enough sample. The green lines are likely to be done in (artists') oil paint, however, due to the presence of lead white pigment. Phthalocyanine green was thought to be present, along with small amounts of barium chromate and Prussian blue. We don't know when the red paint on the back of the stretcher was picked up, but this does appear to be an oil paint.

The commercial alkyd priming contains lead white, kaolin and titanium white. Only one layer was seen in the cross section.

Figure with Cricket Pads, c.1982

Image omitted for copyright reasons

Identification details

Title: Figure with Cricket Pads	*Date:* c. 1982

Dimensions (hxwxd): 198.2 x 148 x 2.5 cm 78 x 58 ¼ x 1''	*Location/owner:* Estate of Francis Bacon

Marks/Inscriptions:
Stamp on stretcher, centre of top bar and again on vertical cross-bar:
"prepared by C Roberson & Co. Ltd., 71 Parkway, London NW1 7QJ"

Stamp on stretcher, top of vertical cross-bar: "118"

Support

Type: <u>Canvas</u> / Board / Paper / <u>Stretcher</u> / Strainer

Description:

Softwood stretcher, square mortice and tenon joints. Six members (horizontal and vertical cross bars), width of members: 7 cm

Linen canvas, thread count: 18 x 18 threads/cm^2. Attachment through steel tacks, spacing 7.5-9 cm, tack heads 6 mm diameter.

Paint and ground

Priming:
Commercial priming on reverse, white

Paint description:
Thinly painted, very little impasto, in flesh only. The bottom left portion of the canvas is unpainted. Thin grey lines on the bare canvas could indicate an earlier positioning for the edge of the grey floor. A little above this, black lines delineate the area of the grey floor. A thin grey stain appears to have been applied initially inside this line, followed by a more opaque grey paint. Black curves and lines are applied on top of the grey. There are numerous drips of grey and brown paint on the area of raw canvas at the base of the picture. There are also drops of orange paint and smears of red which could be from dry pigments.

The thin grey stain is visible at the boundary between the grey and orange at the right side (figure E.05.2). A brown paint layer appears to have been applied over the background, before being covered over with bright orange paint. Traces of this brown spill over onto the tacking edges at the top and right hand sides of the canvas. The orange paint has a fine stippled texture, suggesting it was applied by roller, although a brush has clearly been used around the figure (figure E.05.1). The brown paint is also visible in some areas under the flesh, and in the reserve between the background and flesh.

The black lines around the figure are done partly in a reserved area (at left side & lower right) and partly with black lines applied on top of the orange. An area around the figure has a very thin black wash and a scrubbed looking appearance, as though paint has been removed from this area.

A more glossy, slightly greasy looking paint is used for the flesh, over grey/brown. The brown paint shines through in an area at the top of the figure. In other areas grey paint left in reserve forms the outline of the figure. Some hairs are stuck in the pink paint. The pink varies considerably in thickness, with very thin areas revealing the brown beneath (figure E.05.1), and thicker areas with low impasto. A fairly bright pink is used in a shape at the left of the figure, with a white paint applied on top.

A patch of black paint has been applied over the orange background at the centre of the right hand side, and a similar patch of a dark orange at the left side – both are painted with rough brushstrokes – may have been Bacon wiping his brush.

A footprint can be seen on the painting at the lower left side, over grey and orange areas. The print is in orange, with a pattern of dots from the textured sole.

Surface coatings/gloss

No coatings apparent, the paint has a fairly matt appearance apart from the flesh paint, which has a slight surface sheen.

Samples taken

No.	*Colour/Description*	*Location*
1	orange over brown (grey stain on canvas left behind)	Top edge, from edge of loss, 2cm from right
2	brown scraping	Top edge, 5cm from right. On tacking edge.
3	orange scraping	Top edge, 34cm from left. On tacking edge.
4	pink over grey + pink flake from figure	41.5cm from top, 73cm from left
5	white over pink (grey beneath not collected)	57cm from top, 63cm from left
6	grey scraping from floor	44cm from right, 86.5cm from top
7	blue grey over light grey, bottom left of floor	53cm from left, 26.5cm from bottom
8	orange over grey/black	Top edge, 25cm from left
9	Priming	Back of canvas

Notes

It is suggested that the patches of black and orange paint on the left and right sides are areas where Bacon wiped his brush.

There are several other examples of paintings with a figure in cricket pads against a bright orange background – left panel of *Diptych: Study from the Human Body*, 1982-84 (Smithsonian), and *Figure in Movement*, 1985 (on loan to Tate).

Figure E.05.1. Detail showing brown shining through thin flesh paint, and brushstrokes of orange paint around the outlines of the figure

Figure E.05.2. Detail showing strip of stained canvas between grey and orange areas, with edge of brown under-paint also visible

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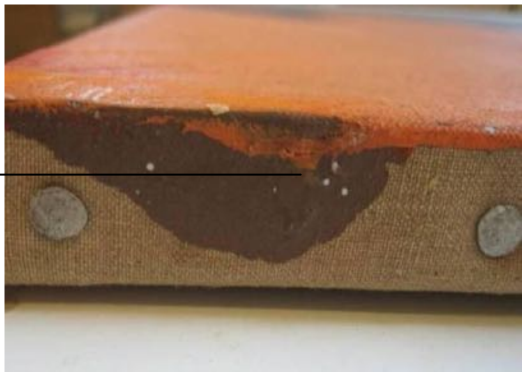

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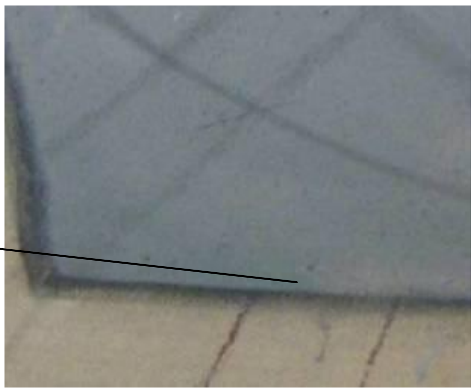

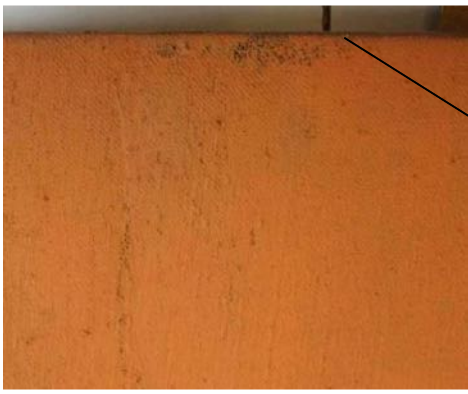

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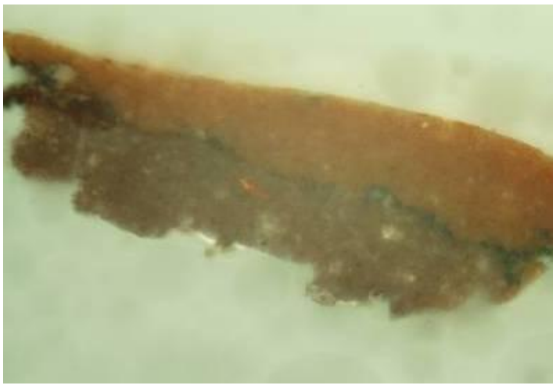
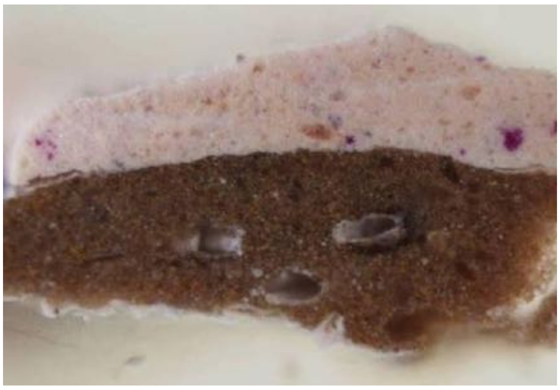
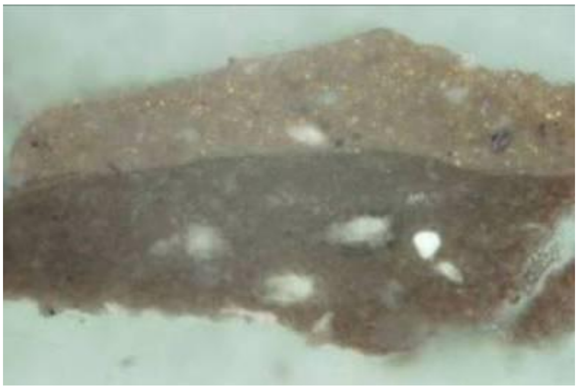
FB05-1 Orange over brown, top right corner


Normal light (taken at x20 magnification)

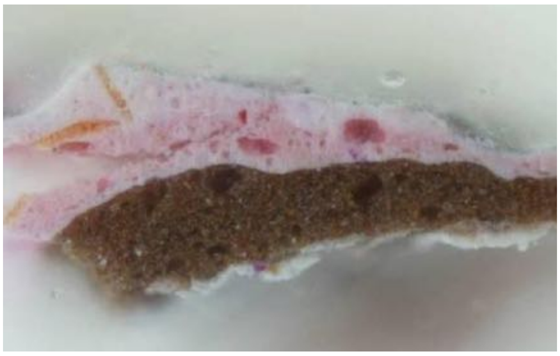

Ultraviolet (x20 magnification)

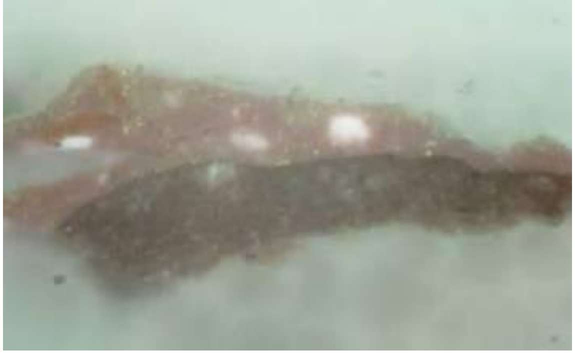
FB05-4 Pink over grey from figure


Normal light (taken at x200 magnification)

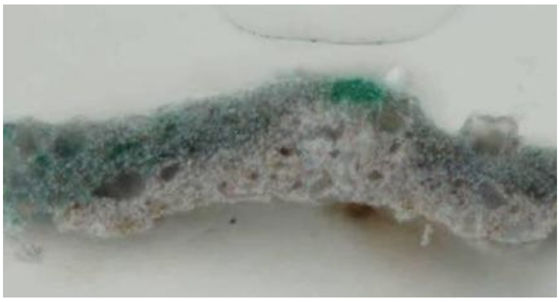

Ultraviolet (x200 magnification)

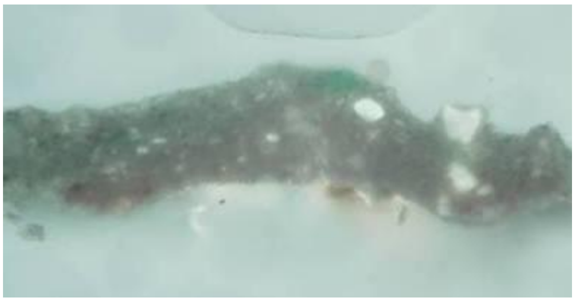
FB05-5 White over pink from left side of figure


Normal light (taken at x200 magnification)

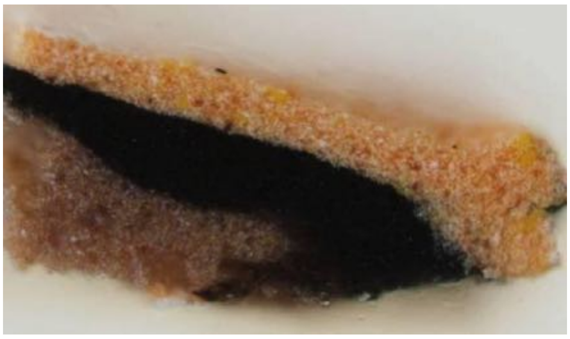

Ultraviolet (x200 magnification)

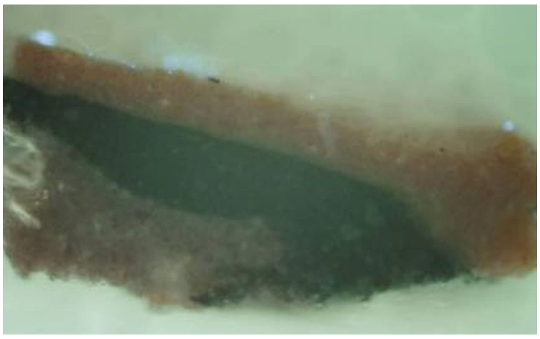
FB05-7 Blue-grey over light grey, bottom left of floor


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB05-8 Orange over grey/black, top edge


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB05-9 Priming from back


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Orange background	3	PyGCMS, FTIR	PVAc
		PyGCMS, FTIR	Arylide pigment PY1
		PyGCMS	PR166?
	1, 3	SEM-EDX, FTIR	Chalk
		SEM-EDX, FTIR	Kaolin
		SEM-EDX, FTIR	Titanium white
	1	SEM-EDX	Cadmium orange
Brown layer under orange	2	FTIR, PyGCMS	PVAc (with methyl styrene?)
	1, 2	FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Barium sulphate
	1	SEM-EDX	Iron oxide
Black	8	FTIR, SEM-EDX	Chalk
Grey	6	PyGCMS	PVAc
	6, 7	FTIR, SEM-EDX	Chalk
	7	SEM-EDX	Titanium white
		SEM-EDX	Kaolin
		SEM-EDX	Phthalocyanine green
Pink flesh	4	FTIR, GCMS	Oil (Az/P = 0.44, P/S = 3.78)
		SEM-EDX	Cobalt violet (phosphate)
	4, 5	FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Magnesium carbonate
		SEM-EDX	Zinc white
		FTIR, SEM-EDX	Barium sulphate
Priming	9	FTIR, GCMS	Ortho-phthalate alkyd (Az/P= 0.71, P/S= 3.34)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Kaolin
		FTIR	Chalk
		SEM-EDX	Barium sulphate

Conclusions

The orange, brown and grey paints all appear to be PVAc household paints, with chalk and kaolin extenders. Iron oxide pigment was found in the brown paint, with organic yellow and red pigments in orange. The black layer also contains a lot of chalk and probably has a carbon-based black pigment, medium not identified. The pink flesh paint is mainly titanium white with an oil medium, presymably an artists' paint. It contains a little cobalt violet and possibly another organic pink.

The priming has an alkyd medium with kaolin, lead white and titanium white. Only one layer appeared to be present in the cross section, but this is likely to be double primed like other canvases.

Untitled (Pope) / L'Homme Assis, 1959

Image omitted for copyright reasons

Identification details

Title:	Date:
Untitled (Pope) / L'Homme Assis	1959

Dimensions (hxwxd):	Location/owner:
198.5 x 142 x 1.9 cm	Private collection

Marks/Inscriptions:

Paper adhesive label on back of stretcher: 'Consignment 40032521
Francis Bacon L'Homme assis 1959'

Pencil writing on horizontal cross-member: 'PAPE'

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
7-member stretcher with square mortise and tenon joints. Wood fairly poor quality, knotty. Width of members 6.5 cm.

Linen canvas, plain weave 15 x 15 threads/cm^2.

Attachment through staples (new-looking, thought to have been re-stretched at Sothebys prior to sale, due to poor condition of attachment). Old tack holes are evident, possibly more than one set, with associated rust stains. There is also a series of small holes around the edges on the front of the picture plane, 3-4 holes on each side, with varied spacing.

The canvas is very distorted with numerous creases, as though it was off its stretcher for some time and got badly crumpled and creased.

Paint and ground

Priming:
Off-white, on reverse

Paint description:
Pope-type figure, seated, rapidly painted with loose brushstrokes. White ‘cage’ structure around figure. Background with vertical stripes of black and dark blue.

A thin black paint appears to have been applied first as a stain to the canvas. At the base of the painting this appears to be the only layer, but elsewhere the background has been covered with a thicker layer of black and dark blue paint in vertical strokes. A viridian-type green is also used in the upper left. A curve marks off the bottom left corner (as in some other works examined). The framing lines around the figure are in white and pale blue paint. There are some areas of thicker paint in the background with a smoother and slightly more glossy appearance. These could be covering earlier compositional features. One such area appears in the background to the left of the figure’s head, another large circular area can be seen further to the left, with extensive cracking to this thicker paint layer (figure E.06.1).

The figure is painted using thicker paint with heavy impasto, mainly in white paint, but also using green, purple, pink and blue. A gritty material appears to be mixed into the white paint forming the edge of the booth. A stroke of pink paint is used on top, picked up by the texture. In the face the paint is most thickly applied, in a mixture of purple, green and pink, which appears to have been mixed on the canvas. Red paint used for the lips and between the eyes.

Large white granular inclusions to the paint can be seen mainly in the lower portion of the canvas. In some areas these are covered with dark blue-black paint, so may have become more visible in places due to abrasion.

There appears to be a red-brown stain to the canvas visible in losses in the top right area of the canvas. A bright blue paint with a powdery appearance has been applied to the left of the sitter’s head, which may or may not be original – this appears to be applied over losses to the black paint (fig E.06.4), but in other places appears to be possibly an earlier layer, seen in losses. It appears to have been applied in a fluid manner but is now dry and underbound.

There are numerous losses to the paint in both the background and the figure and it is often difficult to tell whether these have been repainted, or whether the colour seen in the losses is actually from an earlier paint layer applied to the canvas. In some areas a different colour can be seen in the loss, e.g. a light blue under a dark blue in losses to the left of the figure’s right elbow, indicating this must be an earlier paint layer. In other losses both the colour in the loss and on the surface are the same dark blue/black.   There are also some areas where colour has clearly been applied over both the area of loss and surrounding paint (figure E.06.3), but whether this was applied by Bacon or not is unclear. This is apparent in the watery green paint applied over yellow-brown on the rim of the hat, and in the pale blue stripe in the right side of the figure. It’s possible that the painting became damaged early on in its life and was reworked by Bacon. Alternatively this repainting may be by a different hand.

Surface coatings/gloss

None apparent, surface is very matt in most areas, though more thickly painted passages have a slight sheen

Samples taken		
No.	*Colour*	*Location*
1	Dark blue over lighter blue (visible in loss	Loss at top edge revealing light blue stain to canvas, 38 cm from left
2	Green and black over light blue	Green vertical strokes in background. Top left, 24.5 cm from left, 28.5 cm from top
3	Black-blue over white and bright blue	Upper left background. 39.5 cm from left, 23 cm from top.
4	Black thick cracking area	Upper left background. 27.5 cm from left, 58 cm from top.
5	Green over pink/purple	Elbow of figure. 74 cm from top, 47 cm from left
6	Green over white, gritty paint	Elbow of figure. 80 cm from top, 47 cm from left
7	Dark blue plus inclusion	Lower left background. 28 cm from left, 44 cm from bottom
8	Powdery blue over black	Lower right background. 40.5 cm from right, 40 cm from bottom
9	Scraping from large brownish inclusion	Lower left background. 39 cm from left, 47 cm from bottom
10	Red from face, between eyes	Face, between eyes. 47 cm from top, 60 cm from right
11	Bright dry blue	Left of face, 58 cm from top, 68 cm from right
12	Priming	Back of canvas

Notes

Recently sold at Sotheby's, dated 1957-9. Said to have been acquired from the artist in 1959. It is thought to be a rare work surviving from Bacon's time in Tangier, which he visited to see Peter Lacey, which was left behind when Bacon left in July 1959. But according to Tate catalogue 2008, the relationship with Lacey had ended by the end of 1958. *Pope with Owls*, 1958 was the only work reportedly to have survived from Tangier (Alley).

The painting is said to have been given to a friend for the canvas to be reused. The surface is somewhat difficult to interpret, due to the numerous old losses and damages, some of which appear to have been overpainted. The canvas was probably off its stretcher at some time, as the canvas has become very creased, as though crumpled up into a ball.

Figure E.06.1 Thick cracking paint in background

Figure E.06.2 Detail from right edge of canvas, showing creases to canvas with paint loss, some filled with black stain

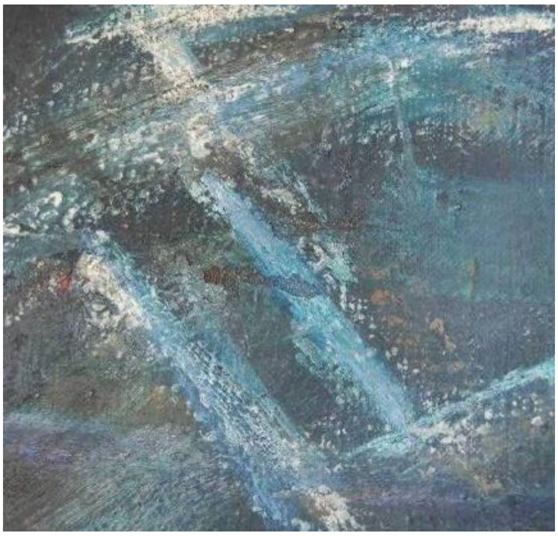


Figure E.06.3 Detail from area to lower right of head showing pale blue paint stroke over loss in earlier paint layers.

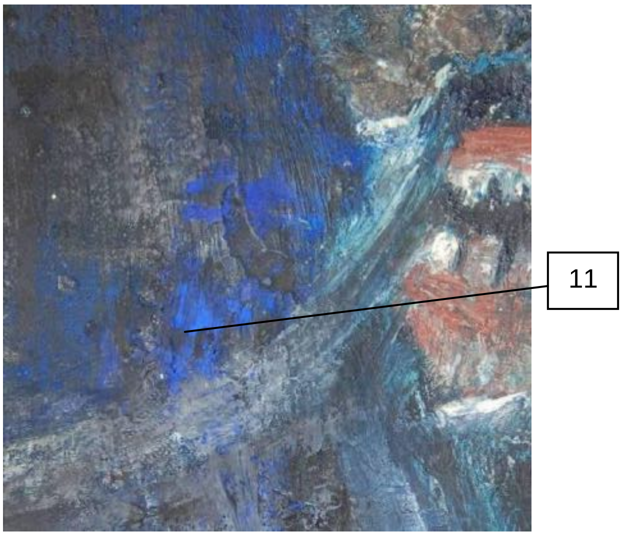


Figure.E.06.4 Detail from area to left of mouth, showing bright blue over paint loss.

Sample sites

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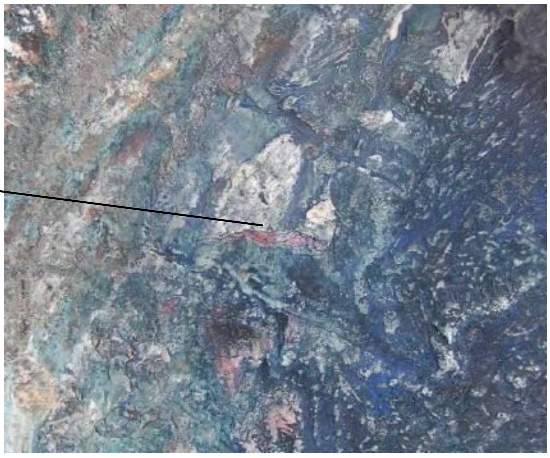

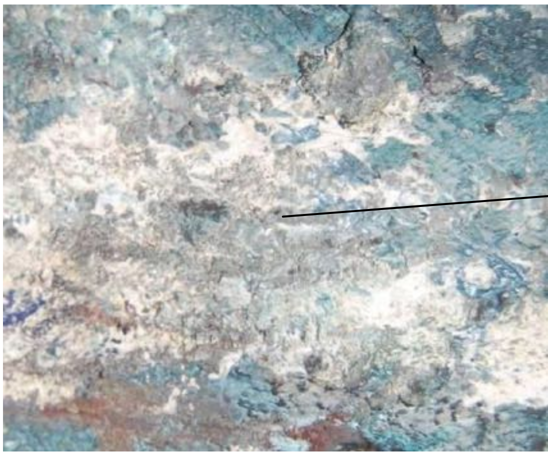

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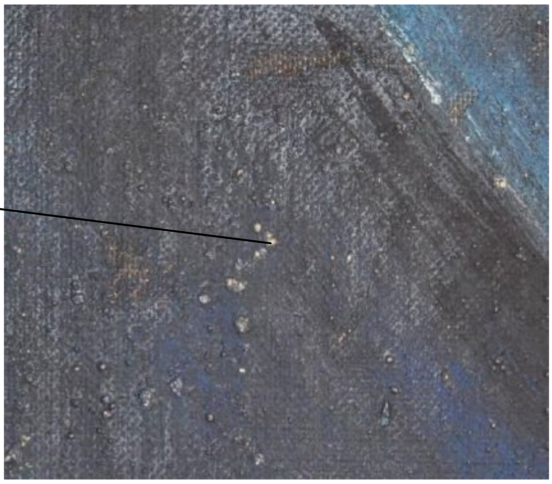

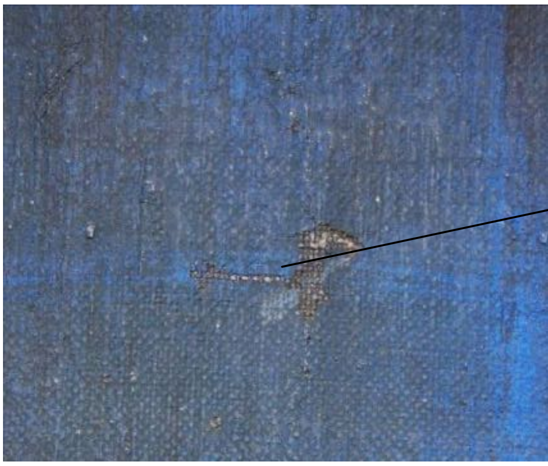

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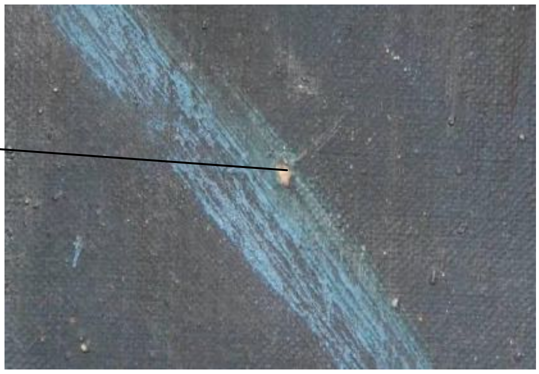

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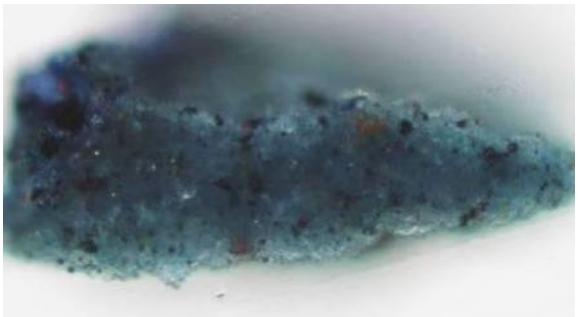
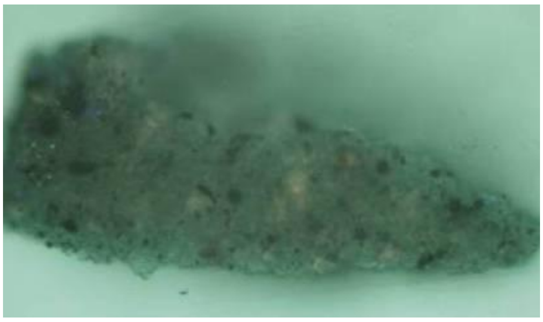
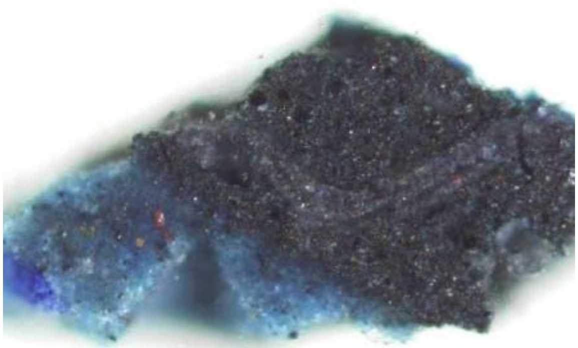
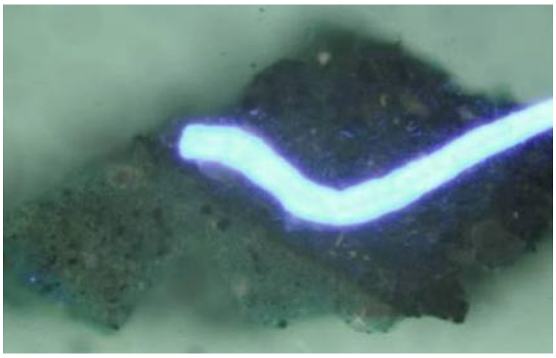
FB06-1 Dark blue over lighter blue, background, top edge.


Normal light (taken at x200 magnification)

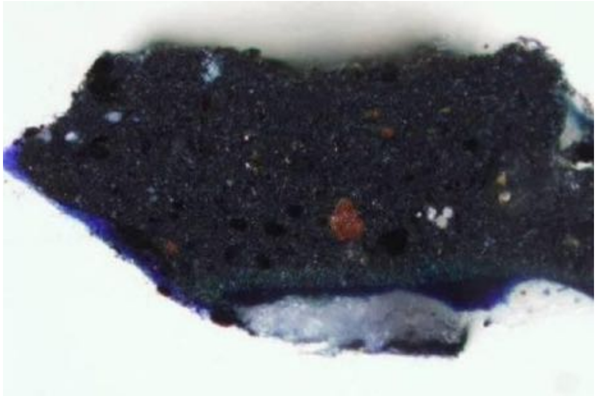

Ultraviolet (x200 magnification)

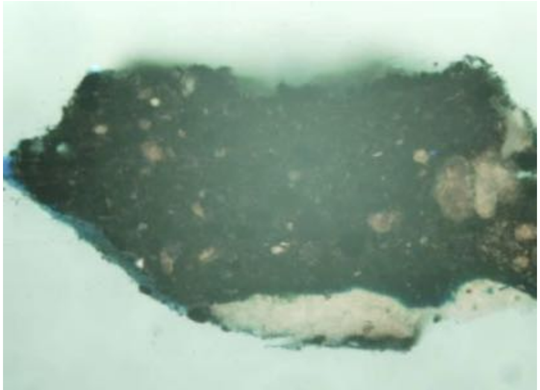
FB06-2 Green/black over light blue, background upper left


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

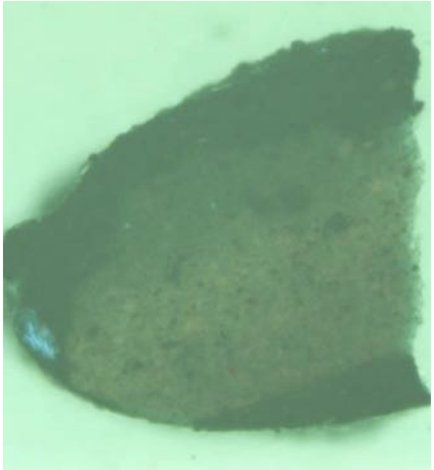
FB06-3 Black-blue over white and powdery bright blue, upper left background


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

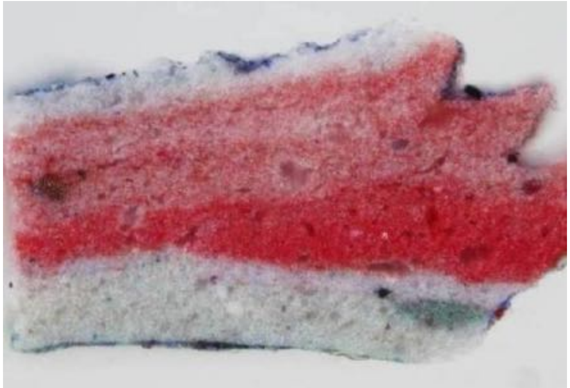
FB06-4 Black thick cracking area

Normal light (taken at x50 magnification)

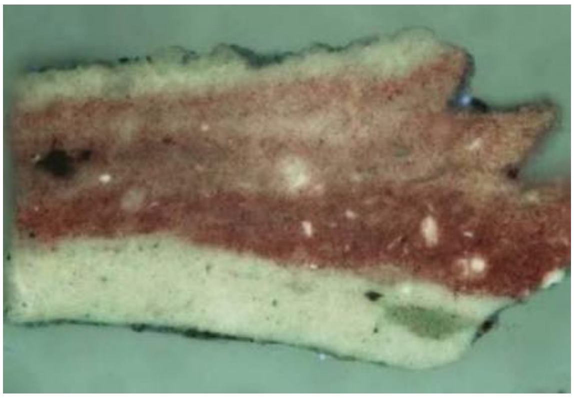


Ultraviolet (x50 magnification)

FB06-5 Green over pink-purple

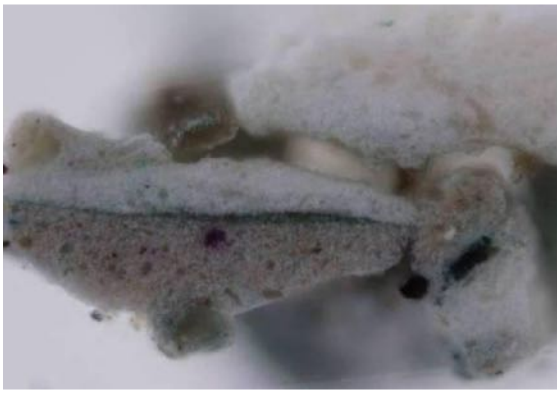


Normal light (taken at x200 magnification)

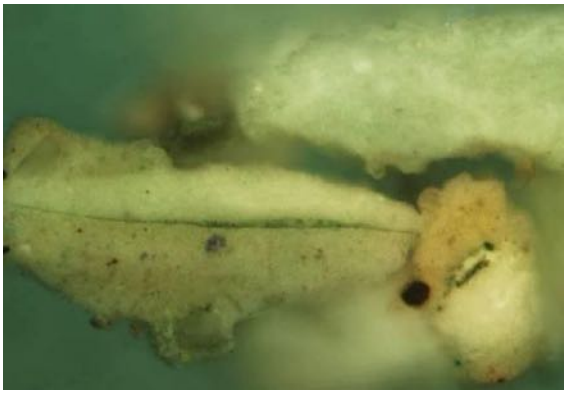


Ultraviolet (x200 magnification)

FB06-6 Green over white, gritty paint from figure

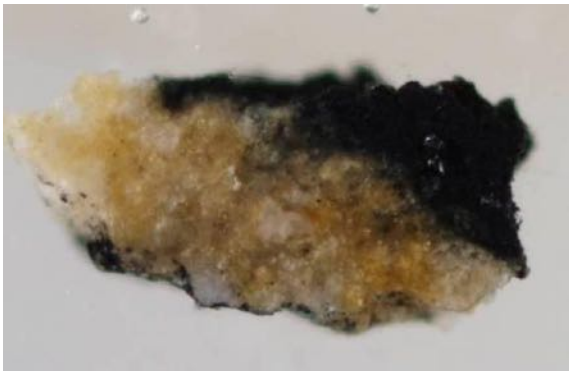


Normal light (taken at x200 magnification)

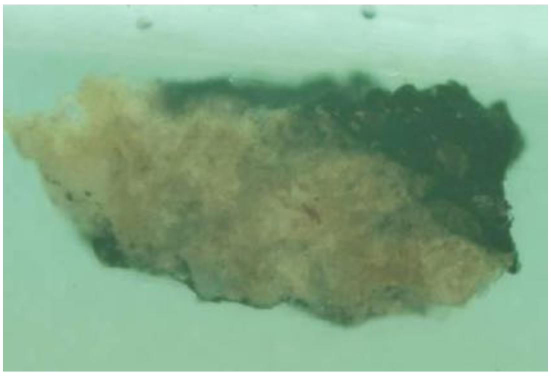


Ultraviolet (x200 magnification)

FB06-7 Black with inclusion.

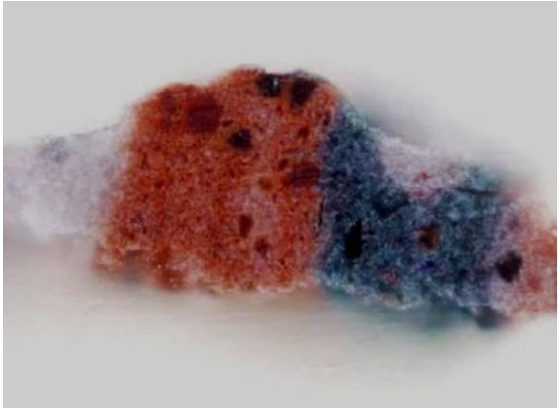


Normal light (taken at x50 magnification)

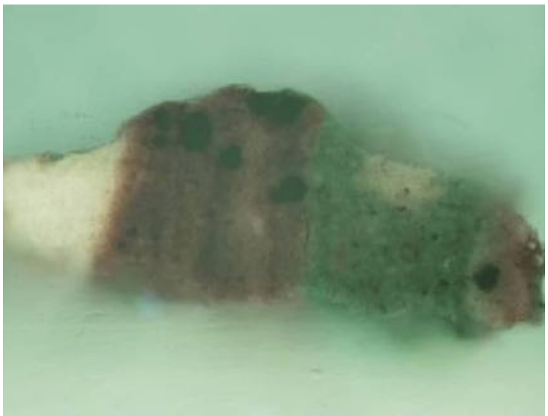


Ultraviolet (x50 magnification)

FB06-10 Pink from face.

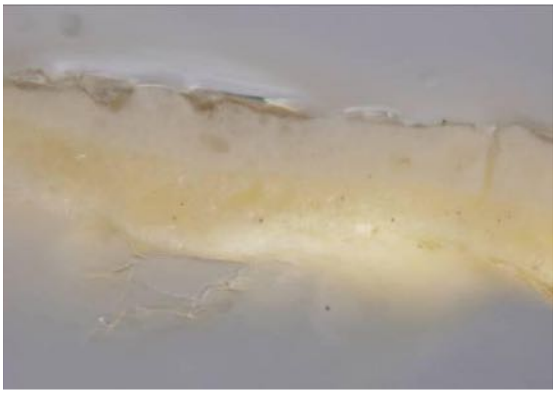


Normal light (taken at x200 magnification)

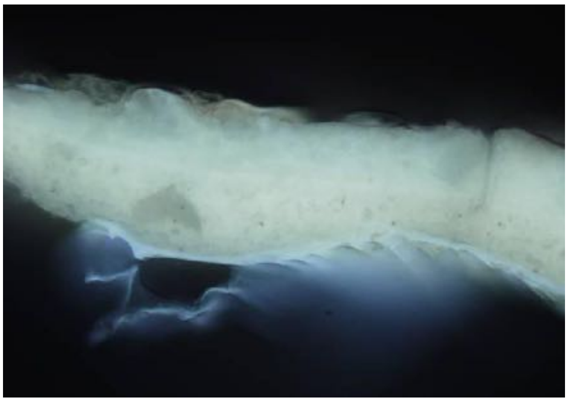


Ultraviolet (x200 magnification)

FB06-12 Priming



Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Pale blue	1, 2	SEM-EDX	Chalk
		SEM-EDX	Prussian blue
White	6	FTIR, GCMS	Oil-terephthalate alkyd? (Az/P = 2.23, P/S = 3.08)
	5, 6, 10	FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Barium sulphate
		SEM-EDX	Zinc white
Black-grey	3	SEM-EDX	Ivory black
		SEM-EDX	Chalk
		SEM-EDX	Barium sulphate
		SEM-EDX	Iron oxide
Black	4	GCMS	Drying oil (Az/P = 1,68, P/S = 1.65)
		SEM-EDX	Ivory black
		SEM-EDX	Chalk
Bright blue	3	SEM-EDX	Ultramarine
Pink	5	SEM-EDX	Cadmium red
		SEM-EDX	Chalk
		SEM-EDX	Barium sulphate
		SEM-EDX	Magnesium carbonate
Violet	6	FTIR, SEM-EDX	Chalk
		SEM-EDX	Barium sulphate
		SEM-EDX	Zinc white
		SEM-EDX	Cobalt violet (phosphate)
Brown inclusion	7,9	FTIR, SEM-EDX	Silica
		SEM-EDX	Chalk
Pink from face	10	FTIR, GCMS	Drying oil (Az/P = 1.03, P/S = 1.80)
		SEM-EDX	Chalk
		SEM-EDX	Iron oxide red
		SEM-EDX	Barium sulphate
		SEM-EDX	Zinc white
Blue-green	10	SEM-EDX	Chalk
		SEM-EDX	Cobalt stannate
		SEM-EDX	Barium sulphate
		SEM-EDX	Zinc white
Dry blue	11	FTIR	Ultramarine
		FTIR	Chalk
Priming	12	FTIR, GCMS	Oil (P/S = 2.57 Az/P = 1.54)
		FTIR	Protein size layer
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Barium sulphate

Conclusions

Many of the samples contain a high proportion of chalk, so may be pastel materials. A mixture of chalk, barium sulphate and zinc white was found in white samples, and no lead white was found, unlike other paintings from this date.

Many samples appeared to be quite underbound, with very little medium present, however an oil binder was identified in two samples. The white/lilac paint in sample 6 had a terephthalate content, which may indicate an alkyd medium. However this was not found in other samples.

Ultramarine and Prussian blue were found in several samples, and cerulean blue in one. Cadmium red and cobalt violet were also found.

Technical Examination

Raking light
Many creases and undulations can be seen throughout the canvas, and in more thickly painted areas, the edges of flaking paint. The creases appear to show the canvas was badly crumpled while off its stretcher.

Infrared
The infrared image does not appear to reveal much new information. Some of the brightest blue areas appear lighter in IR, e.g. the shapes to the left of the figure's mouth.

Ultraviolet
Ultraviolet light appears to be merely reflected from the surface of the painting, fluorescence is not really apparent. Several dark patches can be seen in the area around the hat and in the left side of the booth, apparently from areas of retouching paint. However, some other areas of retouching previously noted do not show up in this way, possibly because similar materials were used to the paint used for the original image.

X-ray
Many losses can be seen as black patches in the x-ray, but not all relate to paint losses on the front of the canvas – some are due to losses to the priming layer on the back, e.g. the large area of loss in the upper left corner. It is not easy to tell the difference without examination of the front and back of the canvas. Some losses appear to correspond to the dark patches seen in UV, e.g. in the left side of the booth.

Head II, 1949

Identification details

Title: Head II	*Date:* 1949
Dimensions (hxw): 80 x 63.3 cm	*Location/owner:* Ulster Museum (examined at Tate Britain)

Marks/Inscriptions:

None visible. The back could not be properly inspected.

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
Wooden strainer with horizontal and vertical cross bars, square joints.
Steel tacks 5 mm diameter, unevenly spaced 5-7.5 cm.
Plain weave linen canvas, 15 x 14 threads/cm^2.

Paint and ground

Priming:
Off-white commercial priming, on reverse

Paint description:
The painting is fairly monochrome. It shows fragments of a head, with the jawbone and bared teeth being the most dominant feature. What appears to be the left shoulder of the figure is demarcated, wearing a white shirt with purple stripes and a white collar. A small white arrow points towards the area of shadow beneath the chin. The head is set against a grey curtain, with a safety pin attached through some of the folds.

The canvas is very heavy with the thickness of paint on the upper portion. Bare canvas is exposed in an area marked off with a curve in the bottom left corner. Stripes of grey/black paint mark a frame round the perimeter of the canvas at the left, top and bottom edges. Many layers of paint have been applied on the remainder of the canvas in the grey background and head. Some areas appear to have been built up in paint (and some other material?) to give a relief effect, for example in the white collar, the cheek and the white arrow. The many layers of paint applied to the background can be seen at the edges of losses to paint layers around the edges of the canvas. At the top edge one area of paint appears to be delaminating from the canvas. At the tacking edges lips of white, blue and grey paint can be seen from earlier paint layers.

The background has a thick scaly texture, with cavities in the paint through which the colours of earlier layers can be seen – traces of blue, red, orange and green. Bright red traces can be seen particularly in the lower right at the line of the shoulder. There may also be sand mixed in to the paint in this area.

The grey paint applied on top in vertical strokes appears to have skipped over any lower points in the texture. The horizontal grey stroke across the top has a smoother texture that the rest of the background. The shirt is painted in white with purple strokes of paint applied on top. White strokes are used for the teeth, safety pin and arrow. There are also strokes of blue around the mouth. In an area of flesh-coloured paint on the head there appear to be small hairs stuck in the paint, which may be from added dust.

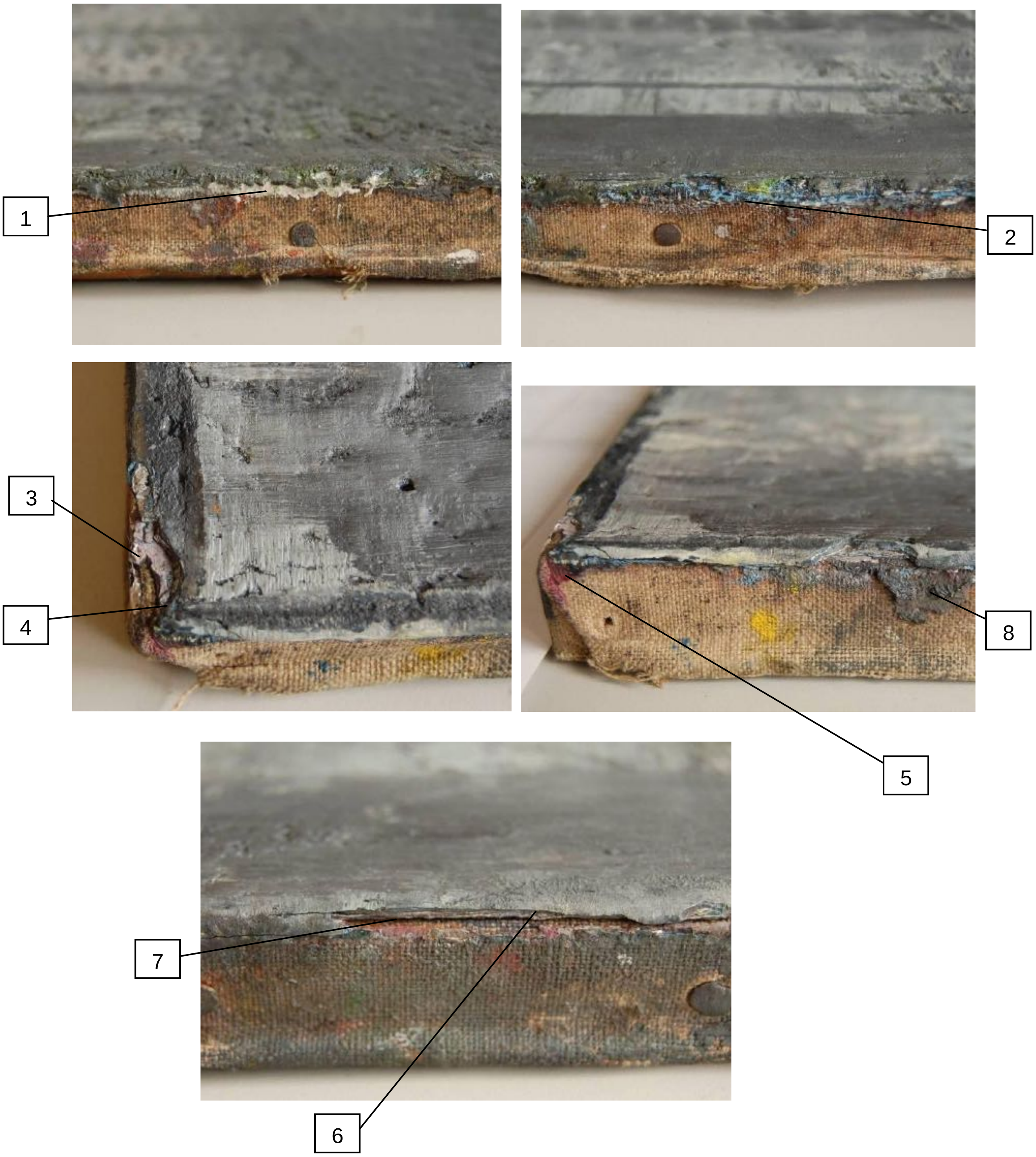
Surface coatings/gloss

Slight surface sheen in area of head.

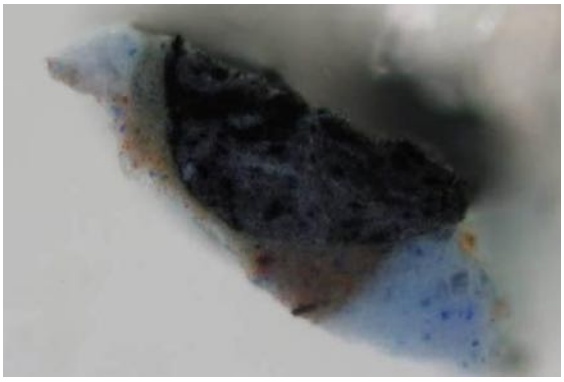
Samples taken

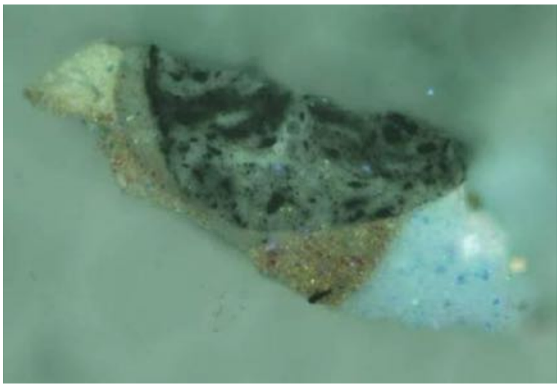
No.	*Colour*	*Location*
1	White	Left edge, drip onto tacking margin, 41.5 cm from bottom
2	Pale blue	Left edge, drip onto tacking margin, 24 cm from top
3	Purple over black and white	Top right corner, edge of loss, lower stratum of layers
4	Grey/pink?	Top right corner (top edge), edge of loss, upper stratum of layers
5	Pink	Top right corner(top edge), drip onto tacking margin
6	Grey with layers beneath	Top edge, 11 cm from left, near area of lifting paint
7	Pink over orange	Top edge, layers on canvas beneath lifting thick grey paint, 15.5 cm from left
8	Grey gritty paint	Top edge, drip onto tacking margin, 6 cm from right
9	Priming	From reverse of canvas

Notes
The painting is very heavy – is this just due to the weight of paint on it or are there other additions? e.g. wax, sand, heavy pigments (lead-based). An x-ray plate of the painting appeared just white due to the concentration of x-ray blocking pigments Texture of paint 'like rhinocerous skin'? - quote in Sylvester interviews p32 Bacon in *Interviews with Francis Bacon*, p18: 'There was an early one of a head against curtains. It was a small picture, and very, very thick. I worked on that for about four months, and in some curious way it did, I think, perhaps, come through a bit.' (*Head II* is illustrated)

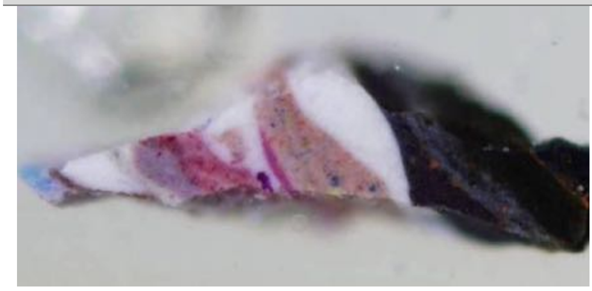


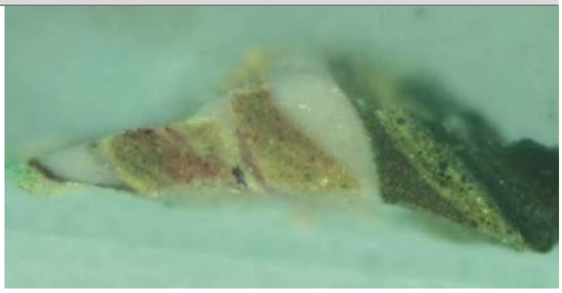
FB07-2 Grey over pale blue


Normal light (taken at x200 magnification)

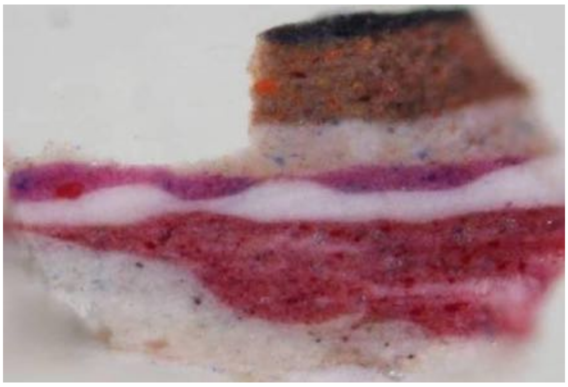

Ultraviolet (x200 magnification)

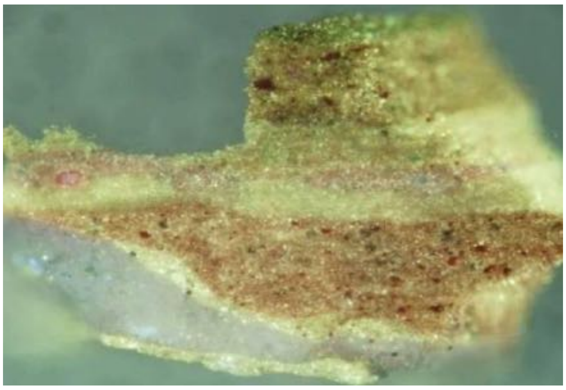
FB07-3 Grey over pink. Top right corner

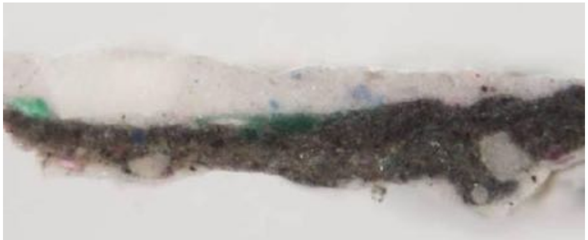

Normal light (taken at x50 magnification)

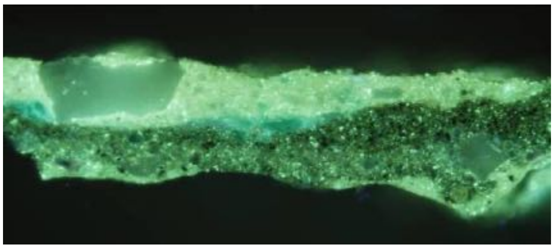

Ultraviolet (x200 magnification)

FB07-4 Grey over pink. Top right corner (broke in two)


Normal light (taken at x200 magnification)

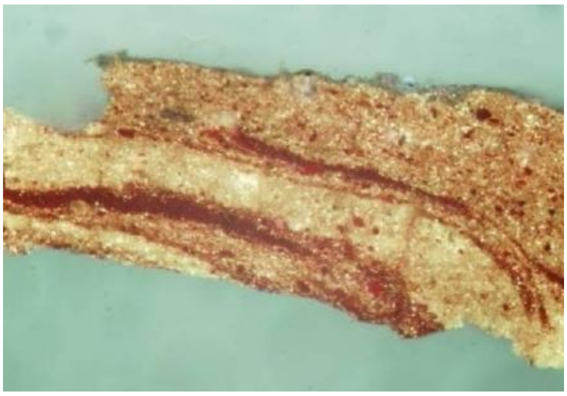

Ultraviolet (x200 magnification)


Normal light (taken at x200 magnification)

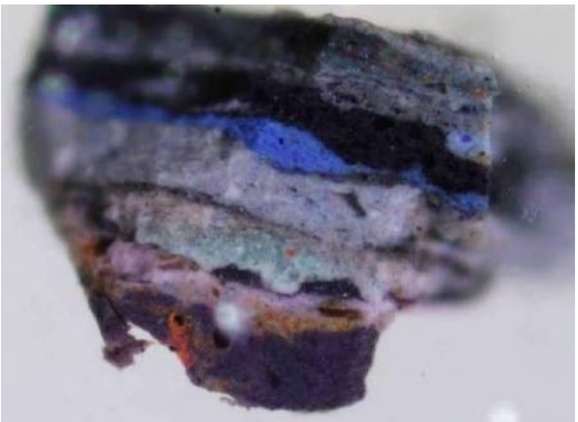

Ultraviolet (x200 magnification)

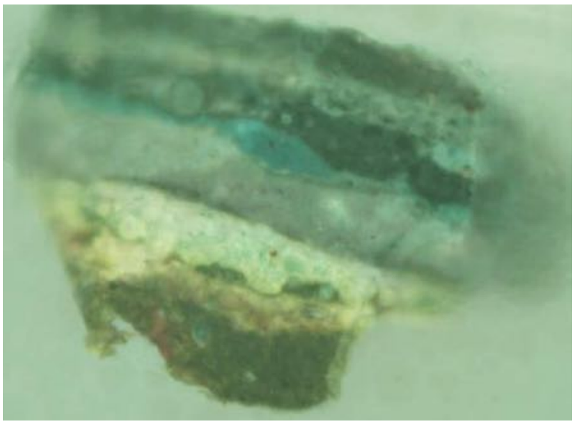
FB07-5 Pink, top right corner

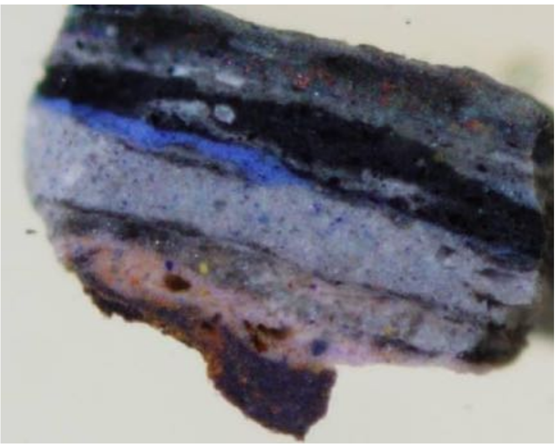

Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

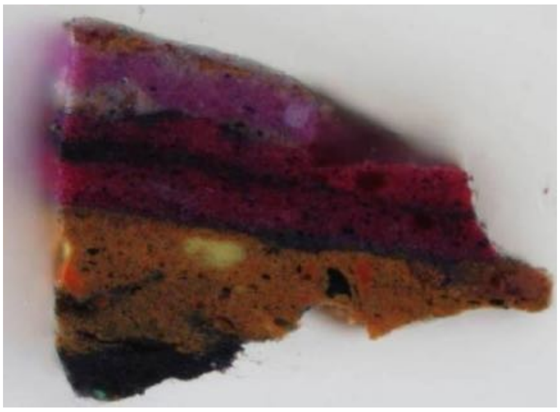
FB07-6 Grey, top edge

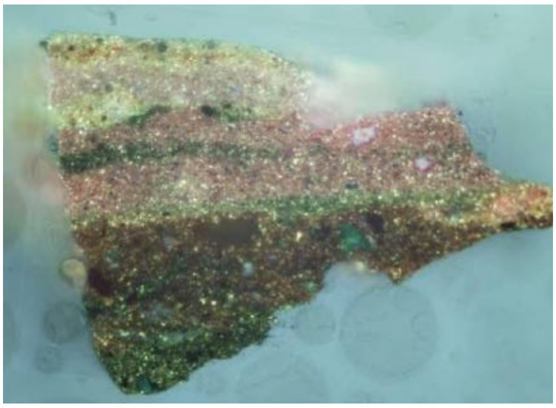

Normal light (taken at x50 magnification)


Ultraviolet (x200 magnification)


Normal light (taken at x50 magnification)

FB07-7 Pink over orange


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB07-9 Priming


Normal light (taken at x200 magnification)

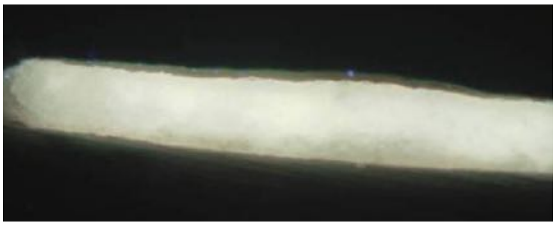

Ultraviolet (x200 magnification)


Figure E.07.1 Grey surface with blue traces below surface

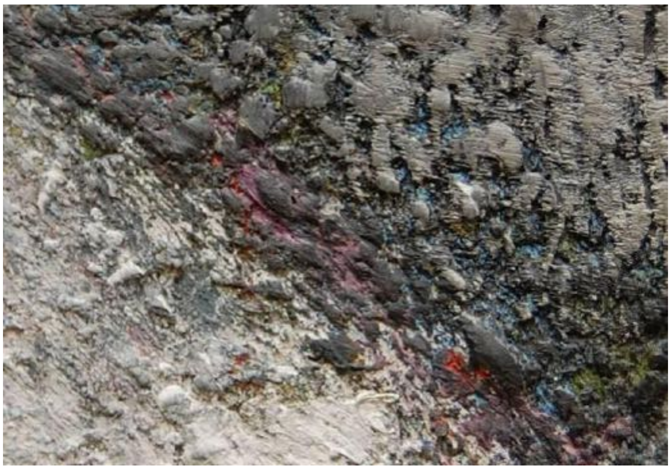


Figure E.07.2 Edge of shirt with red, pink, blue and green below grey surface

Analysis Summary			
No.	*Description*	*Analysis carried out*	*Material identified*
1	White, left edge	FTIR, GCMS	Lead white, oil (Az/P = 0.52, P/S =2.82)
2	Pale blue, left edge	FTIR, GCMS, XSec, EDX	Lead white, zinc white, bone black, cerulean blue, vermilion, Oil (Az/P = 0.49, P/S =2.58)
3	Purple over black and white. Top right corner	XSec, EDX	Lead white, zinc white, cerulean blue, cobalt violet, vermilion, cobalt blue?, umber?
4	Grey/pink? Top right corner	XSec, EDX	Vermilion, Lead white, zinc white, cadmium pigment, organic red?, cobalt violet, viridian, cerulean, ivory black
5	Pink. Top right corner	XSec, FTIR, EDX	Alizarin crimson, zinc white
6	Grey with layers beneath, top edge	FTIR, XSec, EDX, GCMS	Oil (upper layers: Az/P = 0.39, P/S =2.81, lower layers: Az/P = 0.45, P/S =2.25), lead white, chalk, ivory black, iron oxide, cerulean, zinc white, cadmium yellow
7	Pink over orange, top edge	XSec, EDX	Zinc white, vermilion, cadmium yellow
8	Grey gritty paint, top edge	FTIR, GCMS	Drying oil (Az/P = 0.71, P/S =2.17), GCMS includes large peak for hydroxy-C18 ester. Lead white, sand?
9	Priming from reverse	FTIR	Lead white, Oil (Az/P = 0.71, P/S =2.65)

Conclusions

The painting is extremely thickly painted, and many layers of paint can be seen in cross sections. Sixteen layers were counted in section 3, but it is probable that not all the layers present were collected even in this case, due to the difficulty of penetrating all layers while taking only a small sample, and the likelihood of fragmentation.

The complexity of the samples makes it difficult to identify with certainty which layers correspond to the surface layers of the painting. The grey paint collected with blue in sample 2 is likely to be the grey paint visible on the surface of the painting, and was found to consist of bone black with zinc white, and barium sulphate extender. The paint is incompletely mixed with relatively large black particles. Sample 6 also has several grey surface layers, one of which has the same composition as that in sample 3, followed by several further grey layers including a small number of blue and orange particles. Lead white, zinc white, vermilion, and possibly cerulean blue were found in these layers.

Both lead and zinc white seem to have been used throughout the samples, sometimes in adjacent white layers, as can be seen by examination in UV, due to the bluish fluorescence of lead white in contrast to the yellow-green appearance of zinc white. In mixtures of white with a colour, zinc white appears to be more frequently used. It should also be noted that the (predominantly) lead white paint layers contain a small amount of zinc white. The composition of Winsor and Newton's Flake white is described as basic lead carbonate "with a small percentage of zinc oxide". The zinc white is added to improve working properties and maintain whiteness. This was a brand favoured by Bacon, from the evidence of his studio, and may be used unmixed in some layers. Both zinc and lead whites from W&N contained poppy oil as binding medium up until approximately 1972, which has a palmitate:stearate ratio of 2.9-3.7. This is close to the value found for the white paint analysed by GCMS (sample 1). The other samples analysed by GCMS (grey, pale blue) had a p/s ratio between the reported values for linseed and poppy oils, likely to represent a mixture of a white with black/blue paint. Colours other than white are likely to be bound in linseed oil, an oil with good drying properties but with a tendency to yellow, making it unsuitable for whites.

The predominantly grey surface appearance covers a wide range of colours and pigments used in earlier layers, now visible only as traces round the edges of the canvas. Bright red-orange, pink and blue layers can be seen, containing vermilion, alizarin crimson and cobalt blue respectively.

The only other traces of colour visible on the surface could not be sampled, but one might suppose that the same pigments might have been used. For example, in the pale blue rim of the spectacles cobalt or cerulean blue mixed with white may have been used, while the red-purple stripes on the shirt might be alizarin crimson and/or cobalt violet with white.

Some remarks made by Bacon in the Interviews with David Sylvester seem to refer to this painting. Bacon talks of his tendency to take works too far, leading to him destroying them: ‘the canvas becomes completely clogged, and there’s too much paint on it’. He refers to a rare occasion in which he was able to continue working on a painting to ‘pull it through’ rather than destroying it. From the evidence of the cross sections it appears that the earlier stages of the painting were very different in their range of colour, compared to the painting’s current appearance, indicating Bacon may have completely changed his mind several times of what he was trying to achieve. However, it should be borne in mind that samples taken only from the edges of a canvas may not be representative of the whole.

In some places, bright colours can be seen at the base of pits in the scaly grey surface layer, so some of the earlier coloured layers may have been applied in order to achieve this effect. However, the large number of layers applied seems to imply that these were not all completely deliberate, as very few of the layers actually seem to contribute in this way to the final effect. From Bacon’s comments it sounds as though much of the build-up of paint was due to his prolonged attempts to correct what went before. It looks as though paint was applied, but skipped over some lower points of texture, could pastel have been used, which would accept the paint unevenly?

The bright blue layer seen in sample 6 may be the same layer seen peeping through areas of the grey curtain (figure E.07.1). Other colours not seen in the cross sections are also visible, such a bright red and a yellow-green (figure E.07.2). Bacon said that some of the bright colours could only be achieved using pastel, and it’s possible that this was used here.

Untitled (Figure in a Landscape), c.1952

Image omitted for copyright reasons

Identification details

Title: Figure in a Landscape	*Date:* c.1952?
Dimensions (hxw): 212 x 150 (framed) 198 x 136 (78 x 54) est.	*Location/owner:* Private collection

Marks/Inscriptions:

Label, printed, with written additions: 'Marie-Louise Jeanneret – Art Moderne. Artiste..Bacon Francis… cm…212 x 150..'

Yellow printed label: 'Panzironi Art Transport s.r.l. / Via C Benuto 13 – 20131 Milano – Tel 23 62 803 23 62 875 / Transporti – Spedizioni – Imballaggi – Assicurazioni opera d'arte/ Autore: Francis Bacon, 2.12 x 1.50'

Stamp on stretcher: 'Panzironi Art Transport s.r.l. / Via C Benuto 13 / 20131 Milano'

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
Softwood 7-member stretcher, mitred mortise and tenon joints, members are 2.5” wide. The two vertical outer members have diagonal cuts through the wood approximately two thirds of the way up, with metal plates screwed in across the join at both sides. This would allow the stretcher to be disassembled for transport or to fit through a small opening, for example.
The canvas appears to be linen, coarse plain weave. Now quite brittle and darkened. The thread count is 12 x 12 threads per cm^2.

Attachment is through brass staples, quite new looking. Further staples are used to anchor the canvas to the back of the stretcher. Old tack holes are visible along the edges at approx 8-9.5 cm spacing, no visible signs of rust.

Paint and ground

Priming:
Off-white, on reverse

Paint description:
There is a band of black along the top and left edges. Bare canvas is not exposed on the front of the painting, though canvas texture is prominent in some areas. A dark blue-green stain appears to have been applied directly on to the canvas at least in the lower part, as drips of this stain can be seen along the bottom edge.

The sky is painted in opaque pale blue, with a band of lilac beneath which appears to have been painted over a dark underpaint layer. A stripe of bright pink is painted horizontally across the boundary between blue and lilac. Vertical stripes of black paint are used on top to form what look like the bars of a cage.

A figure is loosely painted in dark grey, with orange and white mixed in on the torso. It appears that sand has been added to the paint, which is visible as fine uniform grains in the head and upper body (figure E.08.3). Another grey figure shape, which might be a shadow, is seen to the lower right of the standing figure. A pale orange-yellow paint has been smeared into the texture of the canvas at the lower right on top of dark red. Rapid strokes in black paint in lower right area, one drip of paint from this suggests the paint was quite fluid (figure E.08.4).

Red paint (pastel?) on the canvas shows though in some areas, in canvas texture and not fully covered by black/grey paint (figure E.08.2). There are some strokes of impasto in the paint under the swathe of lilac paint and around the figure which appear to be from an earlier paint layer. There is evidence of reworking around the main figure.

There are lots of hairs in the paint in the sky. The rough, dusty texture is picked up by the strokes of black paint (figure E.08.1). Blue paint is visible under the orange at the right hand side. Some blue shows through under shadow figure also, possibly from the same layer.

Surface coatings/gloss

Slight gloss in thicker areas of paint.

Samples taken

No.	*Colour*	*Location*
1	Pink/purple	Horizontal pink stripe. Right edge, 50.5cm from top
2	Orange over blue	Right edge, 62 cm from bottom
3	Black over orange	Left edge, 36 cm from bottom
4	Pale blue scraping + fluff	Right edge, 49 cm from top
5	Lilac/black	Right edge, 56cm from top
6	Pale green (with dark stain?)	Bottom edge, 53.5 cm from right
7	Dark pink	Bottom edge, 4 cm from right
8	Grey over pale blue	Top edge, 65.5 cm from left
9	Priming	Reverse of canvas

Notes

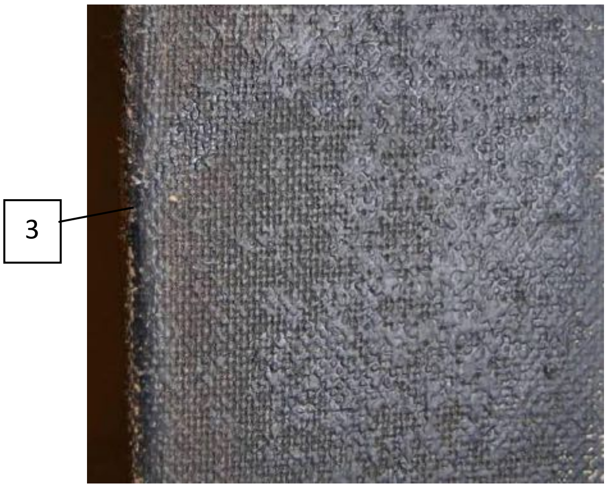
The painting was labelled with the date of 1952 when it was exhibited in Milan in 1973, in the gallery catalogue, but the date is not certain.

Figure E.08.1 Top edge showing tops of black strokes highlighting rough texture of blue background

Figure E.08. 2. Detail of red in texture of canvas

Figure E.08.3. Detail from right shoulder of standing figure with sand added to paint

Figure E.08.4. Black strokes in lower background, showing drip of black paint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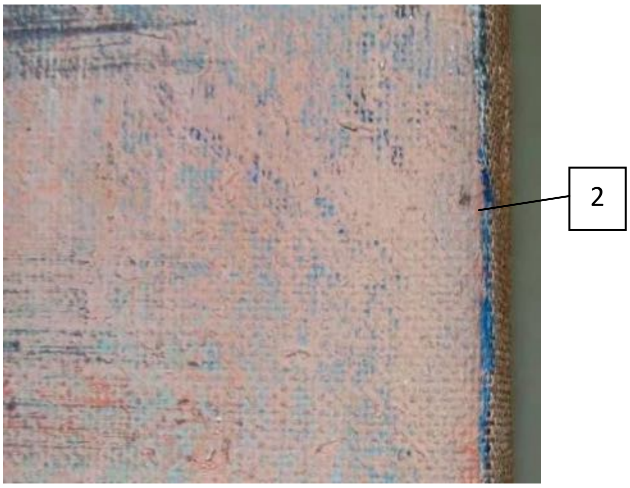
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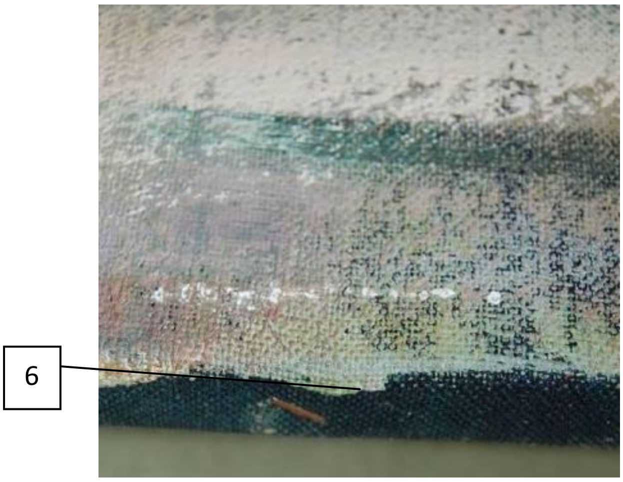
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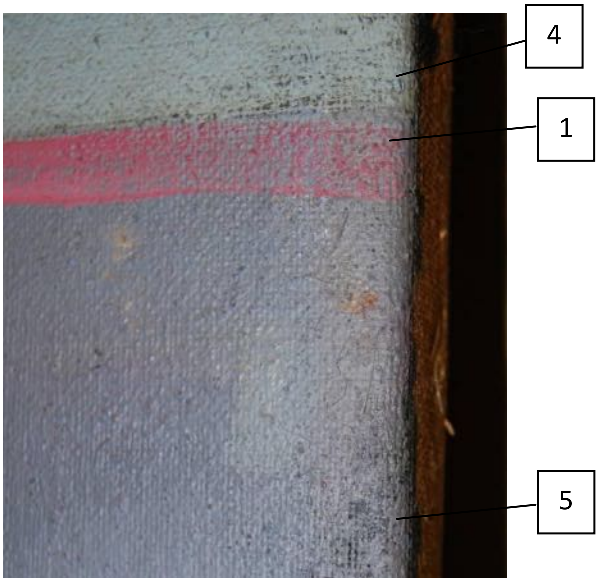
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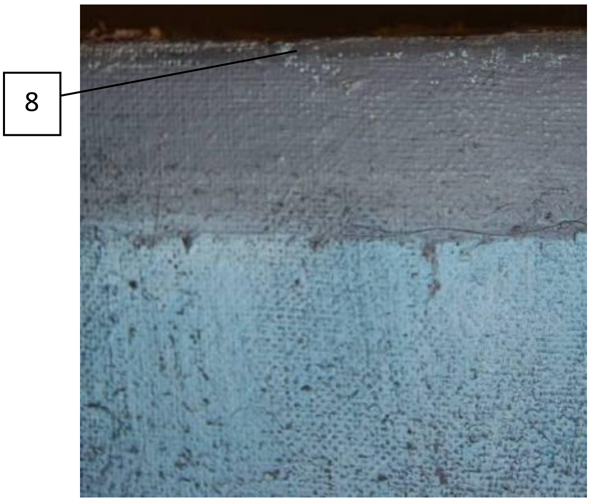
1
5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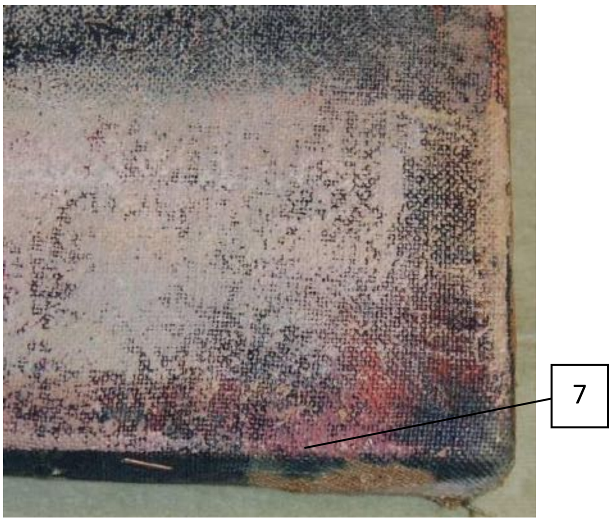
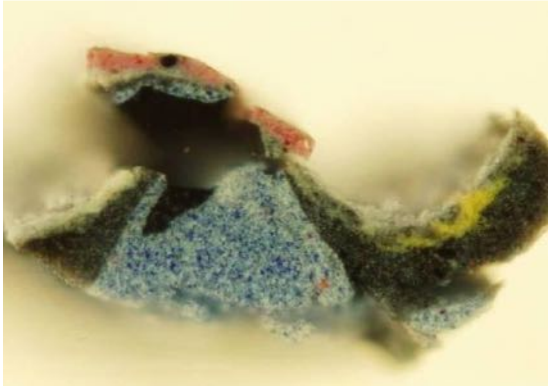
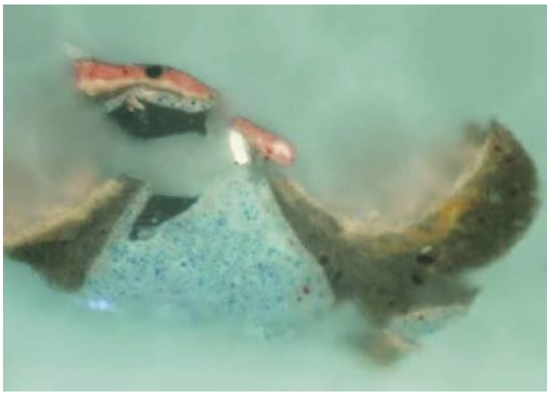

7

FB08-1 Pink over lilac/blue

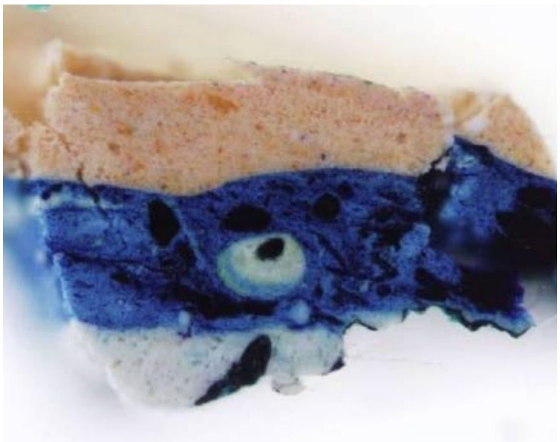


Normal light (taken at x200 magnification)

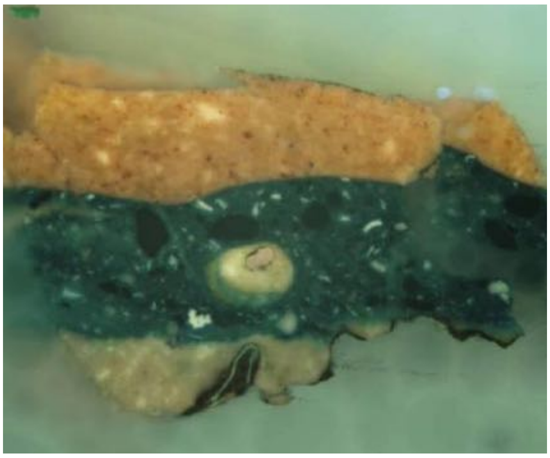


Ultraviolet (x200 magnification)

FB08-2 Orange over blue

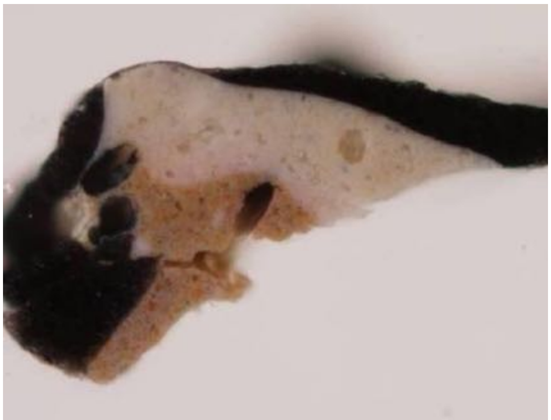


Normal light (taken at x200 magnification)

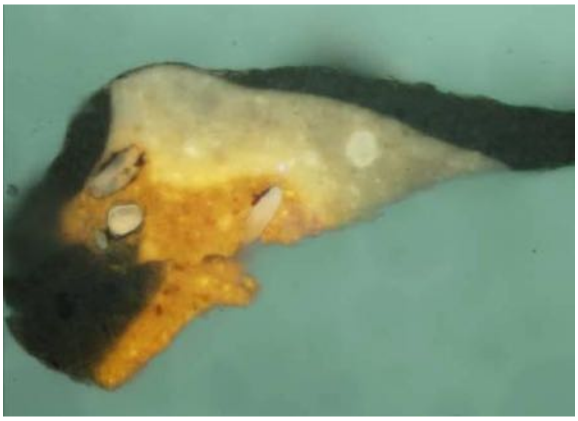


Ultraviolet (x200 magnification)

FB08-3 Black over orange, left edge

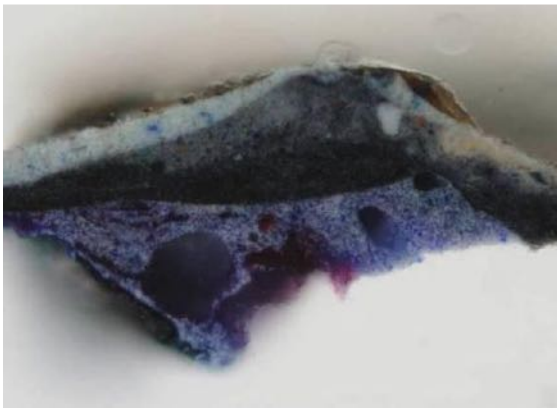


Normal light (taken at x200 magnification)

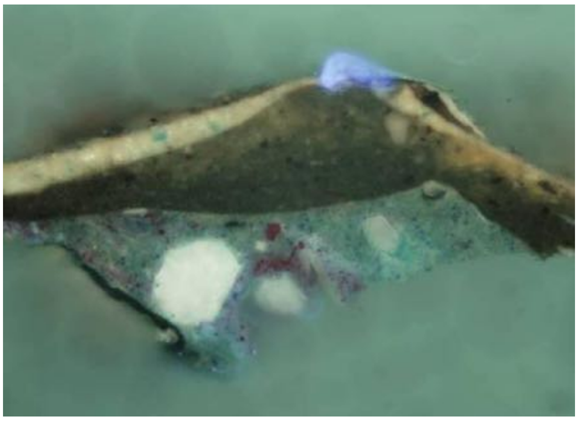


Ultraviolet (x200 magnification)

FB08-4 Pale blue scraping

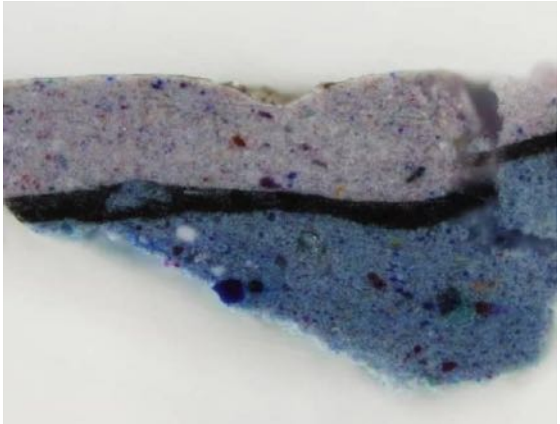


Normal light (taken at x200 magnification)

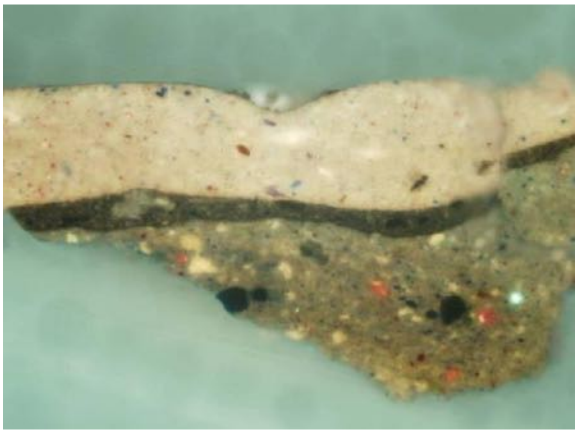


Ultraviolet (x200 magnification)

FB08-5 Lilac over black

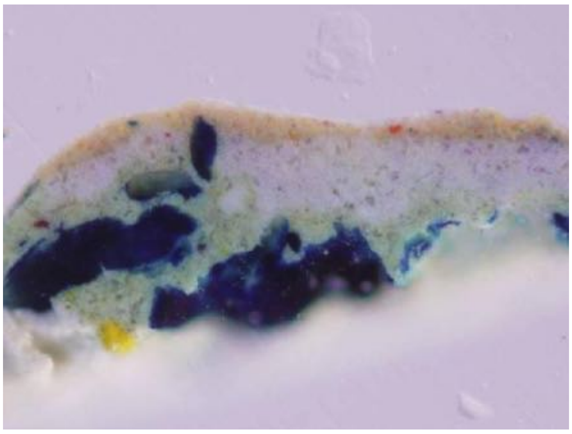


Normal light (taken at x200 magnification)

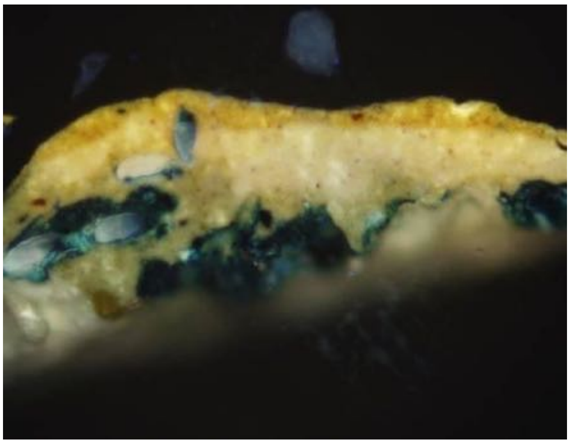


Ultraviolet (x200 magnification)

FB08-6 Pale green, bottom edge



Normal light (taken at x200 magnification)



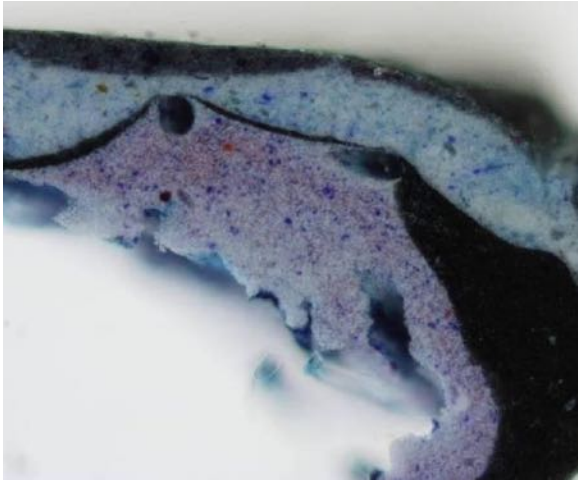
Ultraviolet (x200 magnification)

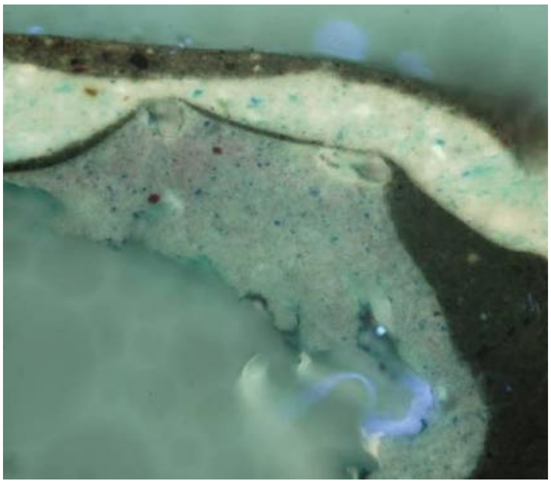
FB08-7 Dark pink, bottom right corner


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

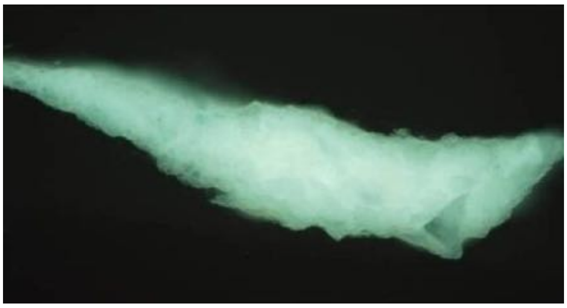
FB08-8 Grey over pale blue


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB08-9 Priming


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Orange	2	GCMS, FTIR	Oil? (P/S = 5.42, Az/P = 0.02)
	2, 3	SEM-EDX, FTIR	Cadmium orange
		SEM-EDX, FTIR	Barium sulphate
		SEM-EDX, FTIR	Chalk
		SEM-EDX, FTIR	Titanium white
		SEM-EDX	Zinc white
Dark blue	2	GCMS, FTIR	Alkyd/oil? (P/S = 3.17, Az/P = 0.32)
		FTIR, SEM-EDX	Prussian blue
		FTIR, SEM-EDX	Barium sulphate
		FTIR, SEM-EDX	Titanium white
Black	3	SEM-EDX	Chalk/gypsum?
		SEM-EDX	Lamp black?
		SEM-EDX	Silicates
White	1, 2, 3	SEM-EDX	Titanium white
		SEM-EDX	Barium sulphate
		SEM-EDX	Zinc white
Pale green	6	GCMS, FTIR	Alkyd? (P/S = 2.91, Az/P = 0.51)
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Barium sulphate
		FTIR, SEM-EDX	Chalk
Pale blue	4, 8	SEM-EDX	Titanium white
		SEM-EDX	Cerulean blue
Pink stripe	1	SEM-EDX	Titanium white
		SEM-EDX	Alizarin crimson?
Yellow traces	1	SEM-EDX	Cadmium yellow
Pink	7	FTIR, GCMS	Alkyd (P/S = 3.10, Az/P = 0.44)
		SEM-EDX	Vermilion
		SEM-EDX	Cadmium red
		FTIR, SEM-EDX	Titanium white
		FTIR	Barium sulphate
Blue-lilac	1, 4, 8	SEM-EDX	Ultramarine
		SEM-EDX	Titanium white
		SEM-EDX	Zinc white
Lilac	5	FTIR, GCMS	Alkyd ? (P/S = 3.11, Az/P = 0.25)
		SEM-EDX	Titanium white
		SEM-EDX	Lead white
		FTIR	Barium sulphate
		SEM-EDX	Zinc white
Blue stain	6, 8?	FTIR, SEM-EDX	Prussian blue
Priming	9	GCMS	Oil (P/S = 2.32, Az/P = 1.23)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk

Conclusions

All samples appear to contain titanium white, which usually appears to be mixed with barium sulphate, which could be an example of an early ‘extended’ titanium white pigment. Lead white was only detected in one sample in lilac/blue paints, which is a little odd as these paint layers were thought to be the same as those seen in other samples. Three different blue pigments were detected. The characteristic IR absorption for Prussian blue was seen in several samples (5, 6, 7 & 8), and this may have been applied as a thin stain over much (possibly all) of the canvas as a first layer. There is also a more substantial Prussian blue layer in sample 2. Cerulean blue was used to form the pale blue sky, while ultramarine was used in the lilac-blue layer below the sky.

The lilac, dark blue, pale green and pink paints all appear to have an alkyd medium and all have very similar P/S ratios, close to 3. The orange paint was the only one tested which appeared to have an oil medium (other than the priming). At this date an alkyd paint indicates an industrial paint, as the first artists’ alkyd paints were not introduced until the 1970s. It’s possible that a white alkyd household paint was used (or alkyd priming paint), mixed with oil colours, e.g. in the poorly mixed Prussian blue/white paint in sample 2. However the blue layers in sample 8, at least one of which appears to be alkyd, both look uniformly mixed, so may be commercially prepared mixtures. The pink paints appear less well mixed, and vermilion and cadmium red are unlikely to be included in household paints, so this may be a mixture of oil and alkyd paints. Visually, the lilac, grey, pale blue and areas of the black have a slightly glossy viscous appearance which would be consistent with a household gloss paint.

The same alkyd medium and titanium white pigment in many of the samples suggests this alkyd paint was used as the white paint throughout, possibly because this was the only white paint to hand when the work was made.

FB09 Study for Self-Portrait, 1963

Identification details		
Title: Study for Self-Portrait		*Date:* 1963
Dimensions (hxwxd): 165.2 x 142.6 x 2 cm	*Location/owner:* National Gallery of Wales, Cardiff	

Marks/Inscriptions:
Inscription on back, black paint: 'Study for Self Portrait 1963'

Pencil on horizontal cross-bar: '5-6'
Pencil on both vertical cross bars: '65+'

Paper label on vertical cross bar: 'This is the property of the National Gallery of Wales Department of Art/ NMWA218/Bacon, Francis/Study for Self Portrait

Support

Type: <u>Canvas</u> / Board / Paper / <u>Stretcher</u> / Strainer

Description:
Softwood 7-member stretcher, mitred mortise and tenon joints. Width of members 51-52 mm

Plainweave linen canvas, 16 x 22 threads/cm^2.

Attachment through grey metal tacks, 8.5 – 10 cm spacing, 6mm diameter.

Paint and ground

Priming:
Off-white, on back of canvas

Paint:
Upper background is painted in white over what appears to be roughened canvas – fibrous texture, a bit grubby-looking. Slightly uneven appearance towards two upper corners – might be due to brushstrokes from an underlying layer showing through, or just uneven application of white. Spray of thin black spots over white & blue to left side of figure. Dark blue stain to canvas used to form couch, with margins of bare canvas at seams and edges (Fig E.09.3). White cushions have been painted on top of the blue, with fine drying-type crackle in white paint (Figure E.09. 4). Area of darker, more glossy blue to right of figure's head might indicate position of head has been changed.

Gritty-textured yellow at base, painted over pale pink/lilac layer. Table was sketched out in dry black/blue paint on canvas, table top painted in beige, legs left unpainted. Smears of dark blue on beige. White ashtray painted on top of beige paint.

Thin black strokes over bare canvas sketch legs of figure, areas of thicker grey paint on top, also sprays and drips of liquid grey paint. Red-brown on shoe. Grey outline above shoe, as though position changed. Strokes of glossier black paint on trousers.

Dark pink on arms, part of which appears to have been worked over blue of couch. Fairly thick white paint on shirt, textured as though sand/grit added. Some hairs in white paint of shirt and texture may be from pressing with fabric on top of paint. Thin lines of green and red on edges of shirt and arms. Pink on face swirls over earlier layers (fairly thick). Patches of broken/ smeared colour in black, dark green & red. Bright green could be pastel - e.g. on left sleeve, and green and pink strokes on right forearm (Figure E. 09.1).

Marks made by printing with textured fabric can be seen in many areas - with purple paint on left side of face, small patch of bright pink below nose, clear purl-weave texture in dark green/black over white on sitter's left shoulder. A similar texture is also seen in white paint in lower part of right sleeve and in texture on nose (Fig E.09.2). Bright red on neck with sand sprinkled on top, giving a diffuse effect. Sand also on brown at base of shirt collar with two tufts of yellowish fluff. Liquid brown paint drips down on to white shirt. Round black spot on bridge of nose with canvas texture – paint appears to have been dabbed off here – maybe with finger & cloth (Fig E.09. 2). Matt surface contrasts with black spots in fairly glossy black paint on face and at wrist. Hair is thinly painted with bright green outlining.

Surface coatings/gloss

Blue and beige are very matt. Slight gloss on thicker paint of figure and on white in background.

Samples taken

No.	*Colour*	*Location*
1	Off-white priming	Back of canvas, top left corner
2	Blue couch	Left edge, drip over edge. 40.2 cm from bottom
3	Bright yellow base	Left edge, drip over edge. 13.8 cm from bottom
4	White background	Top edge, drip on tacking edge. 39 cm from left
5	Pink under yellow	Right edge, 33 cm from bottom
6	Yellow over pink	Right edge, 33.5 cm from bottom
7	Red smear on white	Right edge, 40.8 cm from top

Notes

Small loss to pink/white on chin/neck, which has been consolidated with Beva.

This painting was photographed in its current state by Marlborough Fine Art on 24 Apr 1963, according to Alley.

Figure E.09.1. Detail of dry red and green strokes on arm

Figure E.09. 2. Detail of fabric pattern on upper part of nose

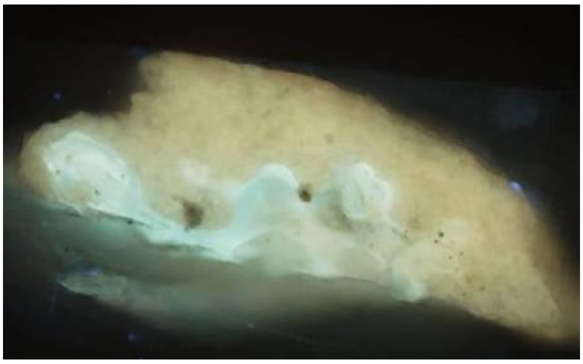
Figure. E.09.3. Line of black 'under-drawing' exposed in margin of bare canvas on couch

Figure E.09. 4. Drying cracks in white paint of cushion, applied over blue of couch

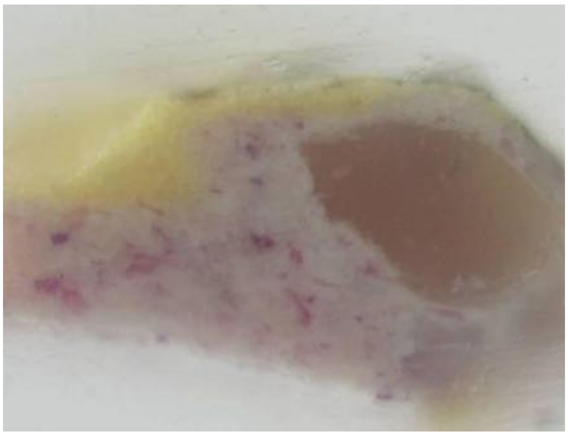
Sample sites

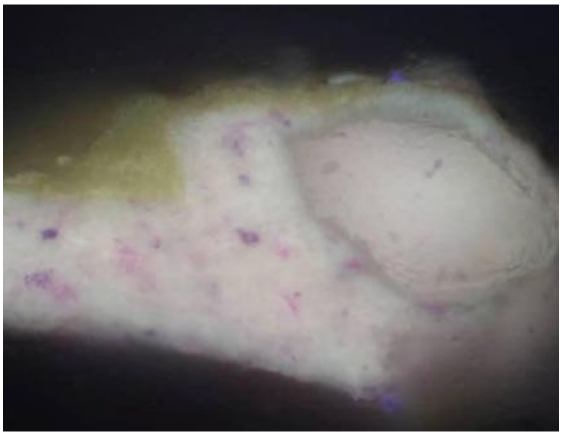
FB09-1 Priming from back of canvas


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

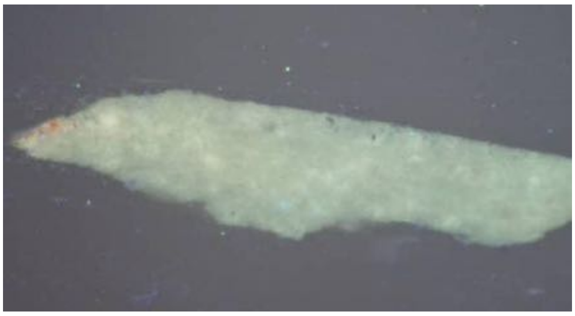
FB09-6 Bright yellow over pink


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB09-7 Red smear over white


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis

Paint	*Sample*	*Analysis*	*Materials identified*
White background	4, 7	GCMS	Tere-phthalate alkyd (Az/P = 0.47 P/S = 1.47)
		FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Silica?
	7	SEM-EDX	Magnesium carbonate/dolomite?
Blue couch	2	FTIR, GCMS	Drying Oil, probably linseed (Az/P=1.24, P/S=1.34)
		FTIR, SEM-EDX	Prussian blue
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
Bright yellow base	3	GCMS	Drying Oil, probably linseed (Az/P = 0.98, P/S = 1.54)
		FTIR, SEM-EDX	Lead white
	6	SEM-EDX	Zinc white
		SEM-EDX	Cadmium yellow
Pink layer under yellow base	5	GCMS	Drying Oil, probably linseed, possibly with poppy/safflower (Az/P = 1.10, P/S = 1.88)
	5, 6	FTIR, SEM-EDX	Lead white
		PLM, SEM-EDX	Cobalt violet (cobalt phosphate)
	6	SEM-EDX	Zinc white
		SEM-EDX	Sand
Priming	1	FTIR, GCMS	Drying oil (Az/P = 0.61, P/S = 2.32)
		FTIR	Protein size
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Chalk
Red smear	7	SEM-EDX	Cadmium red

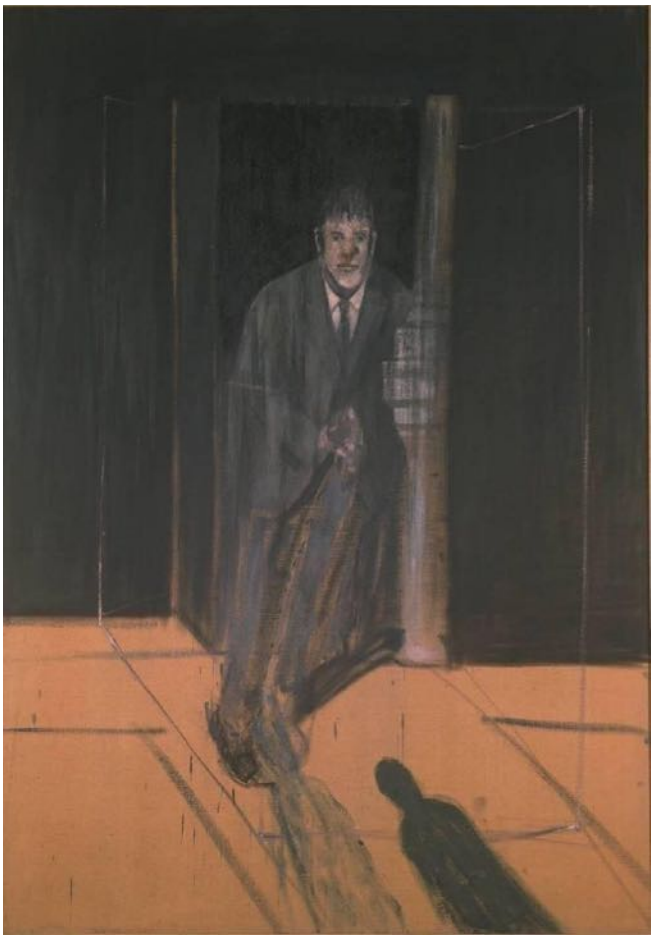
Conclusions

The white background appears to have a terephthalate alkyd medium, with large amounts of chalk and silica extenders. This makes it likely to be a household gloss paint. The blue, yellow and pink paint layers are likely to be artists' oil paint. The palmitate/stearate ratios of the blue (1.34) and yellow (1.54) paints suggest linseed oil is present.[72] The pink paint contains a high proportion of white paint, which is generally bound with a non-yellowing oil such as poppy or safflower. This paint has a higher palmitate/stearate ratio of 1.88, consistent with a mixture of linseed with poppy or safflower oil.

Lead white with a small amount of zinc white is present in the blue, yellow and pink oil paints. This mixture is found in Winsor & Newton Flake White oil paint, and is probably also used in other commercial artists' formulations. In contrast to this the household paint contains only the modern titanium white pigment. Large particles of a pale-coloured sand are mixed into the light pink layer to create the gritty texture seen in the floor.

[72] Mills, J. S. & White, R., The Organic Chemistry of Museum objects 2nd Edition., Butterworth Heinemann, 1994.

Portrait of Lucian Freud, 1951



Identification details		
Title: Portrait of Lucian Freud		*Date:* 1951
Dimensions (hxwxd): 198.5 x 137 x 2.5 cm (78 x 54 x 1”)	*Location/owner:* Whitworth Gallery, Manchester	

Marks/Inscriptions:

Paper label on reverse of stretcher, upper horizontal cross bar, red printing and black ballpoint writing: “THE HANOVER GALLERY/ The Hanover Gallery Ltd 13A St George Street W1 Mayfair 0296/ Artist FRANCIS BACON/ Exhibition PARIS 1957/ No. Study for a Portrait: Lucian Freud 1952/ Canvas: 78 x 54 ins”

Round paper label on reverse of stretcher, upper horizontal cross bar: “G4/18”

Paper label on reverse of stretcher, upper horizontal cross bar, black printing with typewritten details: “CRANE KALMAN GALLERY/178 BROMPTON ROAD, LONDON, SW3 01 584 7566/ Artist BACON Francis/ Title ‘Portrait of Lucian Freud’/ Purchaser Whitworth Art Gallery Date 3/11/80”

Paper label on reverse of stretcher, lower horizontal cross bar, black printing: “Telephone: FLAxman 0430 /...HELSEA ART STORES/ (Walter P. Holland, Principal) /...OLOU..EN./...SW...” (much of label is torn away)

Chalk writing on reverse of stretcher, lower horizontal cross bar: ‘LORD BEAVERBROOK’

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:

7-member softwood stretcher, square mortise and tenon joints. One vertical and two horizontal crossbars. Width of members: 2", depth: ¾ ". Front faces are bevelled. Wood is fairly knotty. All keys are present (14 in total).

Linen plainweave canvas, 16 x 16/17 threads/cm^2

Canvas is attached to stretcher with dark grey metal (steel) tacks, 4mm (3/8 in) diameter, placed at varying intervals, 7-13 cm. The same tacks are used to secure the canvas to the back of the stretcher.

Paint and ground

Priming:

On back, originally white, now yellowed, with patches of brown discolouration

Description:

A thin black stain is applied to the upper ¾ of the canvas, while the base is largely unpainted canvas. Thin lines are painted over the raw canvas at the base in grey. The grey paint used in one horizontal stroke appears to have a waxy texture at the turnover edge (sample 1). Two lines in white-purple paint meet with a thick blob of paint, which is flattened as though the surface was pressed against something while still wet. Two green shadowy figures are painted over the bare canvas at the base. The left hand shadow is very thinly painted in dry paint strokes. The right hand shadow appears to have been first outlined in a bright blue-green paint, before a thicker green paint was used to fill the outline, then a dark green/black was layered on top. There are several vertical drips of paint on the bare canvas, mainly below the figure, in black, grey and pale blue.

There are grey vertical shapes in the background caused by localised areas of dusty material (figure E.10.2). This was sampled and found to be a fatty acid efflorescence (mostly palmitic acid, with a small amount of stearic acid). This occurs only in isolated areas over the black background, so appears to be associated with brushstrokes in either paint or priming/size.

A reserve of bare canvas has been left between the left part of background and the edge of the doorway. The black on the left side appears more purple, and to the right is a stripe of greener black. The upper part of the column is made up of an area of bare canvas with white & grey vertical stripes. The space behind the sitter's head also appears to have been initially painted with grey vertical stripes over bare canvas, before this was covered with an area of glossy, gritty black around the head, figure E.10.1 (the tops of these stripes are visible at the top of the glossy black area).

The face is painted in a pale greyish pink with traces of green. Dark orange sand is scattered over the pink paint in the lower part of the face and over the black paint of the foot (figure E.10.1). The suit is painted in grey with thin smears of green, and becomes thinner and more sketchy in the lower part of the painting.

Surface coatings/gloss

No varnish apparent. The area of black around the head is fairly glossy, as are the more thickly painted areas – face, shirt and upper parts of suit. Otherwise very matt.

Samples taken		
No.	*Colour*	*Location*
1	Grey line	Left edge, 66 cm from base
2	Bright green	Bottom edge, 24.5 cm from right
3	Black over green	Bottom edge, 36.2 cm from right
4	Purple scraping	Splodge, 20cm from base, 65cm from right
5	Black scraping, shiny area	Left edge, 106.5 cm from base
6	Purple scraping	Right edge, 55.8cm from top
7	Light grey scraping	Bottom edge, 53 cm from right
8	Priming	Back
9	Loose sand particle	Area of foot

Notes

According to Alley this was one of the first pictures Bacon executed in Rodrigo Moynihan's studio at the Royal College of Art, where he did most of his painting for the next two years. This study is said to be based on a snapshot of Franz Kafka leaning against the base of a column. When Freud arrived to sit for Bacon he found the portrait almost completed already, and a very good likeness, Bacon said he wanted to work only on the feet, but then changed it a great deal. (Alley p.52)

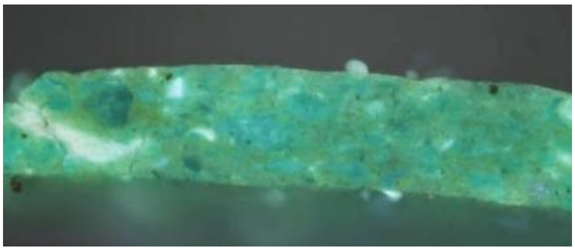
Figure E.10.1 Detail of head, showing yellow sand below nose and glossy black in background around head

Figure E.10.2 Area of black background with stripes of white surface bloom.

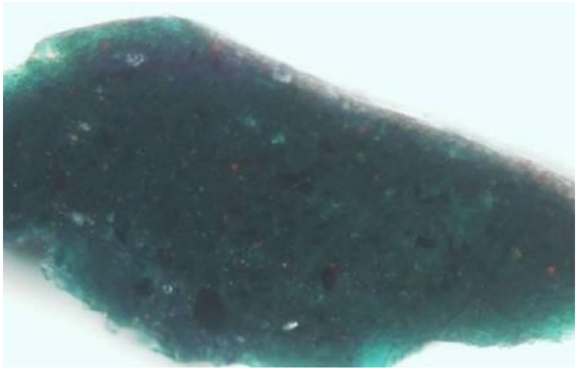

1
2
3
4
5
7
6

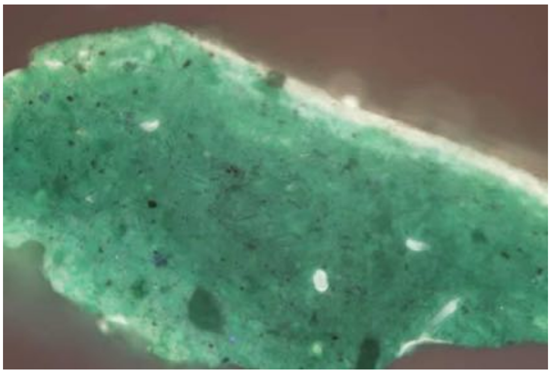
FB10-2 Bright green, from shadow figure


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

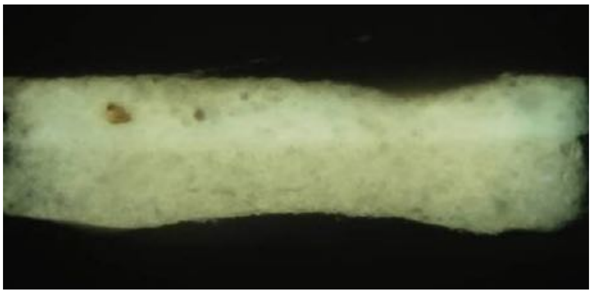
FB10-3 Black over bright green, shadow figure


Normal light (taken at x200 magnification)

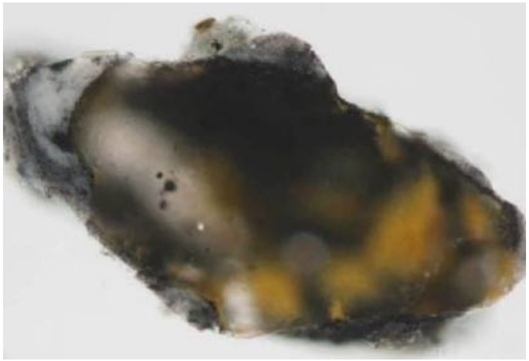

Ultraviolet (x200 magnification)

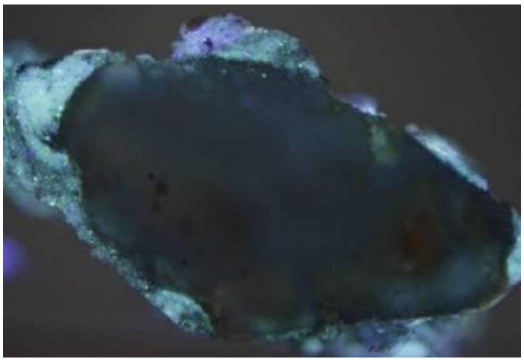
FB10-8 Priming from reverse


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB10-9 Sand/grey paint


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Black background	5	FTIR, GCMS	Oil (P/S = 3.14 Az/P = 0.45)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Carbon black (lamp black?)
Grey	1	FTIR, GCMS	Oil (P/S = 3.63 Az/P = 0.69)
		FTIR	Lead white
Bright green	2	GCMS, FTIR	Drying Oil (P/S = 3.98 Az/P = 0.87)
		FTIR, SEM-EDX	Viridian
		SEM-EDX	Cadmium yellow
		SEM-EDX	Zinc white
Green	3	FTIR, SEM-EDX	Viridian
		FTIR, SEM-EDX	Gypsum
		SEM-EDX	Ultramarine
Purple	4, 6	SEM-EDX, PLM	Cobalt violet (arsenate)
		FTIR, SEM-EDX	Magnesium carbonate
	4	SEM-EDX	Zinc white
Sand/grey paint	9	SEM-EDX	Sand (silica, with some iron?)
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
Light grey	7	GCMS, FTIR	Drying Oil (P/S = 4.41 Az/P = 0.44)
		FTIR	Lead white
Priming	8	GCMS	Oil (P/S = 1.70 Az/P = 2.29)
		FTIR	Protein-based size
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Barium sulphate

Conclusions

All samples tested had a drying oil binder and lead white was also found in several samples. The P/S ratios for all samples were fairly high. The ratios may have been affected by the presence of fatty acid efflorescence, which also had a high palmitate content (P/S ratio of 3.5).

No black pigment was definitely identified, suggesting the presence of a wholly carbon-based black, probably lamp black. Viridian, ultramarine and cadmium yellow were found in green paints. Cobalt violet (cobalt arsenate) was also found. Both green and purple paints had some zinc content, which might be from a zinc component in the prepared oil paint, rather than being added zinc white. The sand used has quite an orange colour and appeared to have some iron content.

The oil-based commercial priming consists of two layers of principally chalk and lead white, with a higher proportion of lead white in the upper layer, over a protein-based size.

Study for Figure VI

Identification details	
Title: Study for Figure VI	*Date:* 1956-7
Dimensions (hxwxd): 60 x 47 x 7/8 in	*Location/owner:* Hatton Gallery, Newcastle University
Marks/Inscriptions: Many paper labels stuck to stretcher bars	

Support
Type: Canvas / Board / Paper / Stretcher / Strainer
Description: Softwood stretcher, 6 members, mitred mortise and tenon joints. Width of members 5.5 cm, depth approx 1.5 cm (outer members), 0.7 cm (cross bars), though exact measurements are difficult as edges are chamfered. Plainweave linen canvas, 15/6 x 16 threads/cm^2 Attachment through grey metal tacks, 5mm diameter, 7.5-8.5 cm spacing

Paint and ground
Priming: on reverse, patchy grey-brown appearance

Paint description:
Thin green stain applied apparently over whole canvas. This has a slightly patchy appearance, in thicker areas it appears almost black. A glossier purple-brown is applied on top, forming a box around the figure's head. This may actually be made with an orange paint, as streaks of red-orange are visible in some areas (figure E.11. 2). Fine spots of red in paint texture may be pastel. A cobalt-type blue line is at the top of the square surrounding the head.
Thin white/pale grey strokes over the green form framework.

Blue-purple lines at neck of jacket, smeared with white shirt collar. Smeared pink paint on face, with streaks of different colours (fig ure E.11.1). Some areas are thickly painted while others are thinner and it appears that paint may have been scraped away, leaving paint smeared into the canvas texture.

Has the position of the head been changed? The paint appears thickest in this area and there seems to be a shape under the paint to the immediate left of the face.

Surface coatings/gloss

Fairly matt overall, the paint has sunk into the canvas over the green stained area. The paint has a slight gloss where it is more thickly applied, especially in the square around the head.

Samples taken

No.	*Colour*	*Location*
1	Green scraping	Drip over edge at base, 4.5 cm from right
2	Green blob, with white/purple?	Bottom edge, tacking margin, 20.5 cm from right
3	Orange	Bottom edge, tacking margin, 12 cm from left
4	Dark purple over green	Top of vertical paint stroke at top edge, 48 cm from right
5	Priming	Reverse, from curled over edge of canvas

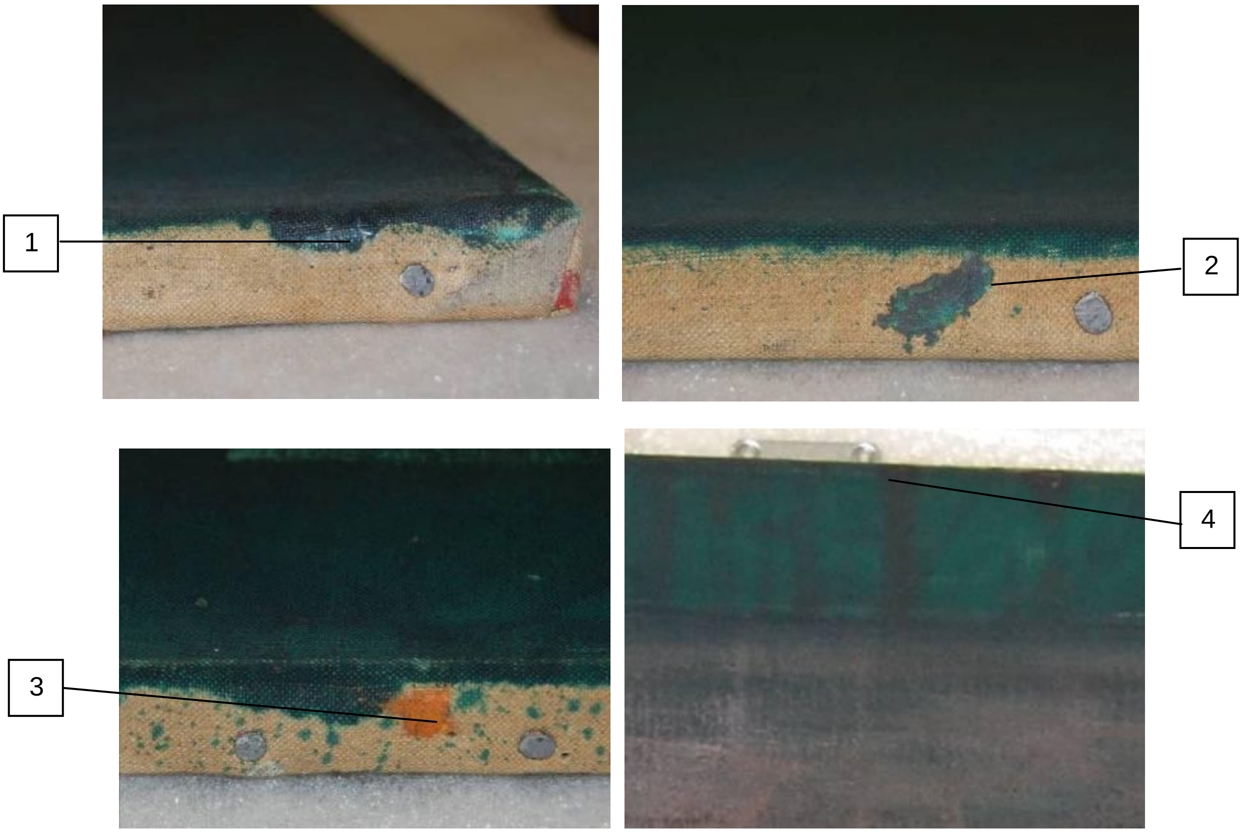
Notes

In Alley dated to1956-7 from Hanover Gallery records (oil on canvas 60 x 46 ¾ ").
Exhibited February-March 1957, Paris.

Figure E.11.1. Detail of forehead, showing wide brushstrokes with smears of white, red, blue and orange and thicker paint in upper part of forehead

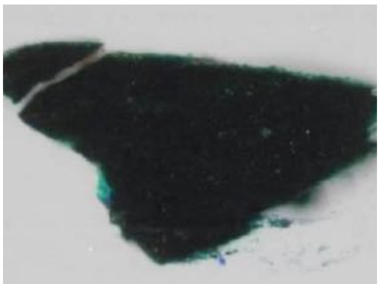
Figure E.11.2. Detail of upper right corner of interior, showing smears of orange

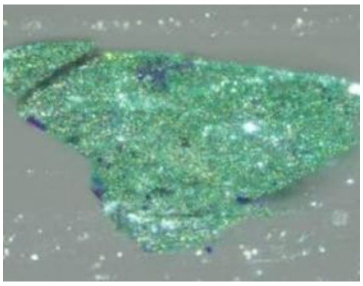
Sample sites



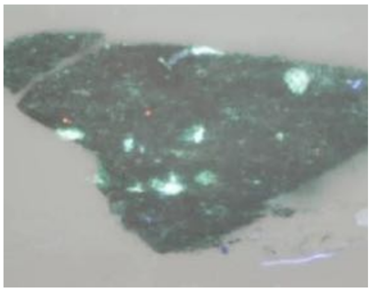
Cross sections

FB11-4 Purple/brown over green



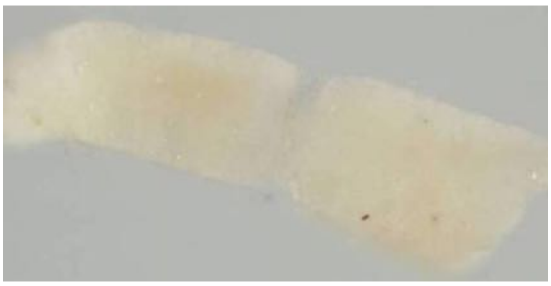


Normal light, left. Darkfield, right (taken at x200 magnification)

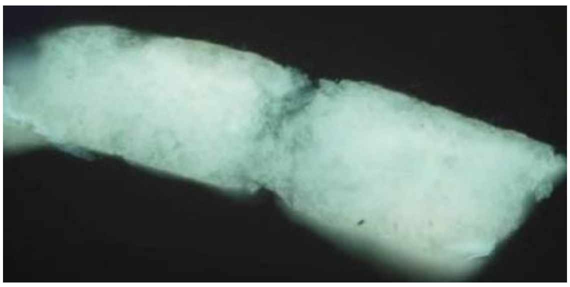


Ultraviolet (x200 magnification)

FB11-5 Priming



Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*sample*	*Analysis*	*Materials identified*
Dark green background	1	FTIR, GCMS	Oil (P/S = 2.85 Az/P = 0.55)
	1, 4	FTIR, SEM-EDX	Phthalocyanine green PG7
		FTIR, SEM-EDX	Barium sulphate
	4	SEM-EDX	Cadmium yellow
		SEM-EDX	Lead white
Green splodge	2	FTIR, GCMS	Oil (P/S = 4.95 Az/P = 1.10)
		FTIR, SEM-EDX	Emerald green
Orange splodge	3	FTIR, GCMS	Oil (P/S = 3.95 Az/P = 0.32)
		FTIR, SEM-EDX	Cadmium orange
		FTIR, SEM-EDX	Barium sulphate
		FTIR, SEM-EDX	Magnesium carbonate
Priming	5	FTIR, GCMS	Oil (P/S = 2.85 Az/P = 1.21)
		FTIR	Protein size
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Barium sulphate

Conclusions

An oil binder was found in all samples. The dark green stain is phthalocyanine green with some lead white and cadmium yellow also, which was applied to the whole canvas. Cadmium orange and emerald green were identified on canvas edges, but it is not known whether these were also used in the composition itself. The orange might be the same as that used in the face and for the box around the figure.

The commercial oil priming appears to have two layers with differing proportions of chalk and lead white, with a protein size layer.

Portrait of Henrietta Moraes on a Blue Couch

Identification details

Title: Portrait of Henrietta Moraes on a Blue Couch	*Date:* 1965
Dimensions (hxwxd): 198 x 147 x 2.1 cm	*Location/owner:* Manchester City Art Gallery

Marks/Inscriptions:

Writing on back on priming layer in black/blue pen: 'Portrait of Henrietta Moraes 1965'

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:

7-member softwood stretcher, mitred mortise and tenon joints. Outer stretcher members: 5.2 cm wide, 1.8 cm deep. Cross bars 5 cm wide, 1.4 cm deep.

Plainweave linen canvas 22 by 18 threads per cm^2.
Attachment is through grey metal tacks, spaced at 10-11 cm, 6-7 mm diameter

Paint and ground

Priming:
On reverse, off-white

Description:
The background is covered with a very thin paint layer, almost a stain on the canvas. Thin lines in grey/brown marking outlines can be seen in some places. The black-grey used for the background has a mottled effect, as though over-diluted (Figure E.12 2). The dark blue couch and pink stripes along the right edge are also very thinly painted. Some areas of bare canvas remain in the area of the blue couch. The door is grey, painted in thin watery strokes over a white underpaint layer. Bright yellow is used for the door handle, with a stroke of black/green smeared in for the modelling.

The figure is painted mainly directly on bare canvas, in a reserve within the blue couch, although it appears to overlap the blue in some areas, e.g. the hand (figure E.12.3). There is a patch of bare canvas to the right of the head. There may have been a slight change in position to the figure, as the lower part of the right leg, foot and shadow appear to have been painted over the blue of the couch, as an area of blue is visible in a break in the painting of the leg.

Smooth white paint is used in swirls of thick impasto on the figure. Black patches with a slightly gritty texture may have added sand. On the thigh sand appears to have been sprinkled on the paint, then stroked over smearing the sand into the pink/white paint. On an area of pale pink paint on the cheek/neck and on areas of white impasto, sand is sprinkled on as a surface layer and is visible as pale yellow grains. Deep red (alizarin shade) strokes on belly and between feet. Brighter red is used in a fine network over hand, face and feet (figure E.12.1). Texture from cloth used in some places – the stripes on the eye may be from a piece of corduroy fabric. And the imprint of a knitted cloth appears over the ear. Dribbles of a glossy greenish-black drip down the edge of the hair and above the forehead (figure E.12.1). The face is painted thickly with fairly gritty paint throughout.

Several vertical drips can be seen below the figure in the strip of bare canvas and on the blue of the couch.

Surface coatings/gloss

No coatings apparent. A few glossy drips over the forehead, slight sheen over more thickly painted areas, matt elsewhere.

Samples taken

No.	*Colour*	*Location*
1	Dark blue	Drip over right edge, 35 cm from bottom
2	Pink	Right edge, 33 cm from top
3	Pink-purple	Top edge, 7.5 cm from right edge
4	Grey over white	Top edge, 11.5 cm from right edge
5	Grey-black	Drip over top edge, 56.5 cm from left edge
6	Priming, off-white	Back of canvas

Notes

Labels on the back of the stretcher and on hardboard backing were not recorded.

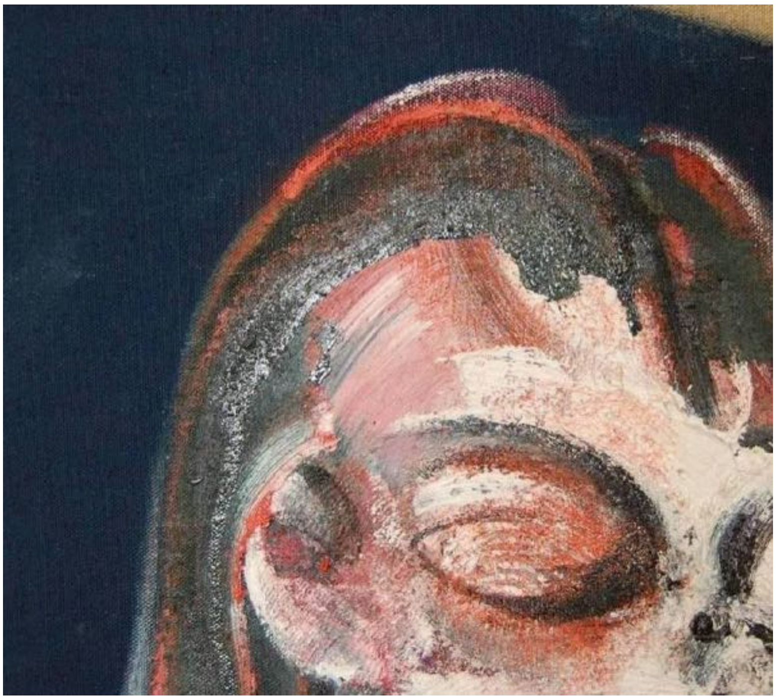


Figure E.12.1. Detail of head showing red/pink strokes at top of head, red printing over eye, and glossy black-brown paint on hair.

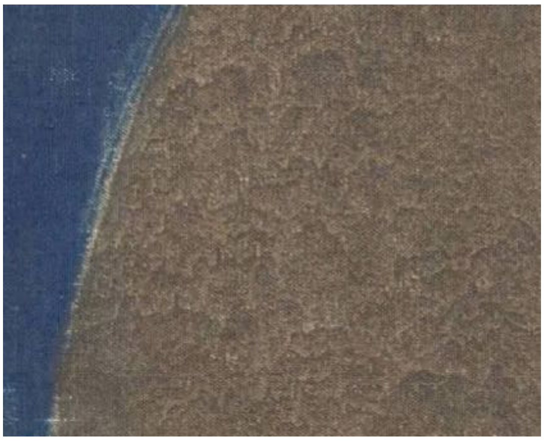
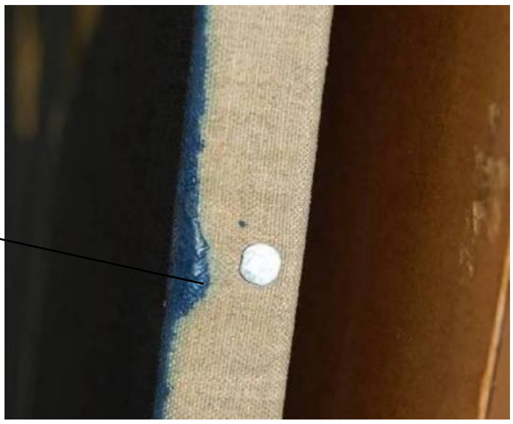


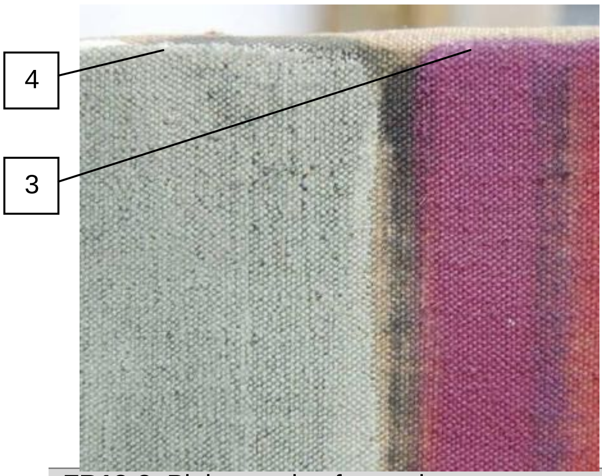
Figure E.12.2. Detail of grey/black background, showing rivulets caused by over-thinning of paint

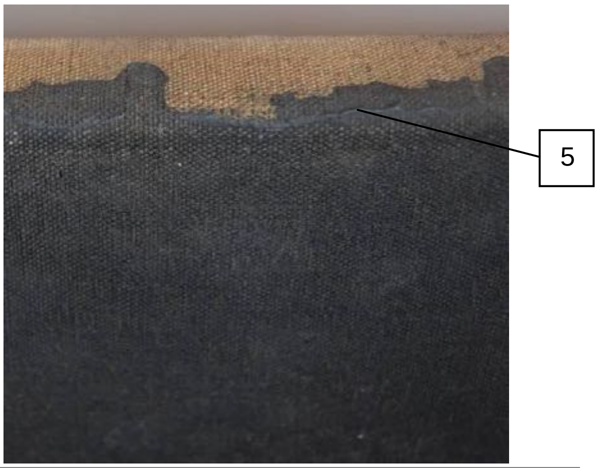
Figure E.12.3. Detail of hand painted over blue couch

1

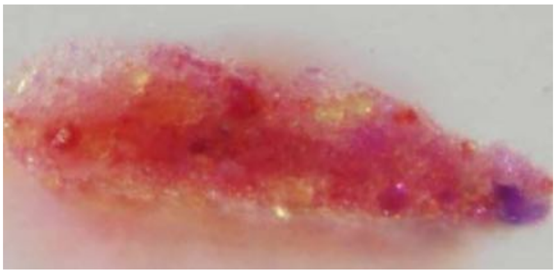


2

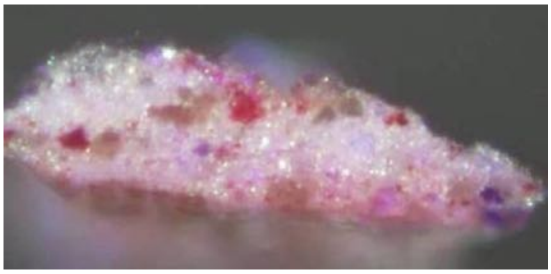




FB12-2 Pink scraping from edge



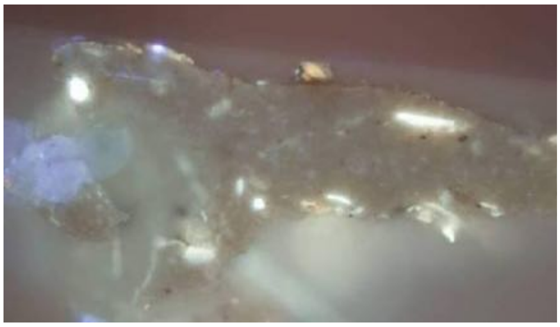
Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

FB12-4 Grey over white, top edge

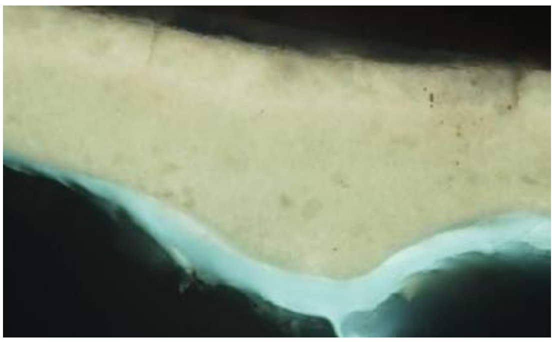
Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

FB12-6 Priming from reverse

Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

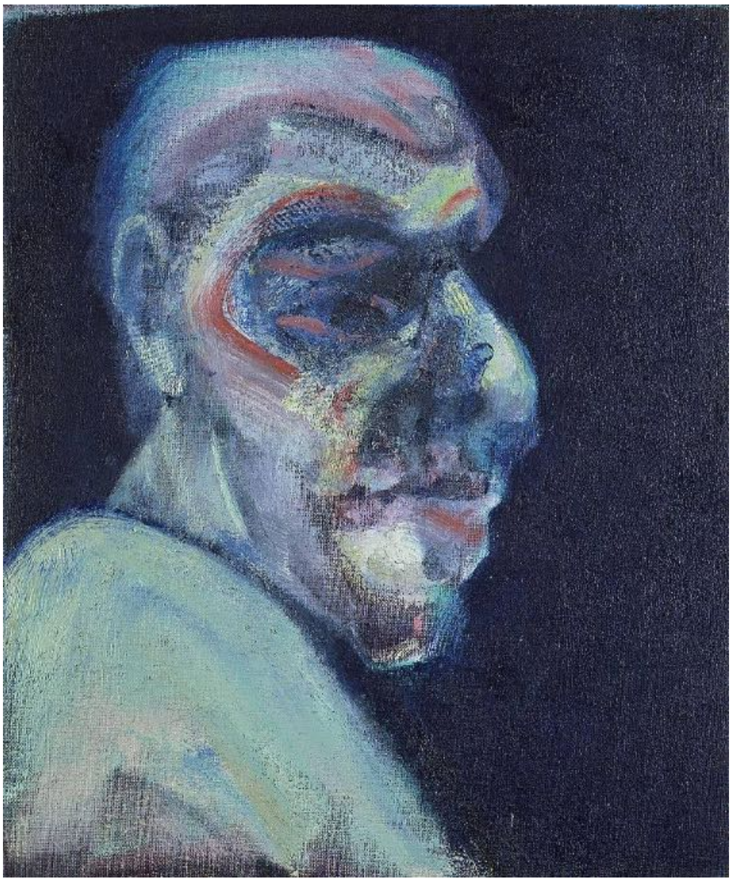
Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
White door	4	FTIR, PyGCMS	PVAc with 2-ethylhexyl acrylate
		FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Kaolin
Blue couch	1	FTIR, GCMS	Drying Oil (Az/P = 0.64, P/S = 1.84)
		FTIR, SEM-EDX	Prussian blue
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
Pink	2	GCMS	Drying Oil (Az/P = 0.24, P/S = 13.19)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Barium chromate
		SEM-EDX	Cobalt violet (arsenate & phosphate)
		SEM-EDX	Zinc white
		SEM-EDX	Vermilion
		SEM-EDX	Magnesium carbonate
Purple	3	GCMS	Drying Oil (Az/P = 0.60, P/S = 2.68)
		PLM, SEM-EDX	Cobalt violet (cobalt arsenate and phosphate)
		SEM-EDX	Zinc white
		FTIR, SEM-EDX	Magnesium carbonate
Black-grey	5	FTIR, GCMS	Drying Oil (Az/P = 0.53, P/S = 3.53)
		SEM-EDX	Carbon black (lamp black?)
Priming	6	FTIR, GCMS	Drying oil (Az/P = 0.65, P/S = 1.57)
		FTIR	Protein size layer
		SEM-EDX	Kaolin
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Lead white

Conclusions

All samples had an oil medium except for the white paint from the door (sample 4) which had a PVAc binder, likely to be a household paint. This paint contained principally titanium white, with kaolin filler, while pink and blue paints contained lead white. The pink contained a mixture of pigments including cobalt violet, barium chromate and vermilion. Both cobalt phosphate and arsenate were identified in samples containing cobalt violet.

The oil priming consists of two layers with lead white, titanium white and kaolin in the lower layer and mainly lead white in the upper layer. A protein size layer was identified by FTIR.

Head of a Man, no. 1, 1960



Photographer: James Austin

Identification details	
Title: Head of a Man no.1	*Date:* 1960
Dimensions (hxwxd): 38 x 31.7 x 1.9 cm (15 x12.5 x ¾)	*Location/owner:* UEA 34

Marks/Inscriptions:

Paper label left stretcher bar, printed: 'James Bourlet & Sons Ltd/Fine Art Packers, Frame Makers / M 5269 / 17&18 Nassau Street / Mortimer Street W' (any more writing obscured, under stretcher bar)

Chalk writing on canvas along back of top stretcher bar: 'SAINSBURY'

Support

Type: <u>Canva</u>s / Board / Paper / <u>Stretcher</u> / Strainer

Description:
Softwood 4-member, mitred mortise and tenon, member width 4.4 cm, depth approx 1.8 cm (bevelled)

Attachment through steel tacks, diameter 4-5mm, spacing 7-8cm. Canvas attached to back of stretcher also with tacks. Tack holes also through canvas and stretcher, from framing/backboard

Plainweave linen canvas 14 x 15 threads /cm^2. Edges cut as though with sharp tool, though not completely straight, slightly wavy. Canvas appears to have been cut down from a larger composition.

Paint and ground

Priming:
On reverse, originally white, now fairly yellowed

Paint:
The canvas has been stained all over with a dark purple coloured paint which extends under the head also. It appears to have been cut down from a larger canvas, as the stain goes all the way to edges. A pale yellow-pink line from the front of the shirt also continues over the bottom edge of the canvas. Strokes of fairly thick pale green and pink paint are used for the shirt, which mixes with dark blue (from the background?) at upper edge of shoulder.

Traces of a bright green used in the background is visible in places, which appears to have covered all the background area around the head, before being covered with blue, then black layer now visible (figure E.13.2). This black was applied last, as brush strokes can be seen outlining the features of the face. A stroke of fairly matt black paint is used along the front of the shirt, over gritty texture.

A mixture of thick and thin paint used in face, with stained canvas texture showing through in places. White impasto and thinner strokes of bright pink, bright yellow paint/pigment used in several areas. Ribbed texture printed on with cloth in several areas – over ear, eyebrow and nose (figure E.13.1). Small hairs stuck in the paint in several areas. Sand added in thicker areas of paint around eye and nose. Patch of more liquid blue on nose (figure E.13.1).

Surface coatings/gloss

Fairly matt overall, pale green used for shirt has slight gloss. Some glossier patches in black/blue used in face

Samples taken

No.	*Colour*	*Location*
1	Black over green	Right tacking edge, 7.7 cm from bottom
2	Pink-yellow stroke	Back, 9.8 cm from left, continued over from front, over dark layer (stain on canvas or from grey paint traces also in this area?)
3	Pale green	Left edge, 4.5cm from base. Paint rather brittle and flaky
4	Priming	From reverse of canvas, flake from edge

Notes

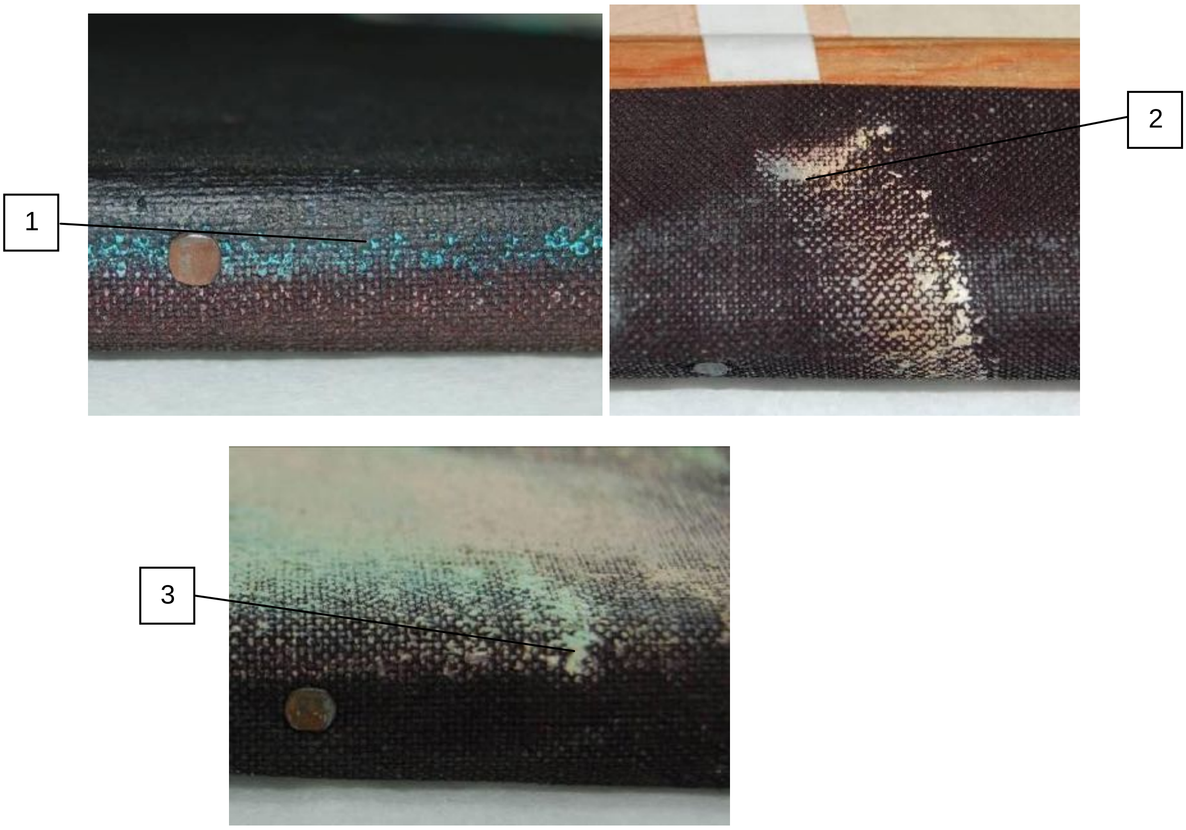
According to Alley this was one of a number of works painted in Bacon's Battersea studio in the period between returning from St Ives in mid-January 1960, up to the opening of the exhibition at Marlborough in March. It was included in exhibition 'Francis Bacon: Paintings 1959-60', Marlborough Fine Art, London, March-April 1960.[73]

[73] Alley, R., & Rothenstein, J. (1964) *Francis Bacon*. London: Thames & Hudson, p133-4.

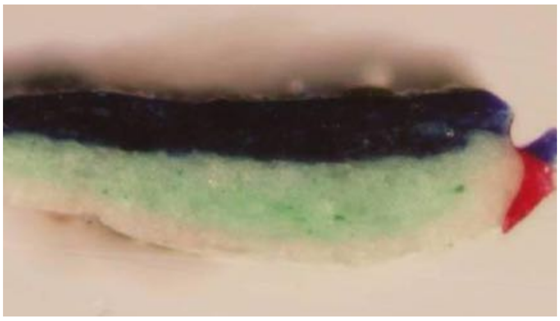
Figure E.13.1 Detail of face showing striped printing above eye and liquid blue paint on

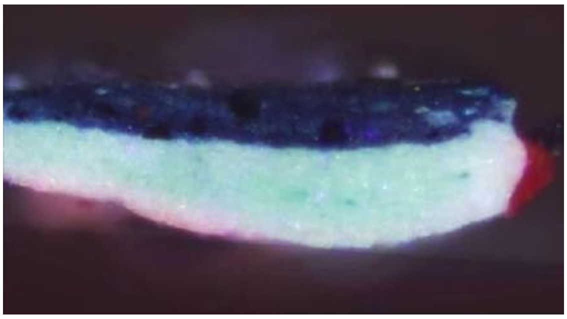
Figure E.13.2 Detail of top left corner, showing repainting of background

Sample sites



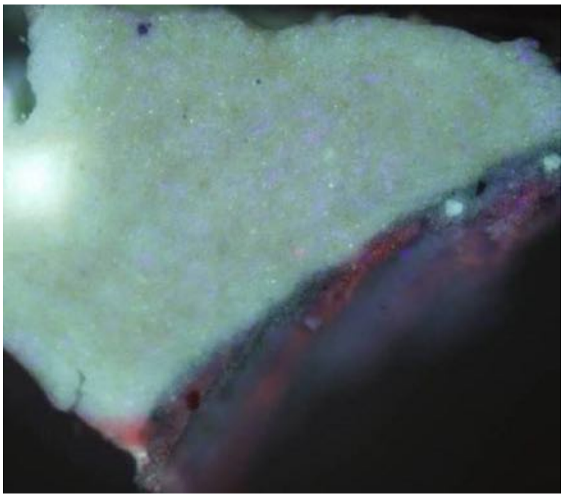
FB13-1 Black/dark blue over green


Normal light (taken at x200 magnification)

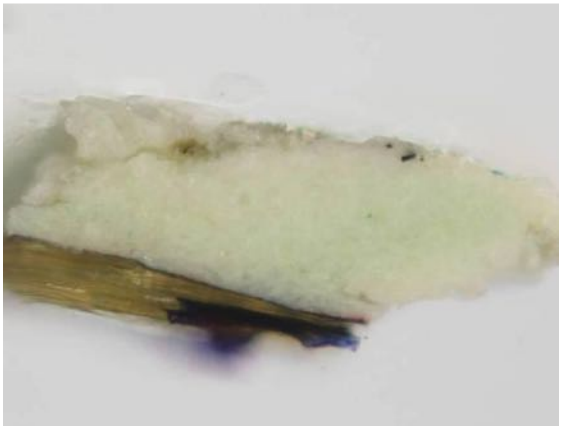

Ultraviolet (x200 magnification)

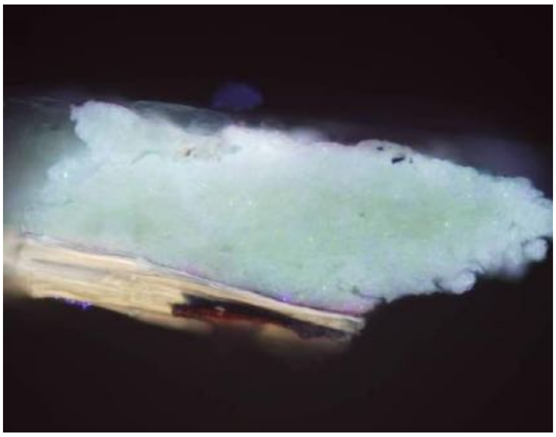
FB13-2 Pink-yellow stroke continued over from front


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB13-3 Pale green, left edge


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Black/blue background	1	FTIR, PyGCMS	Drying oil (Az/P = 1.16, P/S = 4.33)
		FTIR, SEM-EDX	Prussian blue
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
Pale green under background	1	FTIR, GCMS	Drying oil
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Alizarin
Pale pink/yellow	2	FTIR, GCMS	Drying Oil (Az/P = 0.36, P/S = 3.53)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Cobalt violet (phosphate)
Blue-grey	2	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Alizarin crimson?
		SEM-EDX	Magnesium carbonate
Pale green	3	FTIR, GCMS	Drying Oil (Az/P = 0.56, P/S = 3.24)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
Priming	4	FTIR, GCMS	Drying oil (Az/P = 0.68, P/S = 2.93)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk

Conclusions

All samples analysed appeared to have an oil medium. The ratios of the pale pink and pale green paints are similar, suggesting they are both mixed from the same white base, possibly with a semi-drying oil such as poppy. Lead white was also found in all samples, in combination with a little zinc white (a common mixture in commercial lead white paints).

The dark red/purple stain on the canvas was not really seen in cross sections, as this is absorbed right into the canvas, but particles of alizarin were thought to be present on the bottom of some samples from this staining layer. Another darker pigment is also likely to be present in this layer, from the observed colour. The canvas was first stained this dark purple colour, similar to that used in some pope paintings. The background then appears to have been painted white, then green, then blue-black. The white layer may have been used as an underpaint so that the background colour could be changed to a bright green, a colour which Bacon appears to have used often at this date. He may then have changed his mind, choosing a dark blue-black. The first staining layer, and at least some of the painting of the head was completed before the canvas was cut down, but all the subsequent background layers were applied after the canvas was transferred to its present stretcher.

The commercial oil priming consists of two layers with a high proportion of chalk filler in the lower layer and largely lead white in the upper layer.

Head of a Woman, 1960

Photographer: James Austin

Identification details	
Title: Head of a Woman	*Date:* 1960
Dimensions (hxw): 85.2 x 85.2 cm	*Location/owner:* Robert and Lisa Sainsbury Collection, University of East Anglia (UEA 36)

Marks/Inscriptions:

Paper label top stretcher bar, printed: 'James Bourlet & Sons Ltd/ Fine Art Packers, Frame Makers / M 5269 / 17&18 Nassau Street / Mortimer Street W / Phones:- Museum 1871 & 7588

Paper label top stretcher bar, printed: 'FRANCIS BACON / Paintings 1959-60/ 23 March-22 April 196 Cat no. 30 / 17/18 Old Bond Street, London W1'

Paper label, left stretcher bar: 'J. Bomford Esq. /"Laine"/ Aldbourne/Wilts'

Pencil, top stretcher bar: 'Sainsbury'

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
Softwood 4-member, mitred mortise and tenon, member width 5.3 cm, depth approx 1.5 cm (bevelled)

Attachment through steel tacks, diameter 5mm, spacing 7.5-9.5 cm. Canvas attached to back of stretcher also with tacks. Small holes through canvas and stretcher, from framing/backboard

Plainweave linen canvas 14 x 15/14 threads /cm^2

Paint and ground

Priming:
On reverse, originally white, now quite yellowed

Paint:
Canvas has been stained all over with bright green, very thin layer. Green overlaps slightly onto all edges, more so along bottom edge. A square of thin black paint is painted over this, around figure.

Thin white layer used for clothing, with thin strokes of dry pink material (pastel?) at edges (figure E.14.2). Blue-grey paint used at neck for shirt, and also outlining hair

Thin black used for hair and outlining face. Swirls of pink, grey and pale blue used on face, one large sweep of the brush forms the eye socket and cheek (figure E.14.1). In places there is a rather sticky appearance in the pink, with glossy surface. Several small hairs stuck in paint. Vertical line of black hairs particularly down lower centre of face – possibly dust or fibres from cloth. Texture on centre of forehead above eye which may be from cloth pressed into paint, or from stippling with brush (figure E.14.3).

Splodges of thick pink paint adhered on bottom turnover edge, which appears to have sand/grit particles pressed into the surface.

Surface coatings/gloss

Matt over much of surface where canvas is only stained, white has slight sheen, pink flesh is fairly glossy in places.

Samples taken

No.	*Colour*	*Location*
1	Green	Bottom edge, scraping from tack head, 2.5 cm from left
2	Opaque green	Bottom edge, 7.2 cm from right
3	White	Bottom edge, 38.5 cm from left
4	Pink – pale pink, bright pink and grit	Bottom edge 33.2 cm from left
5	Priming	From reverse of canvas, flake from bottom edge 7 cm from proper right
6	Loose fragments of gritty green	From bottom edge?

Notes

This work was completed in Bacon's Battersea studio in the period between returning from St Ives in mid January up to opening of exhibition at Marlborough in March ('Francis Bacon: Paintings 1959-60', Marlborough Fine Art, London, March-April 1960). This was based on the wife of one of the artists there, done from memory. Two other green paintings of the same subject (Alley 160 &161) were also done at this time, one with a very similar composition – Head of a Woman, 1960, 35 x 26 ⅞ in / 89 x 68.5 cm.[74]

[74] Alley, R., & Rothenstein, J. (1964) *Francis Bacon*. London: Thames & Hudson, p129

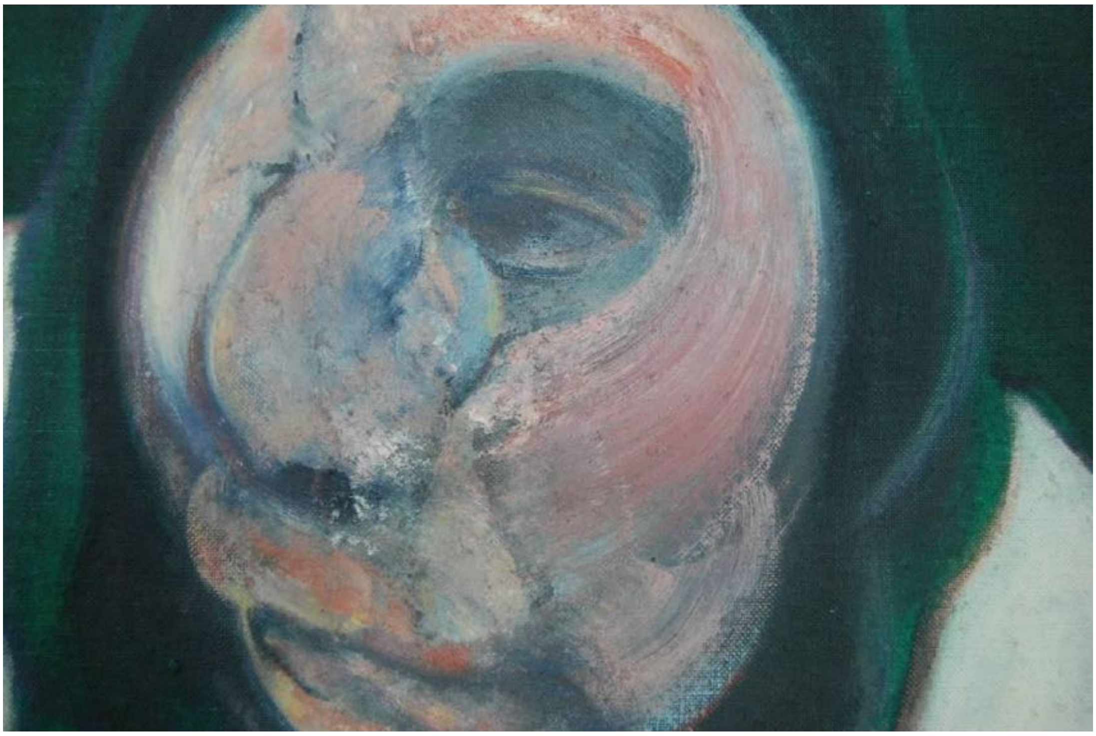


Figure E.14.1 Detail showing sweep of pink paint on cheek

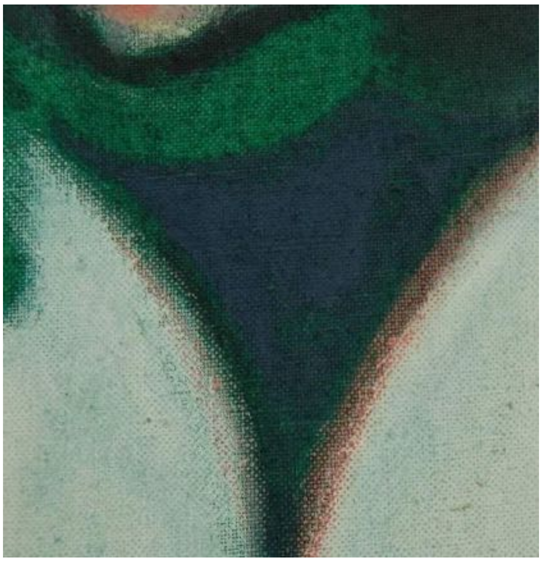


Figure E.14.2 Detail showing green ground colour exposed at neck and thin dry pink strokes at edge of white top

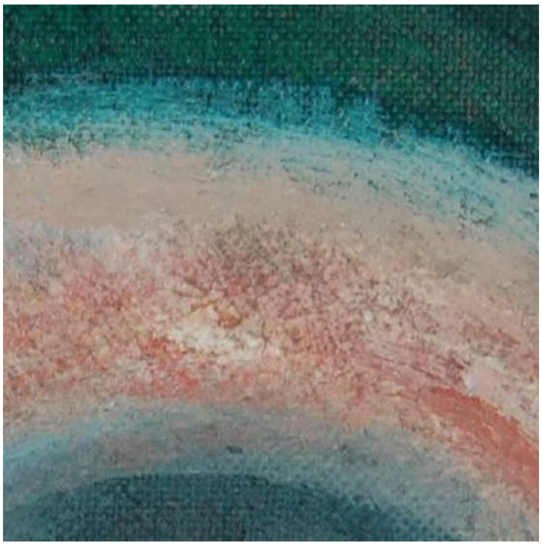
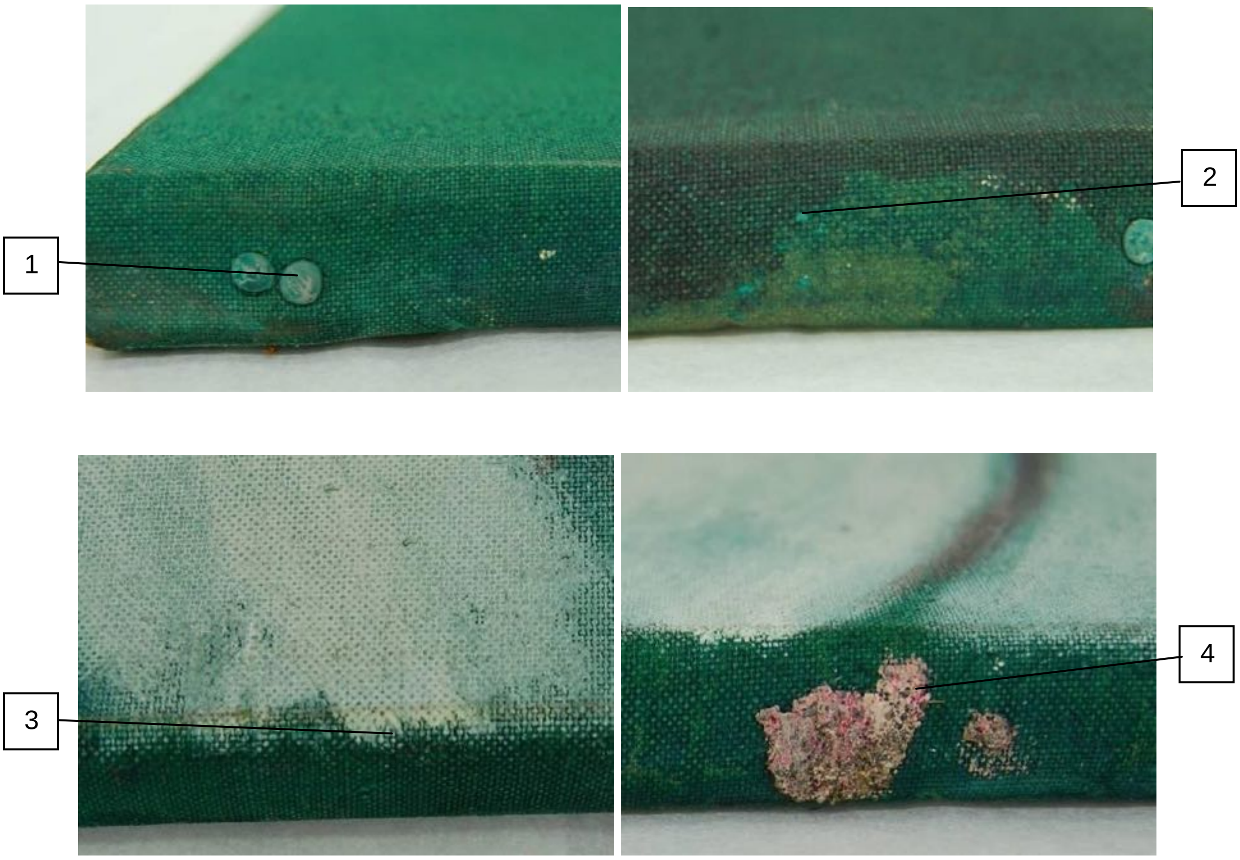
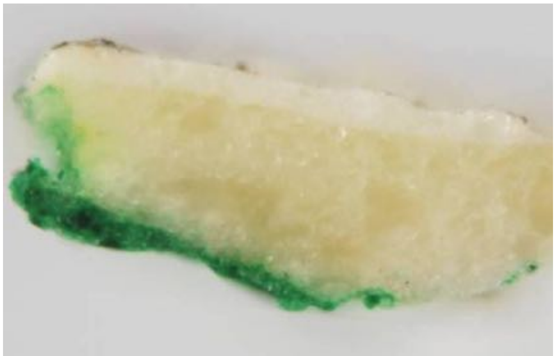
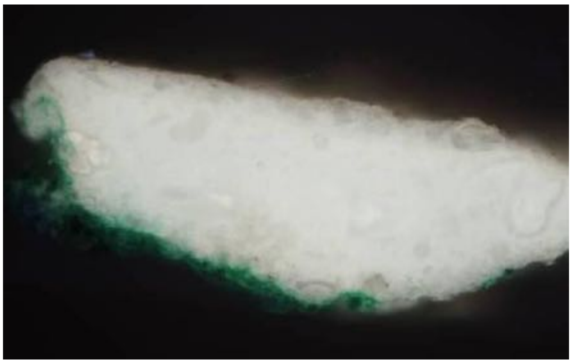


Figure E.14.3 Detail showing texture on forehead



FB14-5 Priming from reverse


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Green background	1	SEM-EDX	Phthalocyanine green PG7
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
Opaque green	2	FTIR	Drying Oil
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Phthalocyanine green PG7
		SEM-EDX	Zinc white
White	3	FTIR, GCMS	Drying Oil (Az/P = 1.37, P/S = 2.29)
		FTIR	Lead white
Pink	4	FTIR, GCMS	Drying Oil (Az/P = 1.37, P/S = 3.86)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		FTIR, SEM-EDX	Barium sulphate
		SEM-EDX	Silica/sand
		SEM-EDX	Cadmium red (sulpho-selenide)
Priming	5	FTIR, GCMS	Drying oil (Az/P = 1.40, P/S = 2.63)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Barium sulphate
Green loose piece	6	FTIR, SEM-EDX	Silica
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Phthalocyanine green

Conclusions

An oil medium was found in all samples, and lead white pigment, usually with a little zinc white (a common mixture in commercial lead white paints).

Phthalocyanine green was identified in the background, probably Winsor & Newton’s ‘Winsor green’ which is mentioned in several notes in Bacon’s hand. The pink paint on the bottom edge was found to contain lead white, zinc white and cadmium red. This paint may be the same as that used in the flesh, although this cannot be confirmed. The pink in the face is similar in colour but slightly more glossy in appearance. Large particles of silica/sand were identified in two samples thought to be from the bottom edge, but may have been picked up accidentally by the wet edge of the painting being leaned against a gritty surface. No sand was evident in the painting of the face or elsewhere in the composition.

The commercial oil priming consists of two layers with a high proportion of chalk filler in the lower layer and largely lead white in the upper layer.

Three Studies for a Portrait of Isabel Rawsthorne, 1965

Identification details

Title: Three Studies for a Portrait of Isabel Rawsthorne	*Date:* 1965

Dimensions (hxwxd): 35.6 x 30.5 cm	*Location/owner:* Robert and Lisa Sainsbury Collection, University of East Anglia (UEA 37)

Marks/Inscriptions:

Left Panel:
Inscription by Bacon on priming layer on back in black pen/pencil: ‘3 Studies for Portrait of Isabel Rawsthorne 1965’
Pencil, on canvas over bottom stetcher bar, right of centre: ‘1’

Centre Panel
Pencil, on canvas over bottom stetcher bar, right of centre: ‘2’

Right Panel
Pencil, on canvas over bottom stetcher bar, right of centre: ‘3’

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:

All three canvases appear to be the same, details taken mainly from left panel:
Softwood 4-member, mitred mortise and tenon, member width 2.9 cm, depth approx 1.4 (bevelled)

Attachment through pale grey metal tacks, 6-7 mm diameter, spacing 8.5-11 cm (4 tacks on each side). Canvas attached to back of stretcher also with dark grey steel tacks, diameter 4mm, spacing 11-12 cm.

Plainweave linen canvas 16-8 x 22 threads cm. There is a small pinhole in all 4 corners of each canvas, approx 1mm diameter.

Paint and ground

Priming:
On reverse, originally white, now fairly yellowed

Paint description:
Left panel:
Thin red-pink stain applied over whole canvas, over which head is painted. Thin dark green applied over red to form background, in places green is thinner, so red shows through a little. Green colour is more apparent where this crosses over onto the white used at the collar. Strokes of white and purplish-pink mainly used to form face, with some strokes of green. A bright red has been used over white in many areas, in many places faint patterning suggests it was applied using a textured cloth. In some areas the red is caught on raised fibres standing up above the picture plane. There are also several peaks of white raised impasto, meaning the surface is fragile and should not be placed face down. The hair is formed from the background colour, with strokes of orange/red, brown and green. Raised fibres show up particularly in the background, from roughened canvas (in all panels).

Centre panel:
Thin red-pink stain over whole canvas, over which head is painted. Thin dark green applied over red to form background. Strokes of white and purplish-pink mainly used to form face, with stroke of dark green at top of forehead. Purple-pink appears to have been used fairly liquid. Sharp raised peaks of impasto in white at centre of forehead. A bright red has been used over white in many areas, on eye, nose and chin. A ribbed texture can be seen in several places, pressed into white paint and also made with bright red printing. Red appears to have fairly matt surface. Black spot at left of cheek and black oval on bridge of nose. Eyes outlined in black. Broken strokes of dry pink paint used at neck. The hair is formed from the background colour, with strokes of orange, brown and green.

Left Panel:
Thin red-pink stain over whole canvas, over which head is painted. Thin dark green applied over red to form background. Green was painted after head, as this crosses over onto chin in one place. Strokes of white and pink mainly used to form face, with stroke of dark green curving round cheek in front of ear. A bright red has been used over white in many areas of the face and neck. Thick strokes of white around eye-socket has a texture with many raised peaks, as though a textured material was pressed into the wet paint then pulled away perpendicular to the surface. A ribbed texture can be seen in the application of the bright red in several places. Eye outlined in black with white highlight on iris. Broken strokes of dry pink paint and white used at neck. The hair is formed from the red background colour, with strokes of orange and brown.

Surface coatings/gloss

Fairly matt throughout. Slight glossy sheen in pink-purple used in face (in central panel particularly).

Samples taken

No.	*Colour*	*Location*
1	Bright red scraping	Left panel, splash over priming on back, 15.8 cm from top, 3.5 cm from proper left.
2	Priming	Left panel, reverse of canvas, flake from bottom edge 5.5 cm from proper left
3	Pink background	Left panel, top tacking edge, 10.2 cm from right
4	Green background	Left panel, top tacking edge, 8.8 cm from right
5	Green over pink	Centre panel, top tacking edge, 11 cm from right
6	Pale pink smear	Centre panel, bottom tacking edge, 16.2 cm from left

Notes

Examination shows the assured brushwork and economy with which these works are produced. The initial pink stain on the canvas is used as the base colour for both the head and hair. The head is built up in strokes of thick pale pink and white paint. Clear strokes made with a wide brush are used to create the contours of the face (figure E.15.3), with darker pink, green and black used wet-in-wet so that colours blend on the canvas forming a gradation of colour (fig E.15.2). Fabric printing using bright red paint is applied, before some final touches are added, such as the dark red stroke on the neck (fig E.15.1). Narrow strokes of thin dark paint are used to form the hair. The thin dark green is applied at a late stage to give the outline of the head. This gives a rich dark background, especially when the paintings are viewed behind glass, when the green colour is much less apparent.

Figure E.15.1 Detail of red fabric printing on chin, central panel. It appears the whole area was printed with bright red before the dark red stroke was made across neck

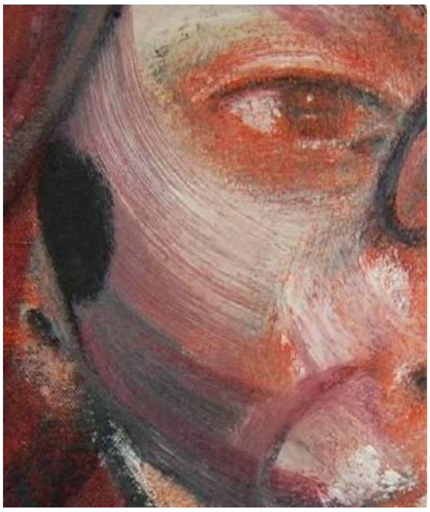


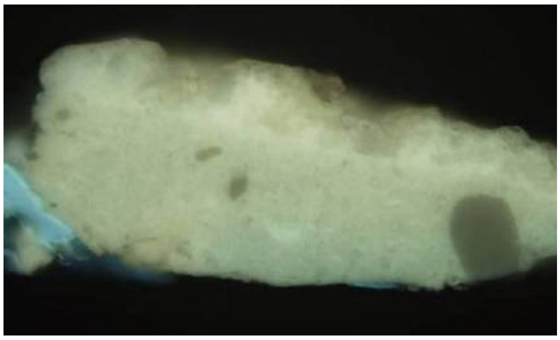
Figure E.15.2 Detail of face, central panel, showing blended colour across cheek

Figure E.15.3. Right panel, detail of face, showing sweep of white around eye with red printing, thin stroke of green extending from hairline.

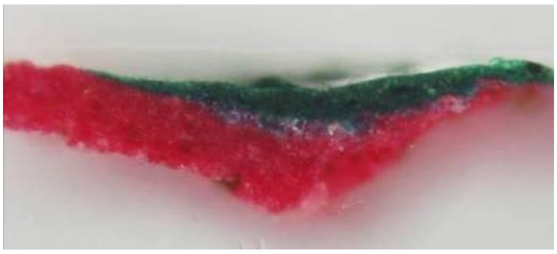
Sample sites

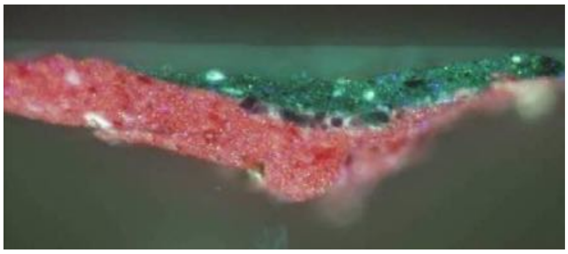
FB15-2 Left panel. Priming from reverse


Normal light (taken at x200 magnification)

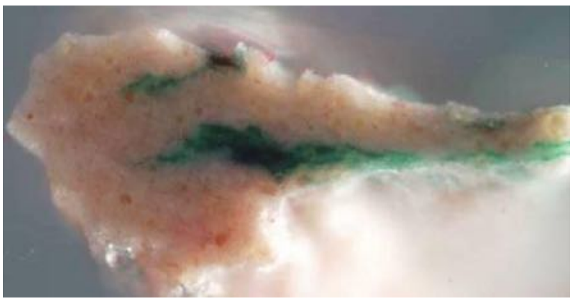

Ultraviolet (x200 magnification)

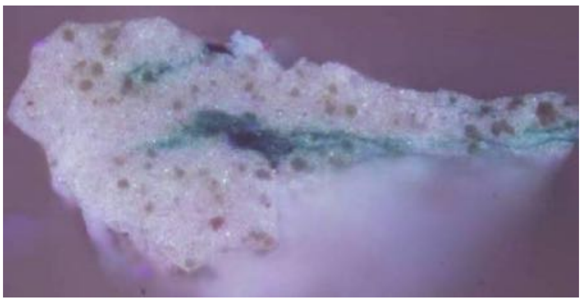
FB15-5 Centre panel, Green over pink from background, top edge


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FB15-6 Centre panel, pink flesh, bottom edge


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Red	1	SEM-EDX	Vermilion
		SEM-EDX	Magnesium carbonate
Priming	2	FTIR, GCMS	Drying Oil (Az/P = 1.25, P/S = 2.16)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Titanium white
		SEM-EDX	Kaolin
		SEM-EDX	Barium sulphate
Pink	3	FTIR, GCMS	Drying Oil (Az/P = 0.94, P/S = 5.03)
	3, 5	FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Alizarin crimson (PR83)
		SEM-EDX	Cobalt violet (arsenate)
Dark green	4	FTIR, Py-GCMS	Drying Oil (Az/P = 0.14, P/S = 1.90)
		FTIR	Magnesium carbonate
		FTIR	Prussian blue?
	4, 5	FTIR, SEM-EDX	Phthalo green (PG7)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Barium sulphate
Pink-green	6	FTIR, GCMS	Oil (Az/P = 0.92, P/S = 4.18)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Barium chromate
		SEM-EDX	Vermilion
		SEM-EDX	Zinc white
		SEM-EDX	Phthalo green

Conclusions

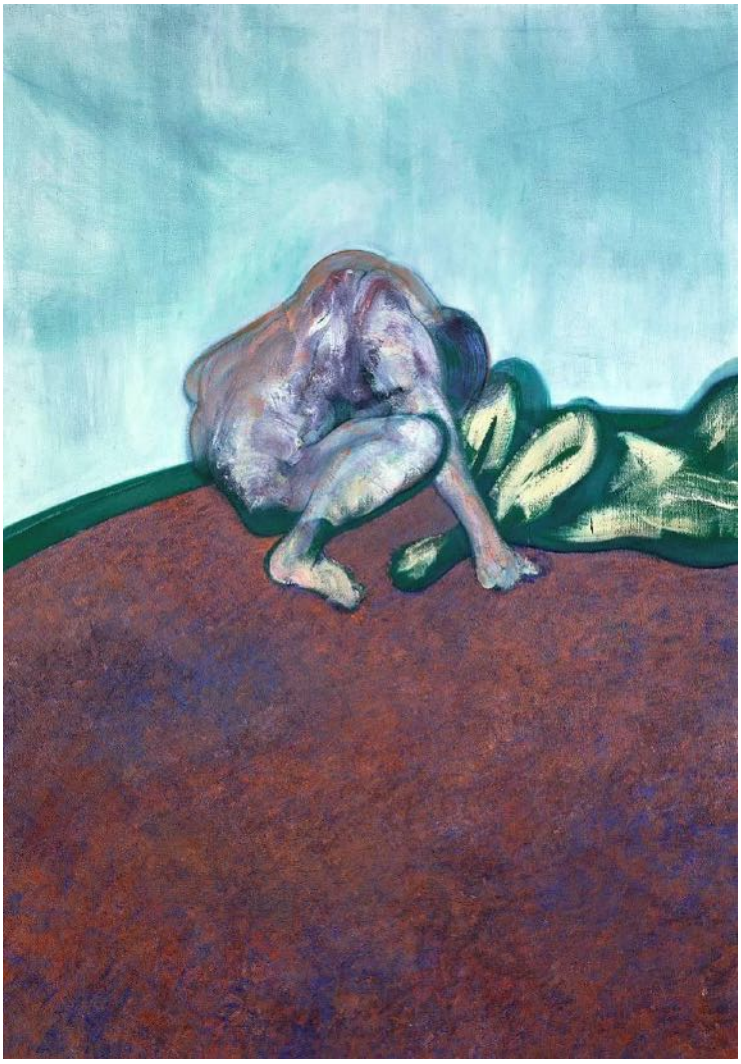
An oil medium was found in all samples analysed. Lead white was a component in most samples, usually with a little zinc white (a common mixture in commercial lead white paints). Alizarin crimson was identified as the principal ground colour, with phthalocyanine green applied on top, probably Winsor & Newton's 'Winsor green'. These two colours are noted down together by Bacon on two separate notes found in the studio, so may have been a commonly used combination to make a dark background. One note, part of a list of ideas written on the endpapers of Eadweard Muybridge's The Human Figure in Motion, says: '3 versions of the Landscape with dark background / alizarin crimson & windsor [sic] green'[75]

The pale pink paint on the bottom edge (s6) was found to contain lead white, zinc white, barium chromate (lemon yellow) and vermilion. This paint is likely to be the same as that used in the flesh, as it appears very similar. The green swirls in this sample appear to be the same as the paint in the background. The bright red smear on the back also contained vermilion, and this colour may have been used to print the bright red over areas of the faces.

The commercial oil priming consists of two layers with largely lead white in the upper layer, and lead white with titanium white, kaolin, barium sulphate in the lower layer over a protein size layer.

[75] Dublin City Gallery The Hugh Lane Archive, RM98F198:2

Two Figures in a Room, 1959



Photographer: James Austin

Identification details		
Title: Two Figures in a Room		*Date:* 1959
Dimensions (hxwxd): 198 x 142 x 2.2 cm (78 x 56 in)	*Location/owner:* Robert and Lisa Sainsbury Collection, University of East Anglia (UEA 33)	
Marks/Inscriptions: Top stretcher bar, pencil: 'UEA 33' Numerous labels attached to stretcher from past exhibitions		

Support
Type: Canvas / Board / Paper / Stretcher / Strainer
Description: Softwood 6-member (horizontal and vertical cross-bars), mitred mortise and tenon, outer member width 6 cm, depth approx 1.5 cm (bevelled) cross-bars width 6.3 cm, depth 1.2 cm. Plainweave linen canvas 14 x 14/15 threads /cm^2.

Attachment through pale grey metal tacks, diameter 5-6mm, spacing 6-9 cm. A second set of tack holes on all sides indicate the canvas has been re-stretched, but many tacks along bottom edge have green paint splashes, implying the canvas was re-stretched before the green stain was applied (or the same tacks were reused). The canvas in and around the old tack holes is also stained green, suggesting the stain was applied when no tacks were in the first set of holes. Canvas attached to back of stretcher with same type of tacks. Small holes also through canvas and stretcher, from framing/backboard.

Paint and ground

Priming:
On reverse, off-white mottled appearance

Paint description:
The canvas has been stained all over with thin green layer, this overlaps particularly onto the bottom edge – may have dripped down canvas. Thin white layer used in upper background, patchily applied leaving green showing through in places, some raised fibres visible. A thin curved line can be faintly seen across the top of the picture, marking a curved ceiling. Thick stippled pink/purple used in lower background, many fine raised peaks of paint, may have been done using rags, some areas have a finer, more regular texture. Some patches of white material within this area also. Paint surface is slightly flattened along bottom edge – may have been framed while paint still wet. Some scratches into paint at bottom edge also made while wet. The green stain is left uncovered between upper and lower areas of background, strengthened with a more opaque green in some places. At the left side a stroke of green appears to have been used over the white to slightly raise this boundary (figure E.16.1).

The figures are painted over the green canvas – the right hand figure is made with several strokes of dry yellowish flesh paint, sand scattered on top in some areas (figure E.16.3). The left hand figure is much more extensively worked, with pink, white and purple paint. Strokes of a more opaque green are used in places. A fine textured pattern is seen in areas of the figure (figure E.16.2), particularly in white paint (similar to some of patterns seen in background). Some parallel marks – made by teeth of comb? Sand mixed into paint in some areas, particularly in leg and foot, some pale coloured sand sprinkled on top of calf, some partly mixed into paint. Pink strokes used at left side of figure appear fairly glossy.

Surface coatings/gloss

Thicker paint has slight sheen, pink is fairly glossy in places.

Samples taken

No.	*Colour*	*Location*
1	White plus trace of green	Top edge, corner of tacking margin, 20.8 cm from right
2	Pink background	Right edge , 88.3 cm from bottom
3	Purple background	Left edge, 15.6 cm from bottom
4	Green scraping	Bottom edge tacking margin, 15 cm from left
5	Priming	From reverse of canvas, flake from folded back edge

Notes

This appears to be an early example of figures placed in a curved interior space formed from blocks of colour, which become a particular feature of Bacon's work. A faint curved line can be seen towards the top of the canvas, showing this might have been originally intended to have a low ceiling, like those seen in *Triptych Inspired by Sweeney Agonistes*, 1967. A similar curved line can be seen more clearly in the closely related *Lying Figure*, 1959 (Alley 148)[76].

[76] Alley, R., & Rothenstein, J. (1964) *Francis Bacon*. London: Thames & Hudson, p120.

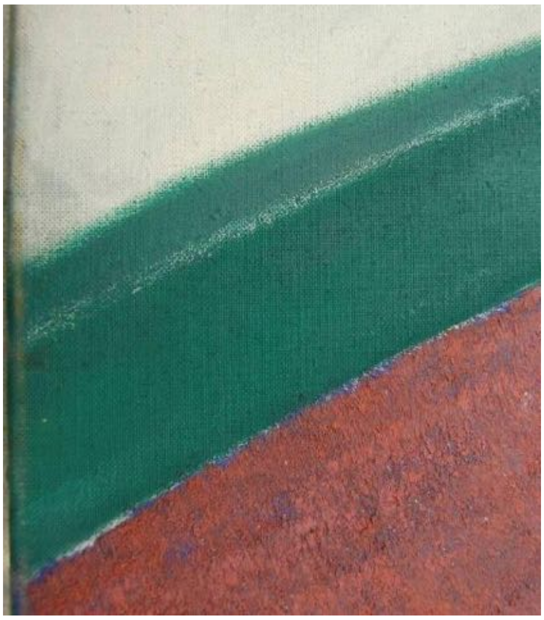
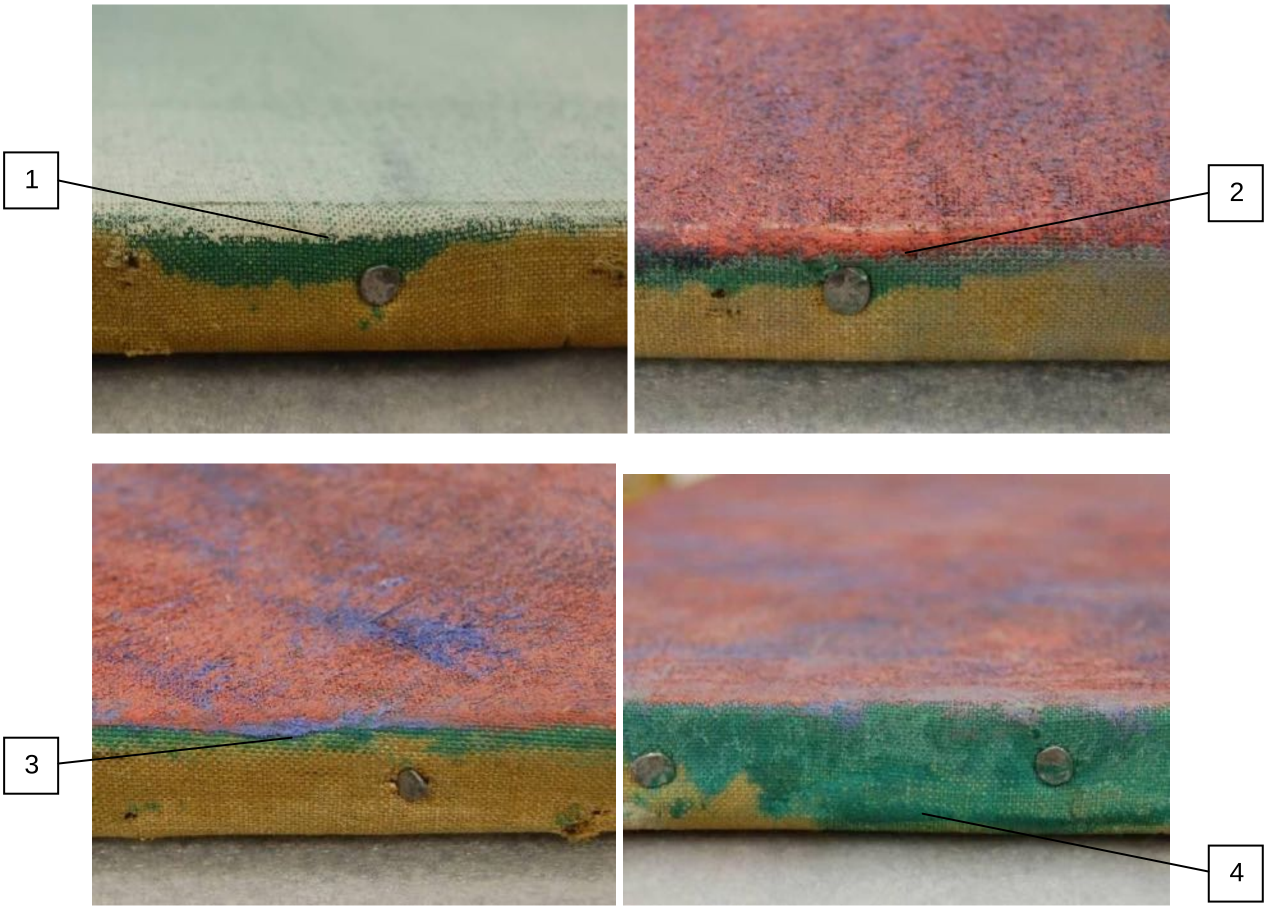


Figure E.16.1 Left edge showing green line painted over white to raise boundary

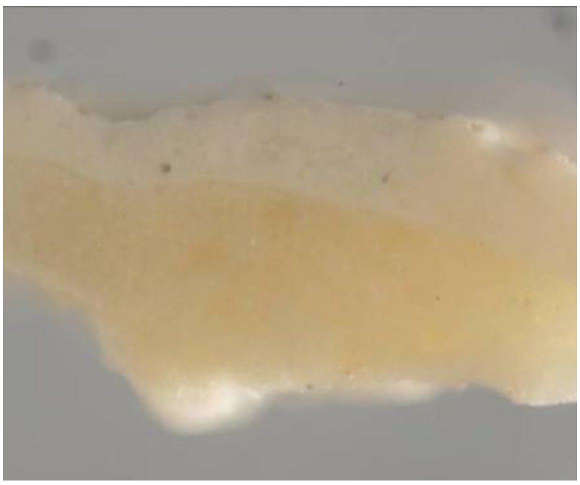
Figure E.16.2 Detail of knee, showing fine texture

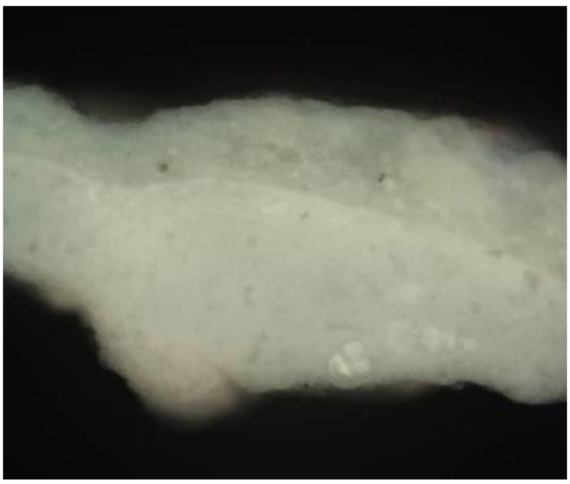
Figure E.16.3 strokes of yellowish flesh paint over green stain in right hand figure, with sand scattered on top

Sample sites



FB16-5 Priming from reverse


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
White background	1	FTIR, GCMS	Drying Oil (Az/P = 1.06, P/S = 2.97)
		FTIR	Lead white
Pink	2	FTIR, GCMS	Drying Oil (Az/P = 1.35, P/S = 2.19)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Ultramarine
		SEM-EDX	Pink/red organic pigment
Purple	3	FTIR, GCMS	Drying Oil (Az/P = 0.97, P/S = 1.80)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX, PLM	Ultramarine
Green	4	FTIR, GCMS	Drying Oil (Az/P = 0.87, P/S = 2.23)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Phthalocyanine green
		FTIR, SEM-EDX	Barium sulphate
Priming	5	FTIR, GCMS	Drying oil (Az/P = 1.18, P/S = 2.21)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Barium sulphate

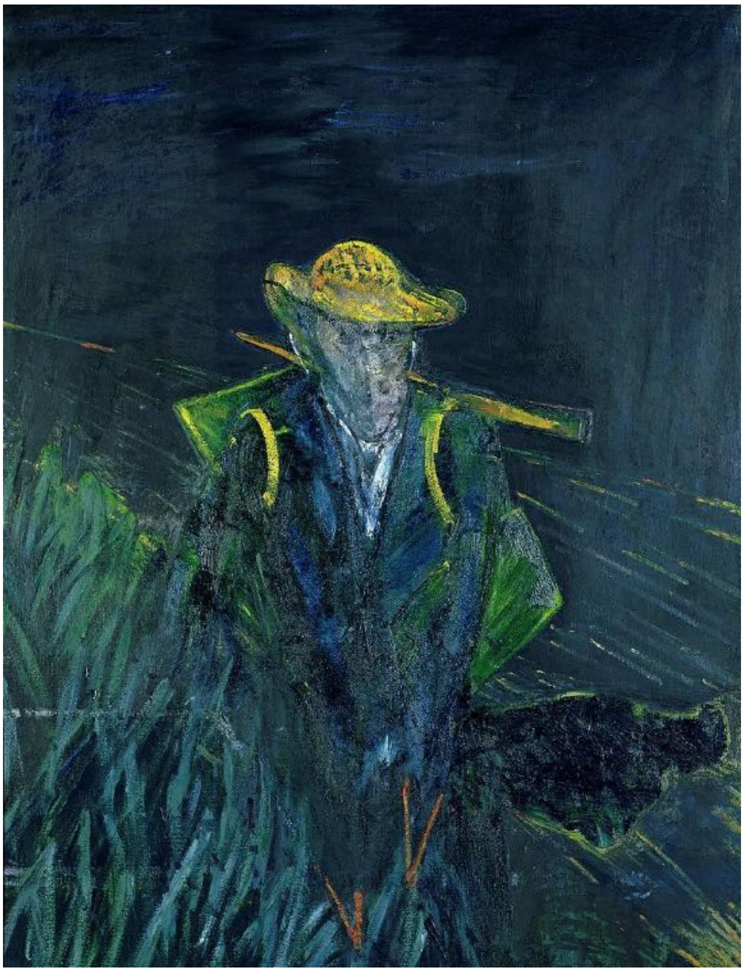
Conclusions

An oil medium was found in all samples analysed, with lead white pigment, usually with a little zinc white (a common mixture in commercial lead white paints).

Phthalocyanine green with lead white was used to stain the whole canvas initially, probably Winsor & Newton's 'Winsor green'. Ultramarine and lead white were identified in the pink-purple background colour, but another red/pink pigment could not be identified. This appears to be an organic pigment, present at low concentration.

The commercial oil priming consists of two layers with largely lead white in the upper layer, and lead white with a large amount of chalk extender and a little barium sulphate in the lower layer.

Study for a Portrait of Van Gogh I, 1956



Photographer: James Austin

Identification details	
Title: Study for a Portrait of Van Gogh I	*Date:* 1956
Dimensions (hxwxd): 152 x 115.6 x 2.3 cm	*Location/owner:* Robert and Lisa Sainsbury Collection, University of East Anglia (UEA31)

Marks/Inscriptions:

Paper label on horizontal crossbar: 'Deliver to – / Robert Sainsbury Esq. / 5, Smith Square / Westminster, S.W.I'

Paper label on horizontal crossbar: 'Francis BACON (1910-) / Study for Van Gogh / oil on canvas: Im.52 x Im.I8 / Collection: Mr. & Mrs. R. Sainsbury/ THE HANOVER GALLERY / 32A ST GEORGE ST. LONDON W1 MAYFAIR 0296

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:

Softwood 6-member (horizontal and vertical cross-bars), mitred mortise and tenon, outer member width 6.1 cm, cross-bars width 6.2 cm

Plainweave linen canvas 16 x 21 threads /cm^2. Selvedge along right side

Attachment through grey metal tacks, diameter 4-5 mm, spacing 10-13 cm. Canvas attached to back of stretcher also with similar tacks and staples. Small holes also through canvas and stretcher, from framing/backboard.

Paint and ground

Priming: On reverse

Paint description:
Thickly painted canvas. Dark blue/black used over upper background, with traces of other colours from earlier layers at edges. Paint is very thick in figure and shadow, paint appears to have been scraped away around edges of figure to give relief effect.

Dark blue staining layer appears to have been used over the canvas in the lower part of the painting, over thin green layer? (green and blue staining visible along bottom edge). Strokes of thick green-blue are seen over this forming grass, with some thick blue/black diagonal strokes (like wire fence in some animal studies, figure E.17.4). There is a horizontal white framing line in bottom left – background paint much thicker above this. Brighter yellow-green towards top of thicker area, shows signs of paint being scraped away here unevenly when semi-dry, leaving rough edges (figure E.17.2). Upper background is black/blue, with many fine parallel drying cracks, showing white/blue beneath (figure E.17.3).

Main part of figure is extremely thick and glossy (figure E.17.1), with gritty texture, probably from added sand. Strokes of yellow used for straps and hat quite matt by comparison. Bright yellow and red/orange used in hat. Strokes of red, orange, pink and yellow in foreground form grass.

Surface coatings/gloss

Thicker areas of paint in figure and shadow are glossy, other areas more matt. Yellow paint used for hat and straps is fairly matt.

Samples taken

No.	*Colour*	*Location*
1	Priming	Back of canvas
2	Green-blue from grass	Bottom edge , 15.5 cm from left
3	Blue-black over bright yellow	Right edge, 58.5 cm from bottom
4	Pale blue under dark surface	Top right corner, drip over edge
5	Red splodge at edge	Left edge, 49.8 cm from top
6	Pale green. 2 pieces – 1 green over dk blue, 1 black over green over blue	Left edge, 13.1 cm from top
7	Red-yellow, shiny surface	Piece stuck inside Perspex glazing, upper area, right of centre – probably from yellow strap

Notes

In Alley it is said that ‘The figure and vegetation were cut from another canvas’ [77], presumably then stuck onto a new canvas, however this is not certain from its appearance. It looks as though a very thick paint layer has been used for the figure which has been scraped down around the outlines of the figure shape to give this impression.

This work is the first of the series of Van Gogh paintings inspired by *The Painter on the Road to Tarascon* but appears to have been made some time earlier than the rest of the series. In Alley it is placed fairly early on in the list of 1956 paintings (painted in March or April), while the remainder of the series occur together in 1957 (from early March) and are said to have been completed quickly to be ready for an exhibition at the Hanover Gallery. This painting and the next three in the series – *Study for a Portrait of Van Gogh II* to *IV*, were listed in the exhibition catalogue (Francis Bacon, Hanover Gallery, London, March-April 1957), while two further studies (V & VI) were added during the course of the exhibition, arriving with the paint still wet. Two further works *Van Gogh in a Landscape* and *Van Gogh going to work* were painted after the exhibition in the same year.

[77] Alley, R., & Rothenstein, J. (1964) *Francis Bacon*. London: Thames & Hudson, p102.

Figure E.17.1 Detail of right side of figure showing contrast in gloss between figure area and background

Figure E.17.2 Detail of left side of background showing edges of scraped-down paint

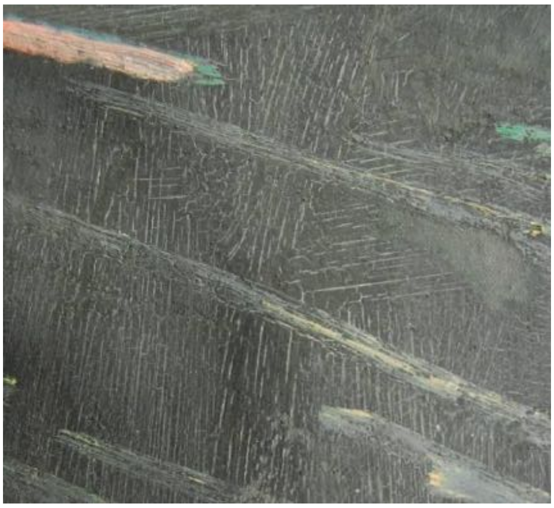
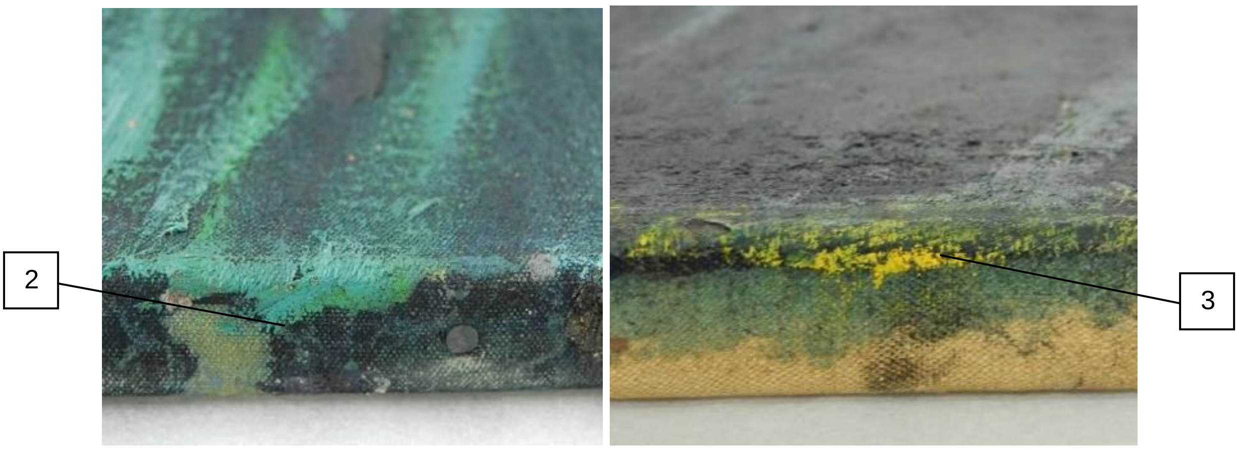


Figure E.17.3 Detail of drying cracks in background

Figure E.17.4 Bottom left corner showing traces of dark diagonal lines over grass

Sample sites



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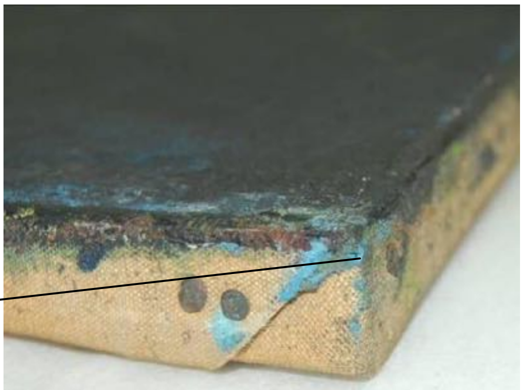

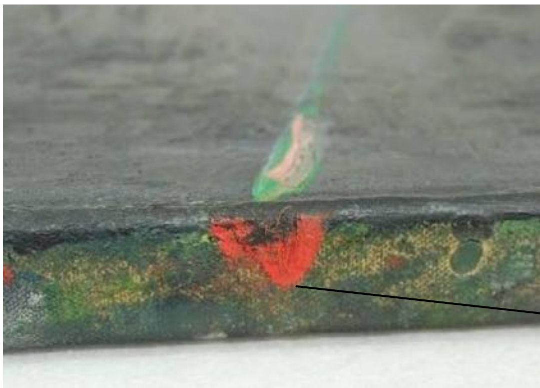

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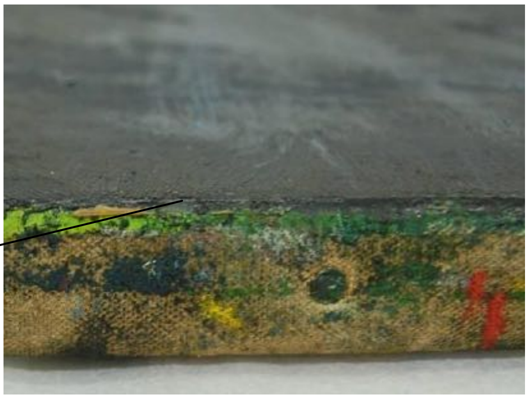


7

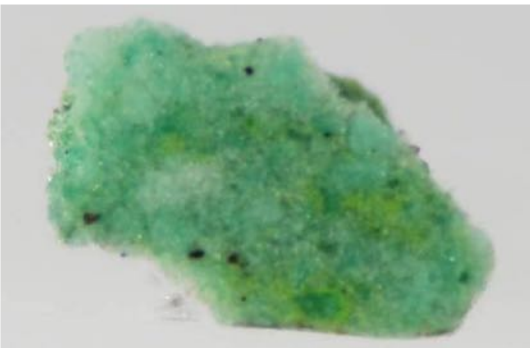
(? Approximate location)

FB17-1 Priming from reverse

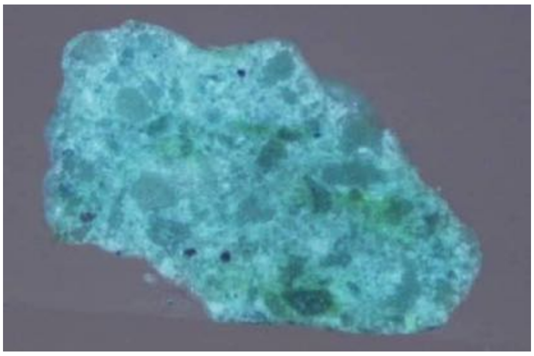
Normal light (taken at x200 magnification)

Ultraviolet (x200 magnification)

FB17-2 Green stroke from bottom edge

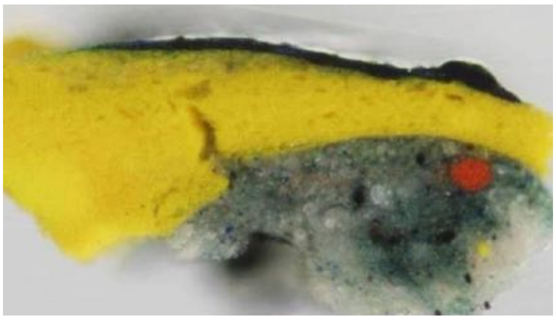


Normal light (taken at x50 magnification)

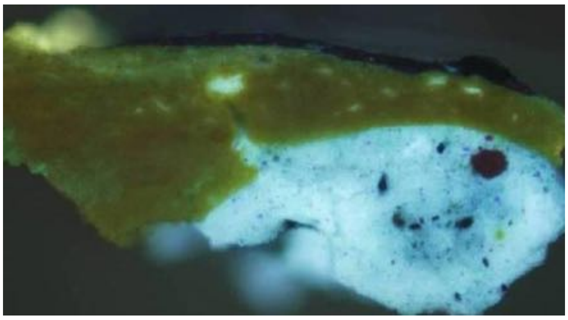


Ultraviolet (x50 magnification)

FB17-3 Blue-black over yellow, right edge



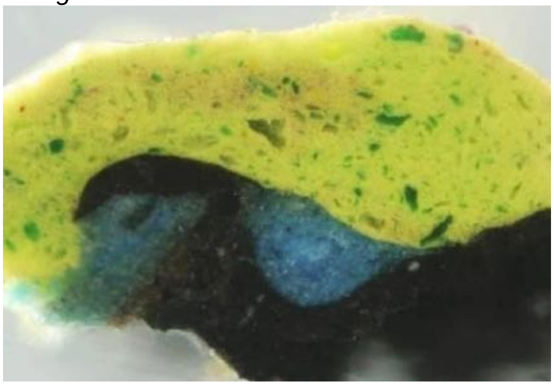
Normal light (taken at x200 magnification)



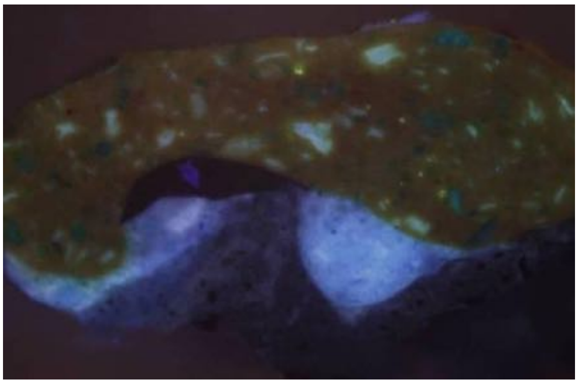
Ultraviolet (x200 magnification)

FB17-6 Black over green, left edge

6a - green over dark blue

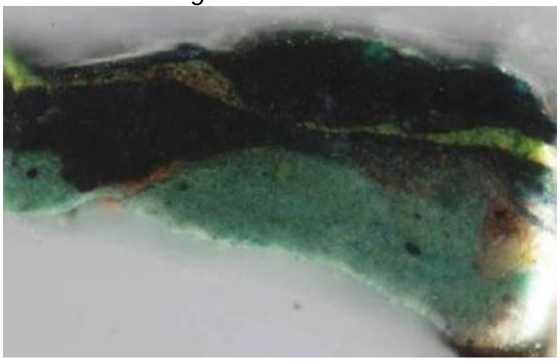


Normal light (taken at x200 magnification)

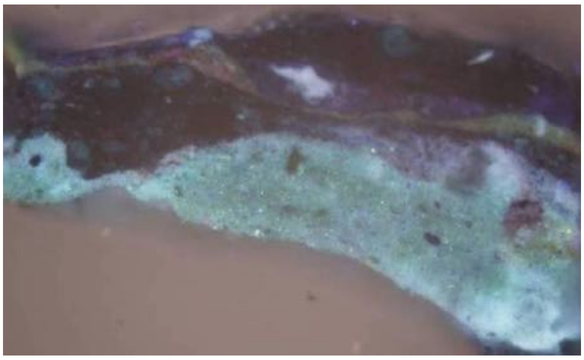


Ultraviolet (x200 magnification)

6b – black over green



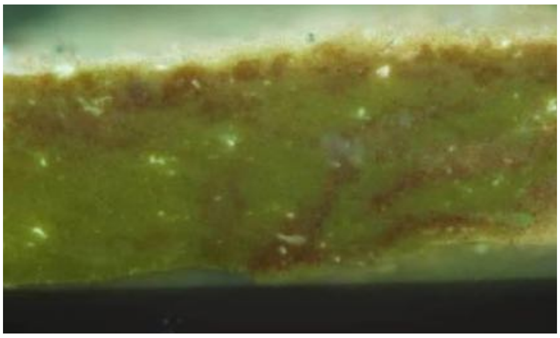
Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

FB17-7 Red-yellow fragment, from strap?

Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Priming	1	FTIR, GCMS	Drying Oil (Az/P = 1.30, P/S = 1.69)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
Green grass	2	FTIR, GCMS	Drying Oil (Az/P = 0.78, P/S = 4.81)
		SEM-EDX	Zinc white
		FTIR, SEM-EDX	Magnesium carbonate
		SEM-EDX	Cadmium yellow
		SEM-EDX	Viridian
Dark blue stain	2	FTIR	Prussian blue
Pale grey	3	SEM-EDX	Lead white
		SEM-EDX	Ivory black
		SEM-EDX	Ultramarine
		SEM-EDX	Cadmium orange
Bright yellow	3	SEM-EDX	Cadmium yellow
		FTIR, SEM-EDX	Magnesium carbonate
Dark blue background	3	SEM-EDX	Prussian blue
Pale blue	4	FTIR, GCMS	Drying Oil (Az/P = 1.15, P/S = 4.63)
		FTIR, SEM-EDX	Lead white
		FTIR	Prussian blue
		SEM-EDX	Zinc white
Red	5	SEM-EDX	Vermilion
		FTIR, SEM-EDX	Chalk
Pale green	6a/b	SEM-EDX	Cadmium yellow
		SEM-EDX	Viridian
Blue	6a	SEM-EDX	Cerulean blue
		SEM-EDX	Magnesium carbonate
Green	6b	SEM-EDX	Lead white
		SEM-EDX	Viridian
		SEM-EDX	Prussian blue
		SEM-EDX	Vermilion
Dark green	6b	SEM-EDX	Viridian
		SEM-EDX	Phthalocyanine green
		SEM-EDX	Raw umber
Yellow-red	7	FTIR, GCMS	Drying Oil (Az/P = 2.08, P/S = 2.17)
		FTIR, SEM-EDX	Barium sulphate
		FTIR, PyGCMS	PY1
		SEM-EDX	Cadmium red/orange

X-ray

The figure of Van Gogh in this painting was reported to have been cut from another canvas and stuck to a new background. In an interview in 1973 Bacon said Alley was ‘mistaken’, but it was also noted that Bacon was ‘obviously not pleased’ by the mention of this practice, which definitely did occur in some other works of the early 1960s.[78] Therefore this denial was taken as obfuscation by Bacon, motivated by regret at letting these works out. The area of the figure is clearly a lot thicker than the surrounding background, but it is uncertain whether this is just due to a thicker build-up of paint. An x-ray was taken of this painting to see if we could clarify whether or not a second canvas was used for the figure.

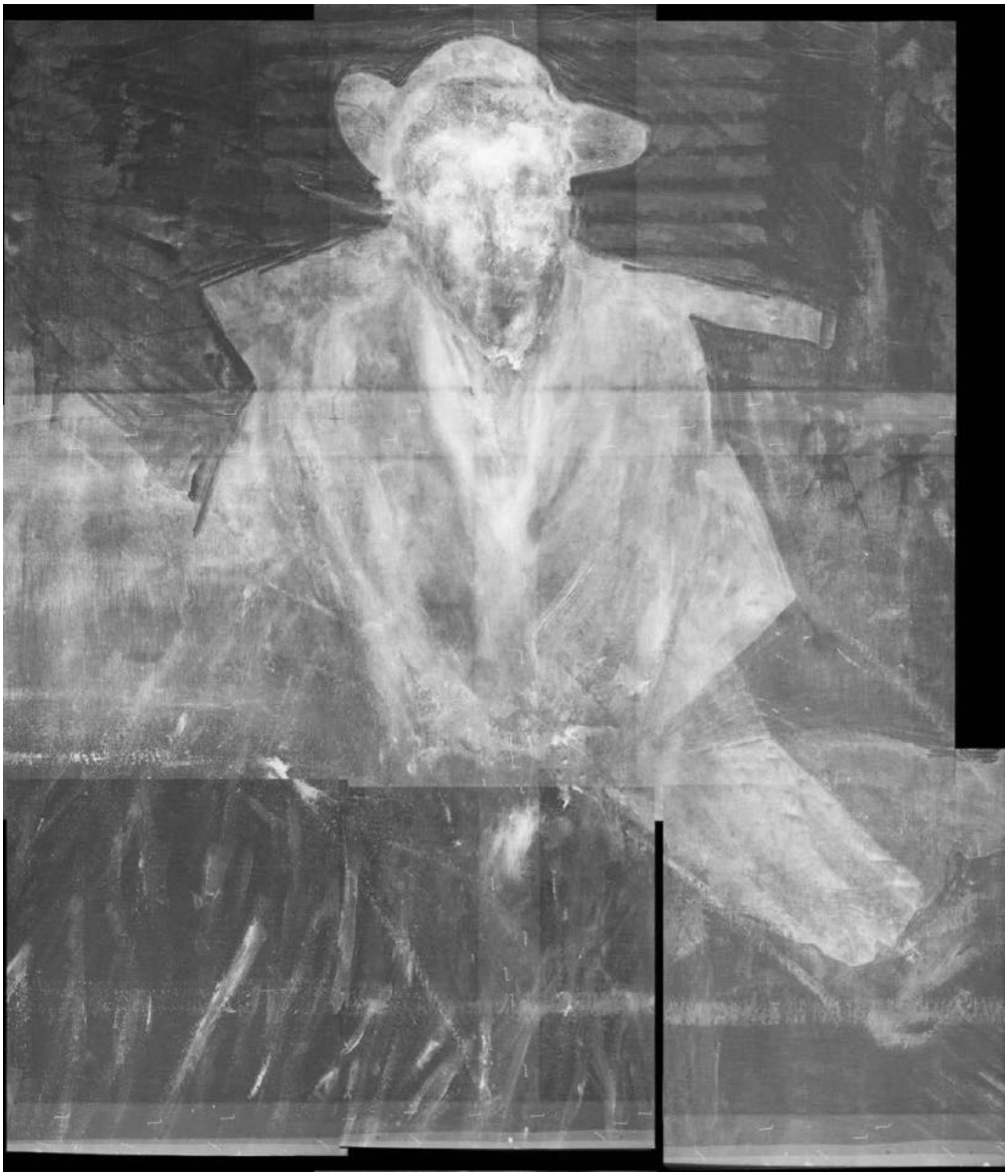


Figure E.17.5 X-ray of main area of painting, formed of nine plates joined together

Examination of the x-ray showed no evidence of a second canvas, and the weave texture could be seen to be continuous over both thinner and thicker areas, with no second weave texture visible (figure E.17.7). The figure appears as a lighter shape in the x-ray,

[78] Davies, H. M. (2009) 'Interviewing Bacon, 1973', in Harrison, M. (ed.) *Francis Bacon New studies : Centenary essays.* Steidl, p110.

presumably due to the thicker paint layers, and round the edges, ridges of white can be seen which seem to correspond to traces of thicker paint left behind in the scraping-down process, e.g. around the hat (figure E.17. 6). The dark blue background was then thinly applied, working around the figure to cover the remaining traces of scraped-away paint.

The contrast between the figure and background is much less marked in the lower part of the image. At the left hand side the scraping down of the background occurs only towards the top, stopping a little below the shoulders. The background paint gradually becomes thinner below this. The shape of the shadow extending to the right of the figure does not correspond exactly to the shape seen in the x-ray, as the part extending furthest to the right appears to be done in thinner paint.

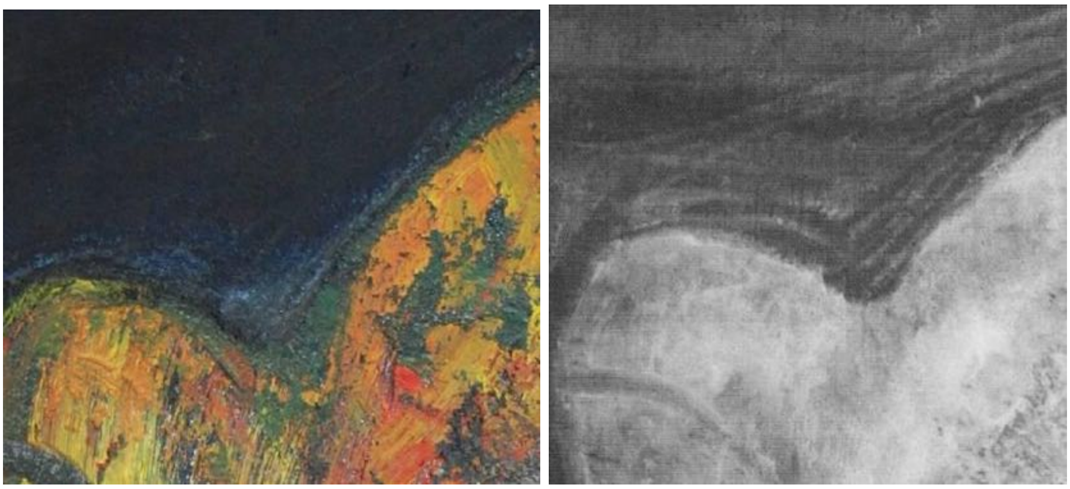


Figure E.17.6. Detail of left side of hat in visible light, left and x-ray, right. Pale residues of paint can be seen around the edges of the hat in the x-ray, subsequently covered with dark blue paint.

Figure E.17.7. Detail from edge of hat, showing canvas weave continuing across both thick & thin areas of paint

Figure E.17.8. Detail of x-ray of left side of face, showing parallel lines, possibly made by comb or similar.

Narrow parallel ridges can be seen in the paint of the face, which may have been made by a wide-toothed comb used to press texture into the paint (figure E.17.8). A series of horizontal strokes can be seen in the x-ray behind the head which do not appear to relate to any feature visible on the surface, so may be from an earlier, now over-painted, compositional feature (Figure E.17.9). It is uncertain what this results from. It could be seen as similar to the stripes used for ‘shuttering’ and curtain effects seen on some paintings particularly in the early 1950s, but these would be vertical rather than horizontal, and usually in narrower stripes. The stripes look a little like a venetian blind, an example of which is seen in the central panel of *Two Figures Lying on a Bed with Attendants*, 1968. A series of thicker horizontal stripes is also seen in *Study for a Portrait,* 1953, used to denote a bare brick wall behind the head of the figure.

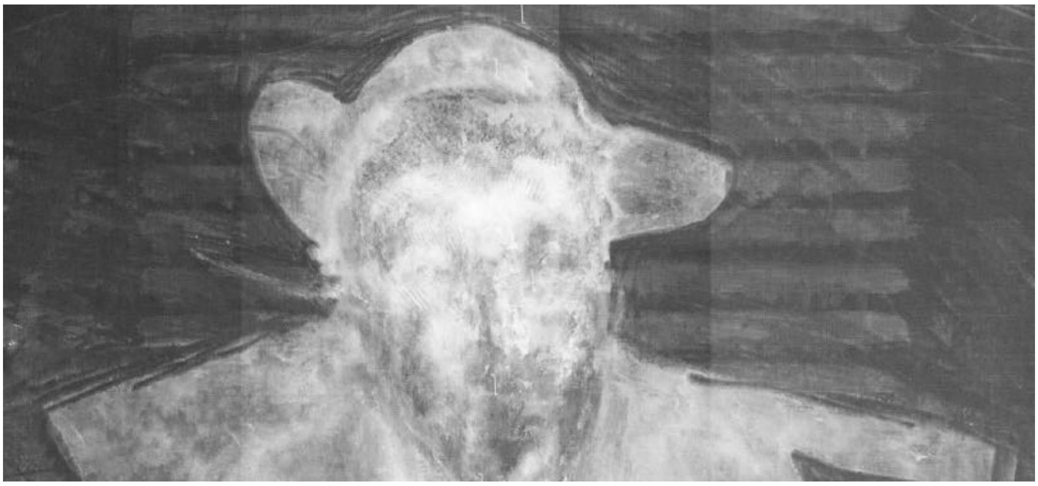


Figure E.17.9. Detail of head with horizontal stripes across background

Conclusions

The paint medium was identified in three samples, and was found to be a drying oil in all cases.

Lead white was identified in several samples, but only zinc white was found in the pale green sample from the grass (sample 2). Prussian blue has been used as a thin staining layer over much of the canvas, and also appears to be used for the dark blue background painted around the figure after scraping down (sample 3). Many different pigments were identified, but some may have only been used in earlier layers of the composition and not in surface layers. As well as Prussian blue, two other blue pigments – cerulean blue and French ultramarine were also identified. Also two red pigments – cadmium red and vermilion, two green pigments – viridian and phthalocyanine green, and two yellow pigments – cadmium yellow and arylide yellow PY1. This is the only example found so far of an organic yellow pigment in an artists’ oil paint, rather than a household paint.

The commercial oil priming contains lead white and chalk, with a higher proportion of chalk filler in the lower part of the layer and largely lead white in the upper layer.

Three Figures and Portrait, 1975

Identification details		
Title: Three Figures and Portrait		*Date:* 1975
Dimensions (hxwxd): 198.1 x 147.3 x 2.2 cm	*Location/owner:* Tate (T02112)	

Marks/Inscriptions:

Inscription, blue felt tip, on priming on back: 3 Figures & Portrait 1975/ Francis Bacon/ Oil & Pastel (Bacon’s hand)

Both vertical cross bars, pencil: ‘39x’

Horizontal cross bar, pencil: ‘58’

Top of left stretcher member, covered by canvas, red felt-tip: ‘F. Bacon / CovD 118 / REV’

(all reported from conservation documentation, back is now covered by sailcloth stretcher-bar lining)

Label removed from backboard of frame, printed with typed details: ‘INTERNATIONAL ART TRANSPORT / 60, RUE SAINT-SABIN - 75011 Paris / 700-93-87 + / Artiste.....BACON..... N/Réf. ....17241 LONDRES... / Titre... / Prêteur...GALERIE C. BERNARD PARIS’

Frame
Gilt frame, initially with Perspex, replaced with laminated glass

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:

Pine stretcher, 7 member, bevelled inner faces. Outer members width: 6.7 cm, thickness 2.3 cm. Cross-members width: 6.6 cm, depth: 1.5 cm. Square mortise and tenon joints. Grey metal tacks, 6 mm diameter, 8.5-10.5 cm spacing.

Linen canvas, plain-weave 16 x 17 threads/cm^2. Size/priming layer on back is visible in canvas interstices.

Paint and ground

Priming:
White commercial priming on back

Paint description:
A pale grey layer appears to have been used first over much of the background – visible at edges, covered with matt orange, then gritty beige. The grey layer does not appear to be visible anywhere on the face of the painting, except as a thin outline around the periphery of some orange areas. The orange is exposed to form the wall behind the portrait, and in a small area to the right of the right hand figure's knee.

Figures at left and right appear to be painted in a reserve of bare canvas. There is also a strip of canvas mostly exposed in the oval around the left hand figure.

The bright yellow band is fairly thickly painted, appears to be directly on canvas, although there is a dark layer underneath the section at the right edge. Lighter modelling in yellow at left side and just to right of right hand (George Dyer?) figure (lighter area shows up more clearly in UV). The pink edging below the yellow is over a strip of bare canvas, but appear to have been painted after the yellow area, as it crosses over on top.

Left figure – spine painted in very dry white paint and very thin black paint, precise. Slightly darker curved area of orange to upper right of back, may indicate changed outline of figure. Thin lines in pink and black outline the figure, with dry strokes white-pink within, thicker paint but sparsely applied. Brighter red-pink applied very sparsely on top in areas – picked up by texture of paint, appears matt – possibly pastel (figure E.18.4). Numerous raised fibres/dust with paint caught on, standing above canvas plane. Thick white appears to be thrown paint (figure E.18.1). Thin white stroke pointing to ear may have been painted after paint was thrown. Paint generally thicker within circle, part of head possibly painted on top of beige gritty paint. Background paint in circle also appears to have added sand, but with texture filled in – thicker layer – less gritty surface.

Right figure – partly painted directly on canvas (at least in area outside circle). Glossy area in blue-black area on back. Powdery dark blue spreads over back above and below black line of circle. Back painted in white, pink, yellow, spots of powdery dark pink. Possibly an area of white thrown paint here too – thin line of paint diagonally within circle, possibly more white paint removed from area to upper right of line (figure E.18.2). Beige within circle has surface similar to surrounding paint.

Portrait – chalky pink, white collar and glossy black background over orange base. Some of thin pink appears to be painted over black, e.g. ear. Several dark blue spots. Thin pink lines frame portrait. Trompe d'oeil pin in top of portrait made with very thin white & black strokes. Portrait approx 11 by 8.5 inches, but outer pink line approx 14 x 12 – may have been drawn using small canvas as template. Technique similar to that used in small portraits?

Circles may have been made with dustbin lid. Diameter of circles approx 19”

Central figure more thickly painted than other figures, possibly over background beige? Pink, white and purple strokes (looks like cobalt violet), some areas more matt than others – e.g. mouth and teeth matt, black strokes fairly glossy. Brighter pink strokes below feet have particularly matt surface – pastel?

Particularly glossy area in background to upper right of central form. Another glossy, smoother patch in beige background below right hand figure. Clear outline with surrounding area having much more gritty surface – possibly a shadow, or different positioning of figure (shows in raking light photograph). Traces of a black layer can be seen below the beige.
Yellow traces along central part of bottom edge, coinciding with box?

Oval outlined in thin black and white lines

Surface coatings/gloss

No coatings apparent, wide variety of different surface textures, through different use of paint. Orange fairly matt, while gritty beige has slight surface sheen. Some glossier patches in beige and also in blue-black used under chin of left figure and at waist of right hand figure.

Samples taken

No.	*Colour*	*Location*
1	Orange	Top edge, 57.2 cm from left (rubbery texture)
2	Grey	Top edge, 39 cm from left (rubbery texture)
3	Gritty buff	Bottom edge, 64.3 cm from left
4	Priming	Bottom edge, 57.2cm from left, flake from edge of canvas
5	Yellow	Top edge, 57.2cm from left (crumbled)
6	Pale pink (& buff?)	Right edge, 90.6 cm from top
7	Dark pink	Right tacking edge, 87.5 cm from top, smear on canvas at edge
8	Pink dry material	Right edge, 100.5 cm from top (powder)
9	Buff/ orange/ grey	Right edge, 65.4 cm from bottom (fragments)

Notes

Microscope examination
Orange appears very matt with numerous small bubbles in surface compared to glossy beige on top. Fine raised peaks in beige paint.
Pink lines ‘drawing’ leg of left figure appears like paint rather than pastel.
Area of exposed orange near portrait appears very porous and matt with many holes of various sizes (figure E.18.3). Surface appears quite fragile, some bridges of paint between holes are broken.

UV examination
Greenish fluorescence in areas of bare canvas, probably from size layer, in contrast with dark areas of housepaint. Bluish/white fibres across surface, few splashes & drips. Pink lines around portrait show up brightly. Yellow appears more orangey, greater contrast with whiter modelling at left edge and right of left hand figure. Lighter strip shows up around left, right and bottom edges, with much thinner strip at top (from frame rebate?)

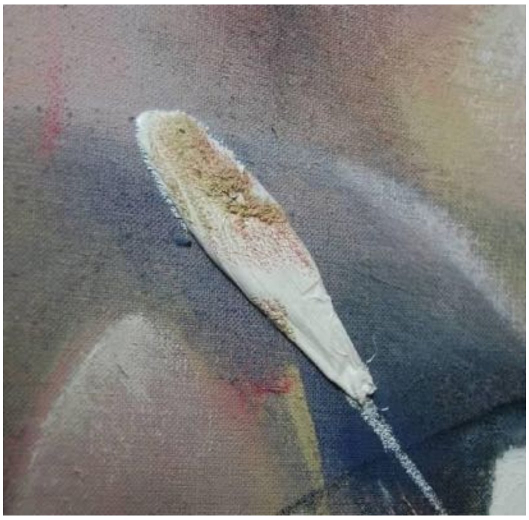


Figure E.18.1 Thick blob of thrown paint, left hand figure

Figure E.18.2 Line of white paint, possibly thrown, with larger area of white to upper right, sand sprinkled over dark spot to give grey surface.

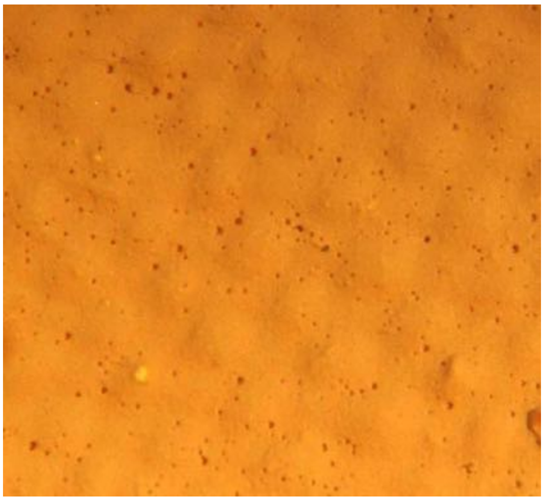


Figure E.18.3 Detail of porous orange paint taken under microscope

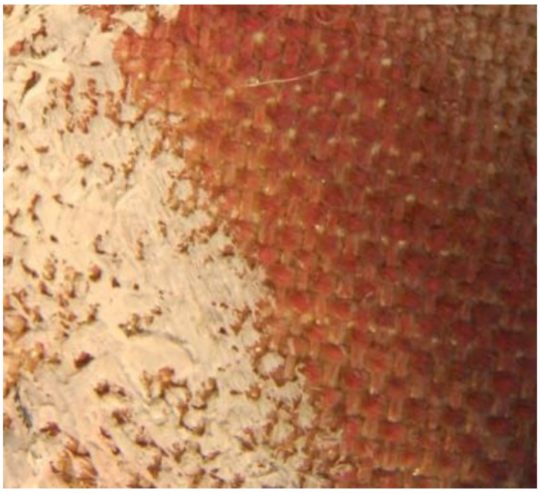
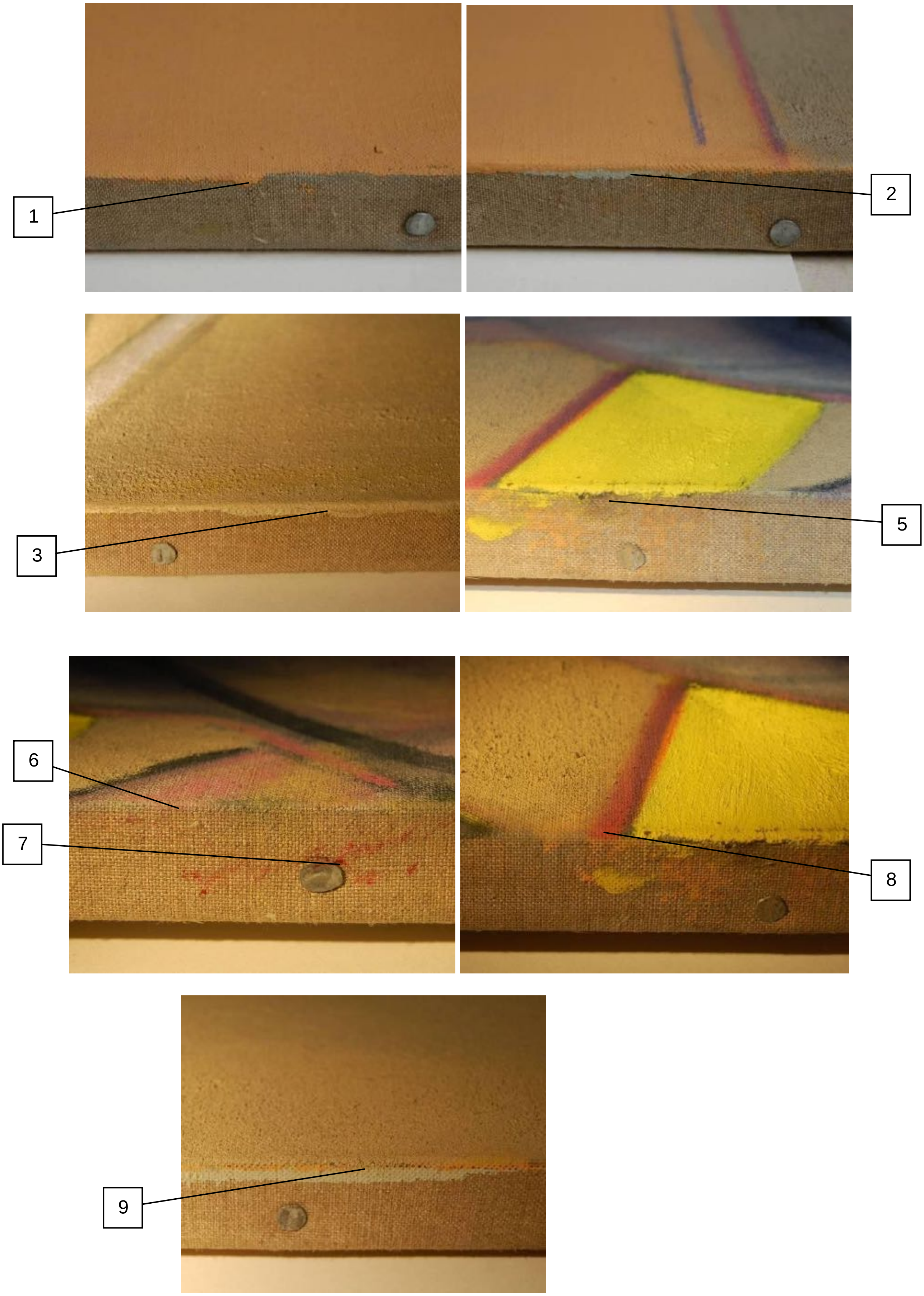


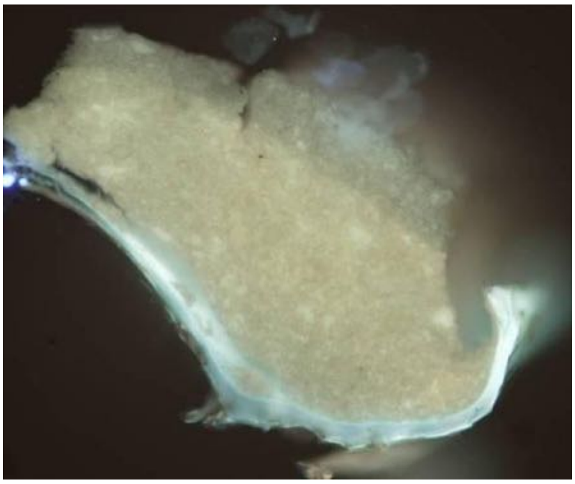
Figure E.18.4 Line of pink dry material, possibly pastel, next to pale pink paint, taken under microscope.

Sample sites

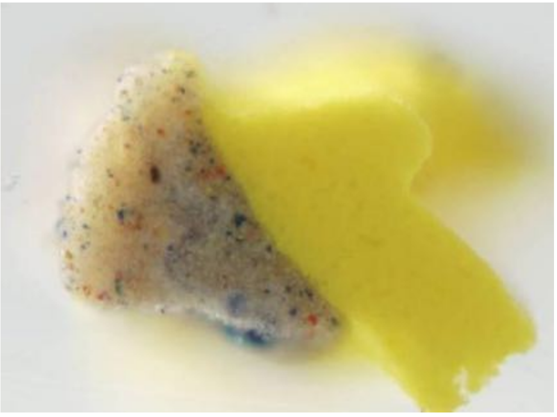


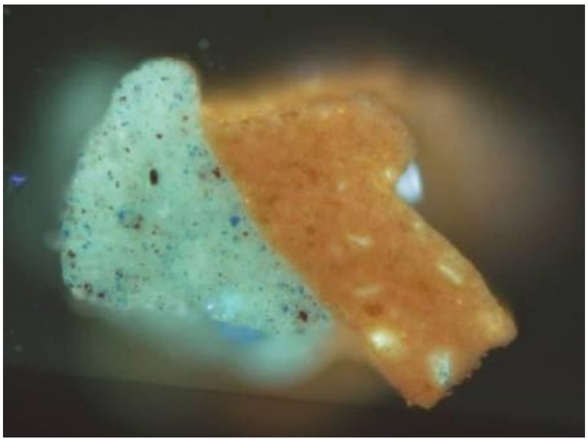
FB18-4 Priming from reverse


Normal light (taken at x200 magnification)

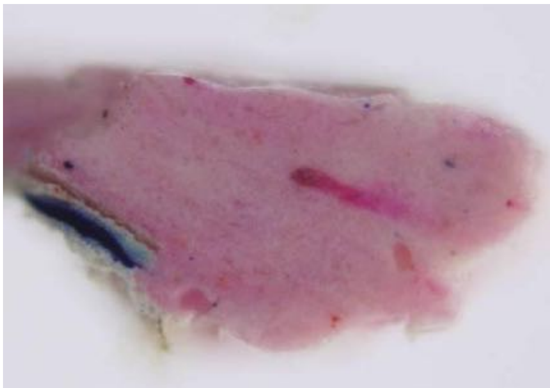

Ultraviolet (x200 magnification)

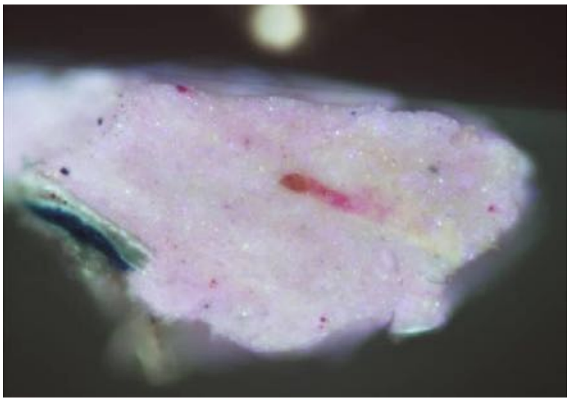
FB18-5 Bright yellow


Normal light (taken at x50 magnification)


Ultraviolet (x50 magnification)

FB18-6 Pale pink


Normal light (taken at x50 magnification)


Ultraviolet (x50 magnification)

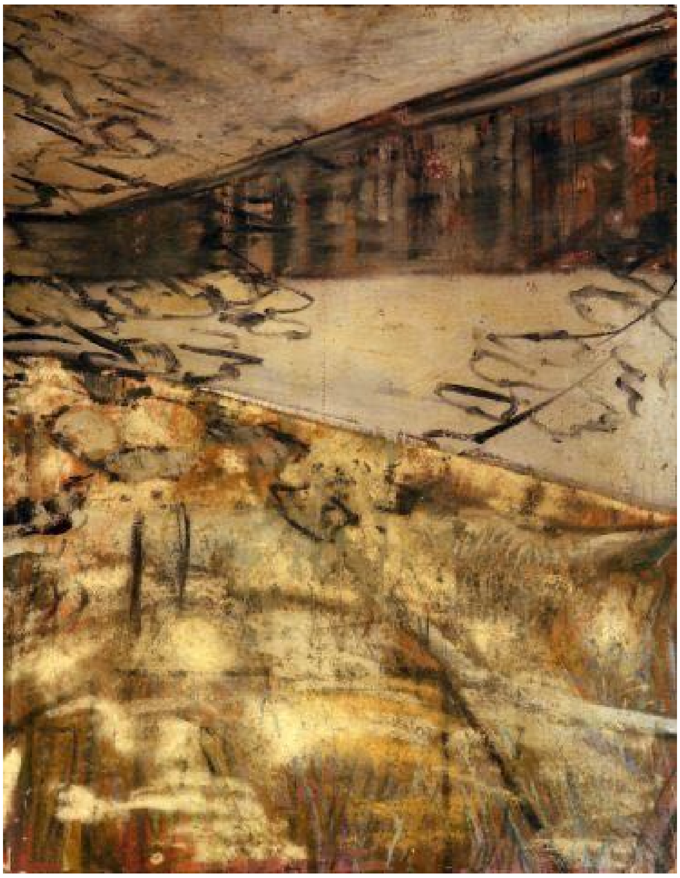
Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Orange	1	FTIR, PyGCMS	PVAc-Acrylic (MMA- 2EHA)
		FTIR, PyGCMS	Organic pigment PY1
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Kaolin
		FTIR, SEM-EDX	Chalk
Grey	2	FTIR, PyGCMS	PVAc-Acrylic (MMA- 2EHA)
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Kaolin
Beige	3	FTIR, GCMS	Drying oil (Az/P= 1.20, P/S= 2.59)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Sand
		SEM-EDX	Zinc white
		SEM-EDX	Titanium white
Yellow	5	FTIR, GCMS	Drying oil (Az/P= 1.53, P/S= 2.90)
		PLM, SEM-EDX	Cadmium yellow
Grey-brown	5	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Vermilion
		SEM-EDX	Ultramarine
Pale pink	6	FTIR	Drying oil
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
Dark blue	6	SEM-EDX	Prussian blue
Dark pink	7	FTIR	Drying oil
		FTIR, SEM-EDX	Magnesium carbonate
		FTIR	Permanent rose?
Pink powder	8	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Chlorinated organic pigment
Beige	9	FTIR, GCMS	Drying oil (Az/P = 0.89, P/S = 3.48)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Titanium white
		SEM-EDX	Iron oxide
Priming	4	FTIR, GCMS	Ortho-phthalate alkyd (Az/P= 1.53, P/S= 2.82)
		FTIR	Protein size layer
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Kaolin
		SEM-EDX	Titanium white

Conclusions

Both grey and orange paints appear to have the same acrylic-PVAc binder, so are probably household paints from the same range. Both also have kaolin and chalk extenders.
All other paints sampled appear to be oil based. Lead white is the principal white pigment.

Cadmium yellow, vermilion, Prussian blue and ultramarine were also identified. The FTIR spectrum of dark pink sample 7 closely matched that of Winsor & Newton permanent rose found in the studio, reported to be quinacridone pigment PV19. The very thin pink in sample 8 was thought to possibly be a pastel material, but from the pigments identified (and lack of extenders such as kaolin or chalk) this is more likely to be a thin oil paint.

Untitled (Landscape)



Identification details		
Title: Untitled (Landscape) / 'Street Scene'		*Date:* c.1943-5
Dimensions (hxwxd): 93.1 x 73.0 cm	*Location/owner:* Private collection	
Marks/Inscriptions: Chalk writing on back: 'Buhler 10'		

Support
Type: Canvas / Board / Paper / Stretcher / Strainer
Description: Paper stuck to Composition board. The paper is crumbling and lifting at the edges (paper is fairly thick, appears yellowed, soft fibred). Thought to be Sundeala board – available in standard sizes & used in other works. Where paper is lifting/chipped at edges, traces of another paint layer can be seen beneath the paper. It appears that the board has been reused - the paper was stuck over an earlier painting. The visible paint traces appear similar in colour to those in the main composition - pale grey and orange-red (figures E.A1.1 & E.A1. 2)

Paint and ground

Priming:
?

Description:

Thin gritty-textured red-brown paint appears to have been used to cover much of board, no priming evident.

A glossy buff-grey paint has been used over the red to form the street and sky. In the street gritty inclusions are visible (small stones?). The largest of these is approx 4 mm wide (figure E.A1.3). Black wandering strokes over areas of grey.

In the building narrow vertical black strokes are visible (almost like drawing) over the red, with thicker strokes of black and grey over this, smeared from left to right. Patches of bright pink also.

At the lower right edge pink appears to have been used as the base colour. Over this are strokes of green and blue forming the grass, some quite glossy, some bright blue strokes are very matt and could be pastel. Black lines delineate box/cage in foreground. Matt yellowish patches throughout foreground, very powdery (figure E.A1.1). A few blobs of thicker white paint (also visible in x-ray) may be accidental splashes.

A line of regularly spaced spots, apparently an impression caused by something leaning against the still-wet paint layer is visible. This traces the shape of a rectangle over the right half of the painting.

Surface coatings/gloss

None apparent, surface generally matt

Samples taken

No.	*Colour/Description*	*Location*
1	Grey over red, paint chip with layers down to paper	Top left corner (1.5 cm from top).
2	Grey over red. Scraping of top grey layer only.	Upper left edge (16.8 cm from top).
3	Dark blue over pink, paint chip	Bottom right corner (4 cm from bottom, 0.5cm from right).
4	Red brown with few black specks on top, paint chip	Lower left edge (13cm from bottom)
5	Bright blue stroke of pastel(?), scraping	Bottom centre (37 cm from left, 4.5 cm from bottom.
6	Yellow powdery material over red-brown, scraping of yellow only.	Left edge (9 cm from bottom).

Notes

The painting is thought to be an early work. Board is a fairly unusual support for Bacon, may have been done in wartime when canvas scarce. Seven works were left in Cromwell Place in 1951 (A1-A7 in Alley Catalogue), in possession of Michael Buhler (also on board?). This and ‘Untitled (deMaistre)’, both on board, are thought to have the same provenance, but were not known about prior to authentication meeting.

The painting was compared to ‘Man in cap’ 1940-41, also on composition board, having Nazi imagery. Buildings here thought to refer to Nazi colonnade.

Lot 152 in Sotheby’s sale 28th February 2008

X-ray:

Difficult to interpret. Shapes are visible (especially at the top) which do not appear to relate to the image, these could be from the earlier painting beneath. E.g. a diagonal line higher than the line of the top of the building, and some rounded shapes along the top edge.
More rounded shapes across the building.
Several straight lines in black and white near the base of the painting could be framing devices, some of these show up more clearly in the x-ray.

Figure E.A1.1 Area of lower left edge, showing lifting edges of paper and pale grey paint layer beneath

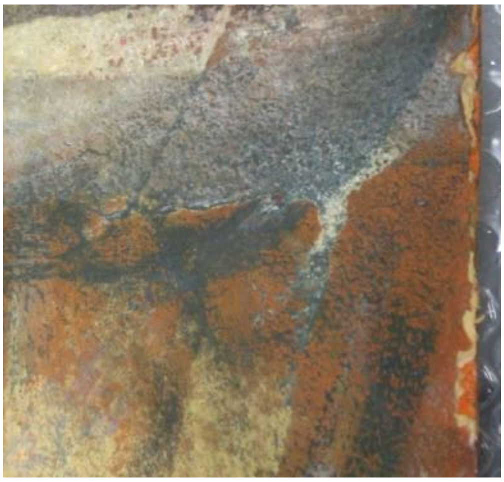


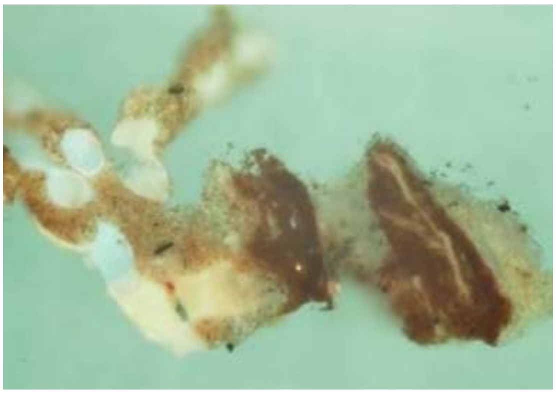
Figure E.A1.2 Area of right edge, showing bright red paint beneath losses to paper

Figure E.A1.3 Area of grey near right edge, with large gritty particles

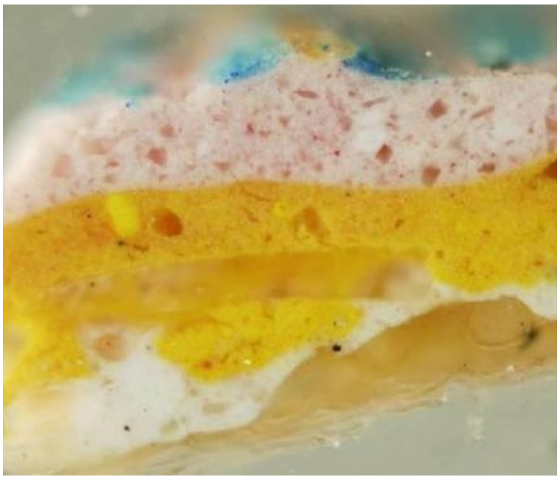
Sample Sites

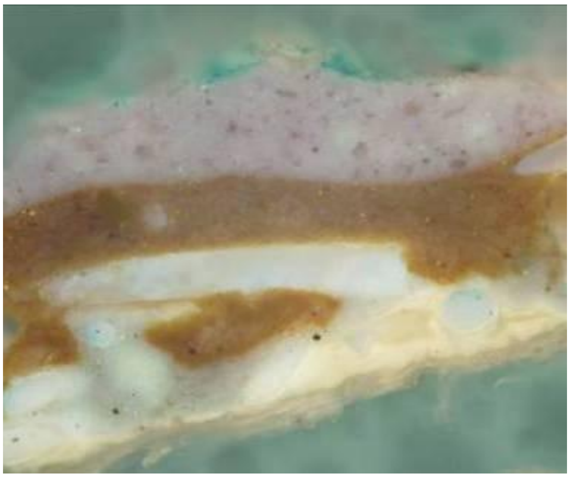
FBA1-1 Grey over red, paint chip with layers down to paper, top left corner


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

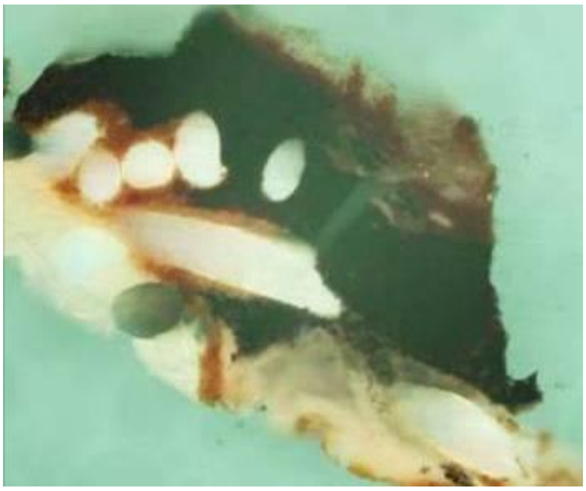
FBA1-3 Blue over pink in grass. Bottom right corner.


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FBA1-4 Red brown with black specks on top. Lower left edge (13cm from bottom)


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Grey	2	FTIR, GCMS	Oil (Az/P = 1.46, P/S =2.17)
	1, 2	FTIR, SEM-EDX	Chalk/gypsum
		FTIR, SEM-EDX	Barium sulphate with zinc – lithopone?
White	3	SEM-EDX	Zinc white
		SEM-EDX	Barium sulphate / lithopone?
Pale pink	3	SEM-EDX	Barium sulphate / lithopone?
		SEM-EDX	Alizarin crimson?
Blue grass	3, 5	SEM-EDX	Chalk
		SEM-EDX	Ultramarine
Yellow-orange	3	SEM-EDX	Cadmium yellow
		SEM-EDX	Barium sulphate / lithopone
		SEM-EDX	Zinc white
Red-brown	4	GCMS	Oil (Az/P = 1.18, P/S =2.16)
	1, 4	SEM-EDX	Vermilion
		SEM-EDX	Cadmium red/orange
Black	4	SEM-EDX	Ivory/bone black
Yellow powdery material	6	FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Gypsum
		FTIR, SEM-EDX	Kaolin
		SEM-EDX	Iron oxide

Conclusions

The grey paint contains mainly calcium, barium and sulphur, with a little zinc, so lithopone was thought to be the main white pigment, with large amounts of chalk extender. These are cheap pigments which might be associated with a low-cost or household paint. Lithopone was also found in several samples from the Tate crucifixion. The white and yellow paints may also contain additional zinc white. The white layer in sample 3 could be interpreted as a ground/priming layer, but this was not seen in other samples. Fibres which might be cotton wool were seen in several samples.

An oil medium was identified in two samples analysed, both with similar ratios. The large proportion of chalk and kaolin fillers in sample 6 make this likely to be a chalk/pastel material. The blue material in samples 3 & 5 was also thought to be pastel, due to the large chalk component.

Untitled (de Maistre), 1949

Identification details		
Title: Untitled (Roy de Maistre)		*Date:* 1949
Dimensions (hxwxd): 65 x 55.4 cm	*Location/owner:* Private collection	
Marks/Inscriptions: Signed twice: 'Roy de Maistre' in left corner in pencil (?) over white paint and in right corner scratched into paint and gone over in red paint (larger).		

Support
Type: Canvas / <u>Board</u> / Paper / Stretcher / Strainer
Description: Composition board, soft and crumbling at corners.

Paint and ground
Priming: White priming from earlier composition?

Paint description:
Geometric shapes in black, white and red at lower edge may be from earlier de Maistre painting. Vertical strokes of grey on top more likely to be by Bacon, as are the strokes forming the head. Orange and green paint can be seen underneath the grey in some places, which appear to be part of the original painting. A curving shape is scratched into the paint, possibly with the end of a brush, in grey over green towards the left side (figure E.A2.1). In the top left the texture of some brush strokes can be seen under the grey paint in raking light, relating to the painting underneath, in particular a rounded shape with the appearance of a halo. The strokes in the bottom left corner appear to be very similar to the same area in a painting in the Tate collection by de Maistre: ‘Marriage’ (1936).

From x-ray examination it is likely that only the grey vertical strokes and the white smeared paint over the head were applied by Bacon. The grey strokes form a curtain like that seen in the Heads series and other works from 1949.

Surface coatings/gloss

Samples taken

No.	Colour	Location
1	Grey over orange over white	Right edge.
2	Grey over white and pink	Top edge (9.5 cm from left).
3	Grey only	Top edge (5 cm from left)

Notes

Appears to be on a re-used board, over a painting by Roy de Maistre. Same provenance as FBA1 (left behind in Cromwell Place, 1951). Maybe wartime, reusing board may point to shortage of materials.

X-ray:
Clearly shows shapes not visible in present painting. In top left are rounded shapes suggestive of two figures, appearance of Madonna and child. The shapes seen in the x-ray could be from a similar composition to de Maistre’s painting *Marriage* (1936). Many features which closely match the colours and composition of this work can still be seen on the painting itself.

Most of the shapes seen in the x-ray appear to relate to the earlier composition, even the white incorporated in the figure’s jacket may have been from the deMaistre picture. Only the smears of white used in the face of the Bacon work appear in the x-ray.

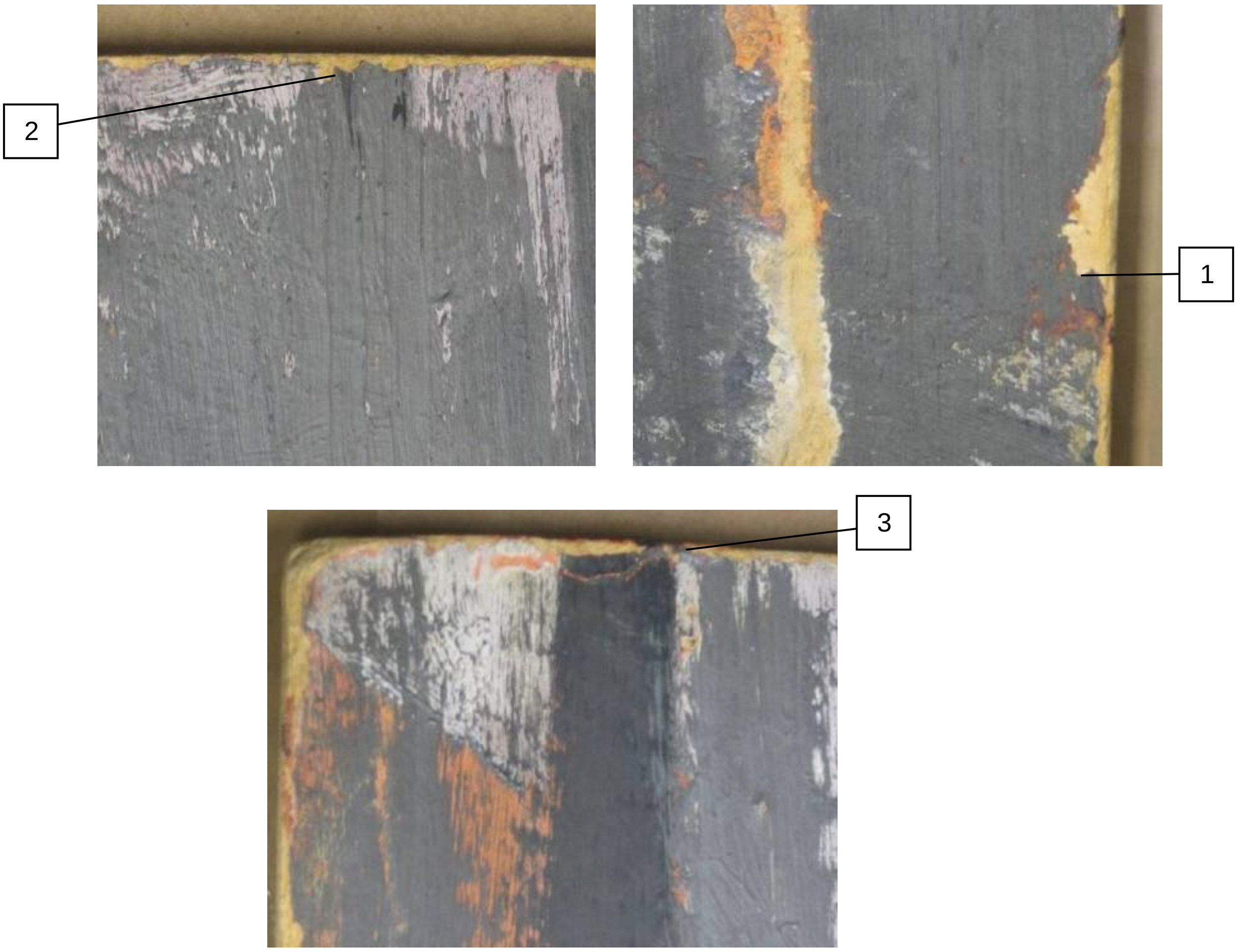
The Tate painting (c.1936) is considerably larger (152.4 x 114.3 cm) and is said to be on canvas. Another version with very similar composition also exists, on masonite, with dimensions similar to the work examined here (73 x 52.6 cm), 1936, Private Collection (Johnson, 1995). The latter work is a little taller, but may be of a similar scale, by comparison with the Tate work, in which there is more space above the heads of the figures

.

Figure E.A2.1 Detail of shape scratched in paint, partly covered with grey paint

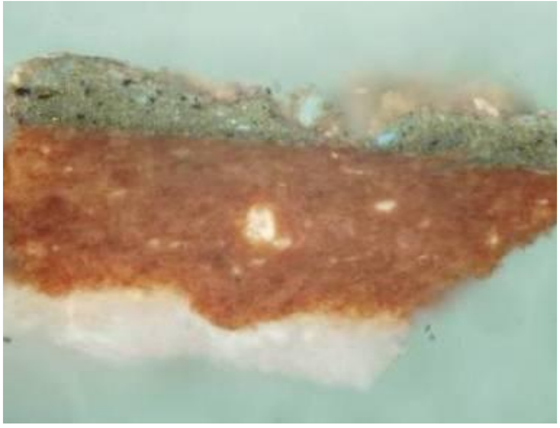
Figure E.A2.2 X-ray of FBA4, showing shapes of figures in earlier composition by Roy de Maistre

Sample sites



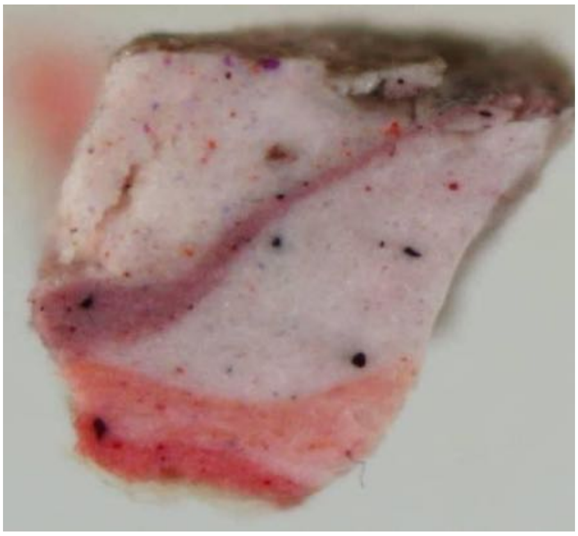
FBA2-1 Grey over orange

Normal light (taken at x200 magnification)

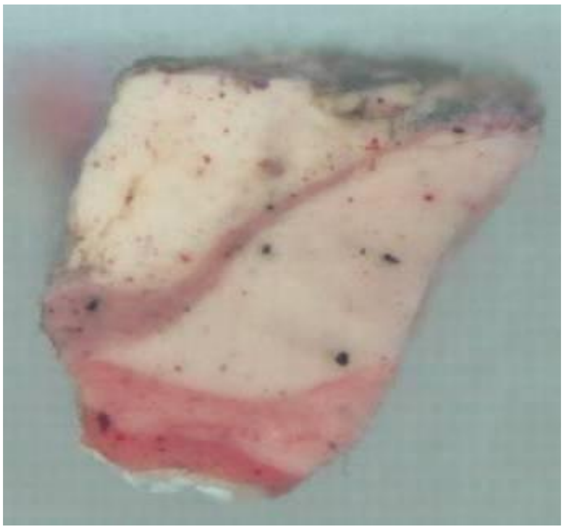


Ultraviolet (x200 magnification)

FBA2-2 Grey over pink.



Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Grey	1	FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Cobalt blue
Orange	1	SEM-EDX	Chrome orange?
		SEM-EDX	Magnesium carbonate
		SEM-EDX	Barium sulphate
White	1	FTIR, SEM-EDX	Gypsum
		FTIR, SEM-EDX	Chalk
Pale pink	2	FTIR	Oil
		SEM-EDX	Lead white
		SEM-EDX	Cadmium red
		SEM-EDX	Cobalt violet (phosphate)
Grey	3	FTIR, GCMS	Oil (Az/P = 0.70, P/S = 3.98)
		FTIR	Lead white

Conclusions

The grey and pink samples were found to have an oil medium. The grey paint, thought to be applied by Bacon consists of lead white with zinc white and cobalt blue. The addition of a blue pigment to grey paint was also seen in some of the layers in Head II. The white paint used for the pink paint layers had no zinc component, whereas that in the grey paint probably did. Lead white with a small amount of zinc white has been frequently found in Bacon's paints.

Although believed to have been applied by de Maistre, cadmium red and cobalt violet are pigments also frequently used by Bacon. The suspected orange pigment however, chrome orange, has not been found before in Bacon's work.

Untitled (self-portrait)

Image omitted for copyright reasons

Identification details

Title: Untitled (self portrait)	*Date:* c. 1967-68
Dimensions (hxwxd): 35.5 x 30.5 cm	*Location/owner:* Private collection

Marks/Inscriptions:

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:

Canvas on 4-member stretcher, square mortise and tenon joints. Secured with steel tacks at approx 7.5 cm spacing. Canvas is fine machine-wove, probably linen, thread count approx 21 by 20 per cm^2. Canvas is stapled to back of stretcher. It is stretched with the raw side outwards.

Paint and ground

Priming: White commercial priming on the back

Paint description:
Splodges of thick white paint on back, plus spatters of black and orange paint. A green stain used on the canvas is evident along the top edge and at bottom in area of shirt, this is very thin and the canvas texture is prominent. Grey, red and white paint has been applied on top of this to form the costume.

A thick white paint and streaks of a bright red were applied to form the collar, with the initial green layer left visible between the white wings of the collar (figure E.A3.1).

A white layer appears to have been applied over the green to form the background and outline the shape of the head, applied fairly thickly with prominent brushmarks. A thin purple-red is applied on top of this, around the outline of the head, apparently after the head was painted. Thicker paint is used in the head and white shirt collar. Texture of cloth pressed onto paint can be seen in two areas, bright red stripes are visible on the neck.

Surface coatings/gloss

No coatings apparent, fairly matt

Samples taken

No.	*Colour*	*Location*
1	Purple over white over green from background (sample crumbled)	Top right corner.
2	Red over grey/green	Bottom left, (2.2 cm from bottom).
3	Red from same area, scraping of paint splashed over onto tack head	3.5cm from bottom
4	Green	Centre top tacking margin, 14cm from right.

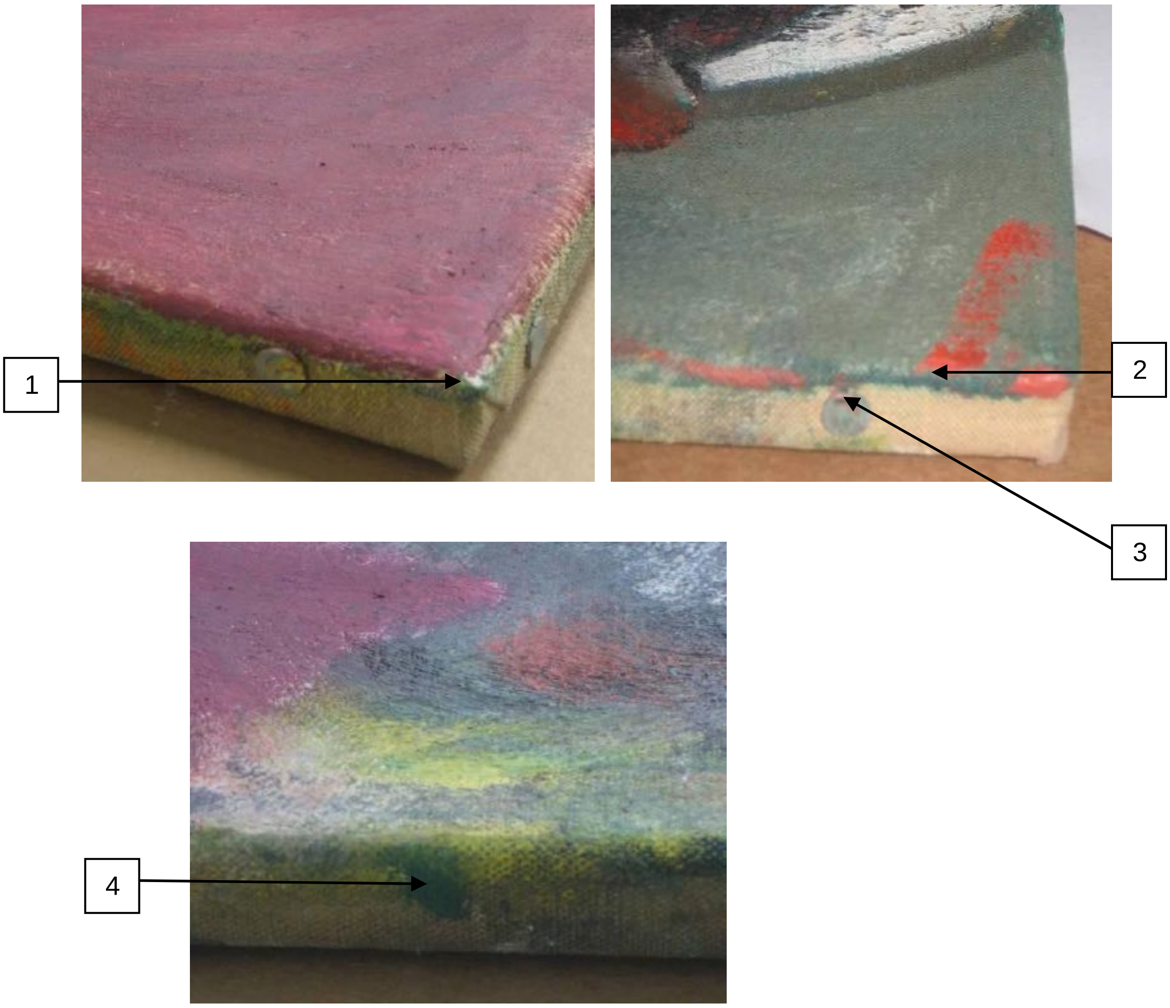
Notes

This green background colour, applied as a stain, occurs in several works by Bacon from 1959-60 particularly, e.g. *Portrait of Miss Muriel Belcher* (1959) and *Head of a Woman*, 1960, appear to use a similar colour over the whole canvas. Bacon apparently referred to this colour as 'Belcher's green' (Harrison, 2005, p138). Later in the 1960s, several small portraits (the same size as this canvas) use a similar background colour, e.g. Study for Head of George Dyer (1967), The green shirt and white collar in this work are very similar to the example here.

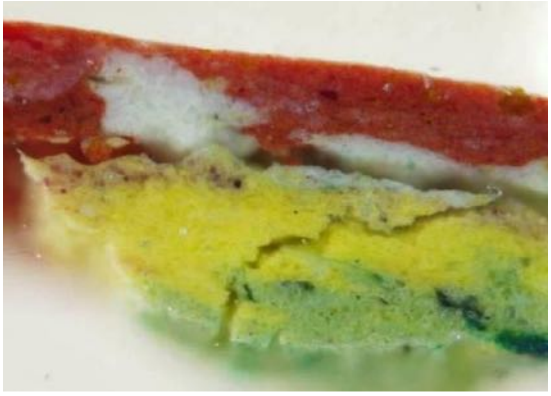
X-ray: The white paint on the back is x-ray absorbing, so obscures the x-ray image.

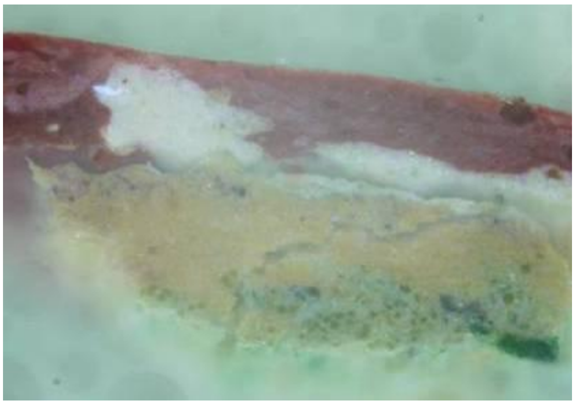
Figure E.A3.1 Detail, bottom centre, showing green stain on canvas visible at collar. The white, red, grey and flesh paints are applied on top of this. At the right hand side thin stripes of red-orange can be seen – probably from fabric used to imprint paint or pigment colour.

Sample Sites

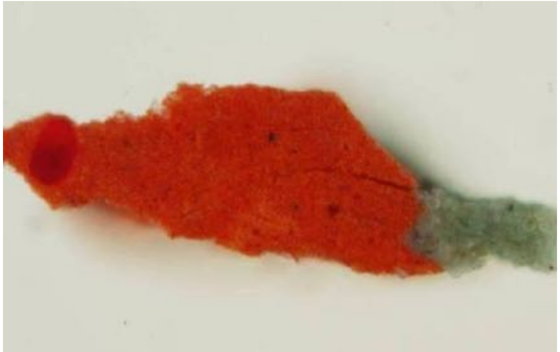


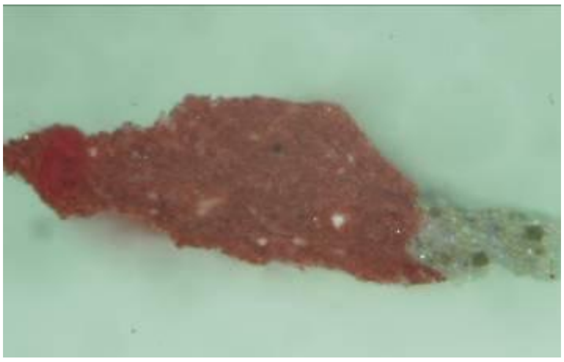
FBA3-1 Purple over white & green, top right corner


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FBA3-2 Red over grey-green


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Green	1	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Phthalocyanine green PG7
		SEM-EDX	Barium chromate
Yellow	1	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Cobalt arsenate
White	1	SEM-EDX	Lead white
		SEM-EDX	Zinc white
Pink	1	SEM-EDX	Lead white
		SEM-EDX	Cadmium red
		SEM-EDX	Iron oxide
Red	3	FTIR, GCMS	Drying oil (Az/P = 1.20, P/S = 3.14)
	2, 3	FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Magnesium carbonate
	2	SEM-EDX	Cadmium red
		SEM-EDX	Alizarin?
		SEM-EDX	Vermilion
Grey-green	2	SEM-EDX	Lead white
		SEM-EDX	Barium chromate
		SEM-EDX	Zinc white
Green	4	FTIR, GCMS	Drying oil (Az/P = 1.63, P/S = 6.17)
		FTIR, SEM-EDX	Phthalocyanine green?
		SEM-EDX	Zinc white
		FTIR	Magnesium carbonate

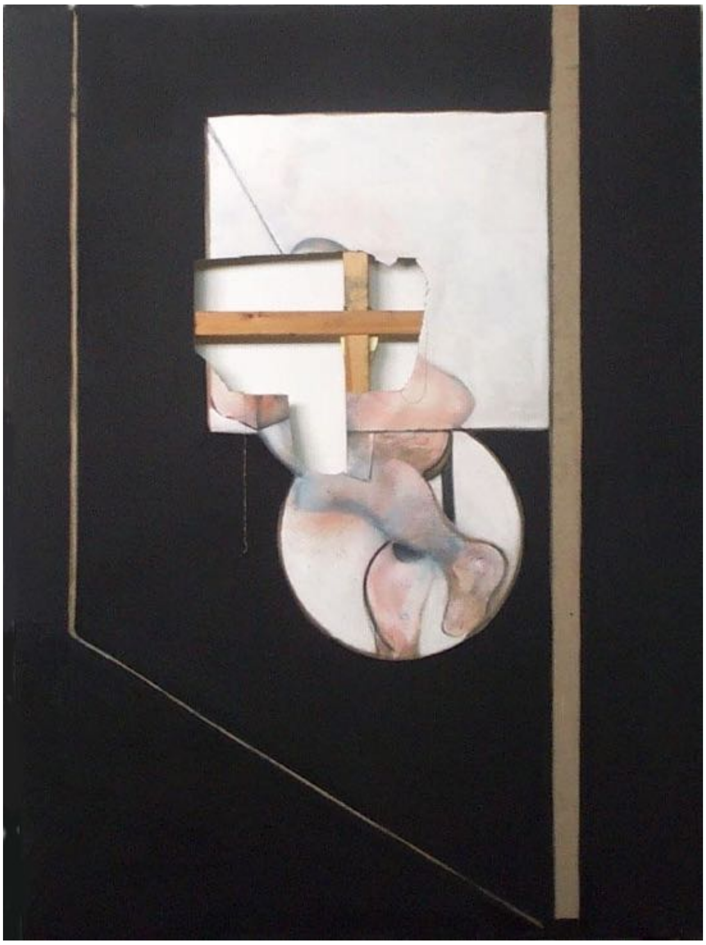
Conclusions

Phthalocyanine green appears to have been used to stain the canvas, applied thinned down so that canvas texture is still prominent, as ground layer over the whole canvas. Swirls of grey and flesh coloured paint are used over the green to form the head. A grey-green, containing a higher proportion of lead white pigment was applied over the green stain to form the shoulders.

The background colour appears to have been changed several times, in cross section a pale green layer is applied over the green stain (similar to the grey-green paint used for the jacket), followed by yellow, white and purple layers.

An oil medium was found in both red and green paints.

Study for portrait



Identification details	
Title: RM98F36 Study for portrait 1986	*Date:* 1986
Dimensions (hxwxd): 198.3 x 147.3 x 2.3 cm	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F36)

Marks/Inscriptions:

Verso top right corner signed & dated in black ballpen: ‘Study for Portrait 1986 Francis Bacon’

Support

Type: <u>Canvas</u> / Board / Paper / <u>Stretcher</u> / Strainer

Description:

9 member wooden stretcher, one vertical and two horizontal cross bars. Members 2” wide, ¾” deep.
Steel tack, 5-6 mm diameter, spacing 8-9 cm.

Plain weave linen canvas, thread count 14 x 18 threads/cm^2.

Paint and ground

Priming:
Commercial priming on reverse, off-white

Paint description:
Thinly applied black background, with reserve of canvas left to form rectangular shape. It appears that the black was applied in two layers, with a dark intense black applied thinly to the canvas, almost like a stain, followed by a thicker matt black layer on top. There is a reserve of unpainted canvas around the white square and circle surrounding the figure.

The figure was first outlined in thin black paint, on which white-pink is applied, with some impasto. The pink appears to be thinly applied, over the white. There is also a pale diffuse blue colour in some areas, probably from a spray paint. Spatters of orange and blue paint over the white circle, possible red-orange spray or powdered pigment. There are brownish-grey fluffy spots of what appears to be dust on the white paint of the circle (figure E.F36.3). Yellowish paint is used for the edge of the chair seat. There is also an area of pink paint at the top of the cut-out area, forming the forehead of the figure. The paint here appears to be fractured in a more rubbery way, possible indicating a different medium/age of paint. The forehead appears to be applied over the white paint of the square. This paint also appears to applied over an earlier outline of the figure, which can be seen faintly under the white to the right of the elbow (figure E.F36.2).

A black ring approx 3.5cm in diameter is present on the foot – this appears to be an impression left, e.g. by the neck of a jar (figure E.F36.1).

A glossy surface is apparent over some areas of the figure, e.g. in the bottom left of the square and the area of elbow also within the white square (although near the upper corner of cut canvas this is covered by a further layer of white with blue spray). The pink paint below the square has a matt surface.

Surface coatings/gloss

Fairly matt, slight gloss in flesh

Samples taken

No.	*Colour*	*Location*
1	Blue spray over white (over pink– left behind?)	Corner of cut canvas, 76 cm from right, 116 cm from bottom.
2	Pink over white	Loose piece from cut edge, 54 cm from left, 116.5 cm from bottom.
3	Priming	Back of canvas, taken from black cut edge
4	Black scraping	Background, left edge, 61 cm from top
5	White + pink spray	White square, loose piece from cut edge, 68 cm from right, 54 cm from top.
6	Pale pink	Forehead, loose piece from cut edge, 64 cm from left, 52 cm from top.
7	Grey over pink-white	Loose piece from cut edge, 57 cm from left, 81.5 from top.
8	Pink over white	Loose piece from cut edge, 67 cm from right, 116 cm from bottom.

Notes

Inscription on back apparently in Bacon’s hand may indicate work was considered completed before being destroyed.

Figure E.F36.1 Detail of foot with round imprint, from jar/lid

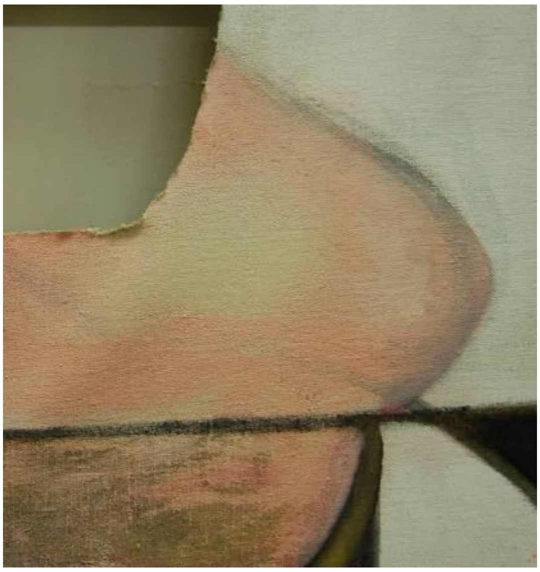


Figure E.F36.2 Detail of figure, with faint outline under white paint to upper right of form

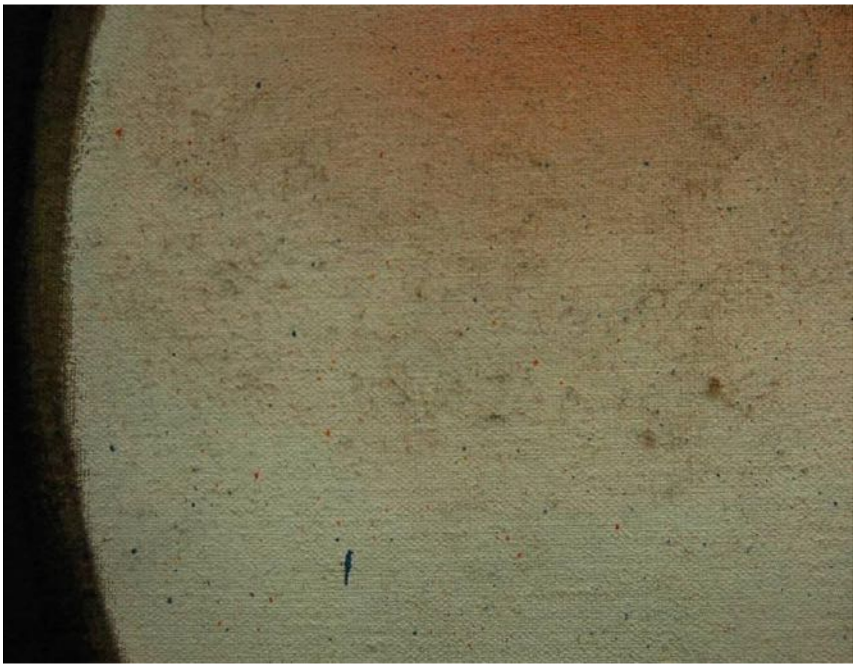
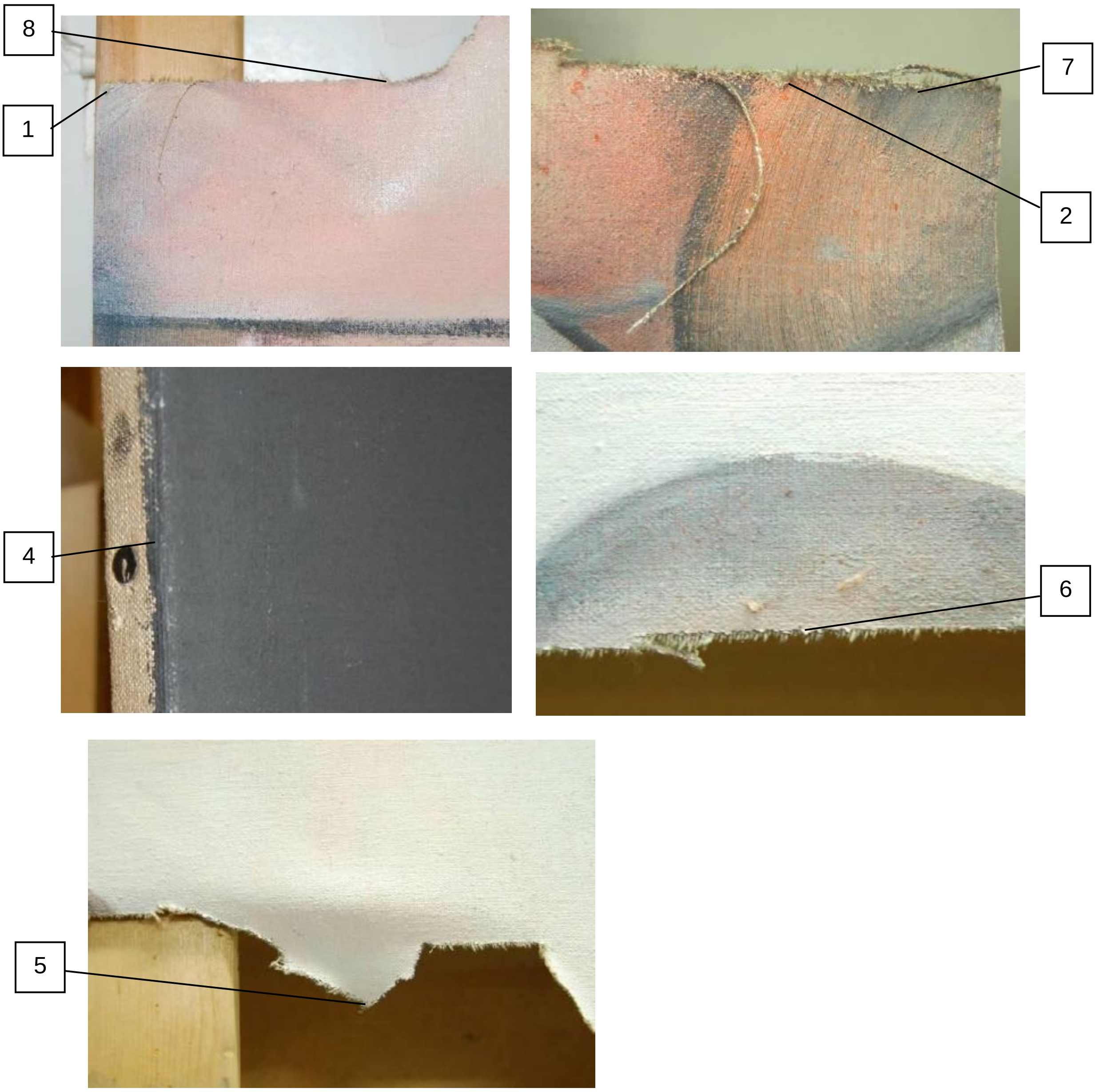
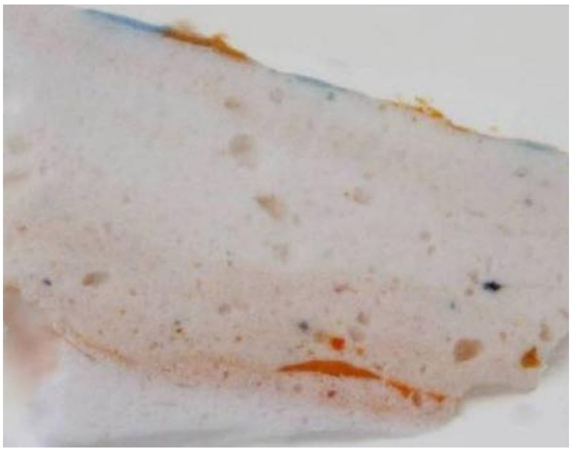
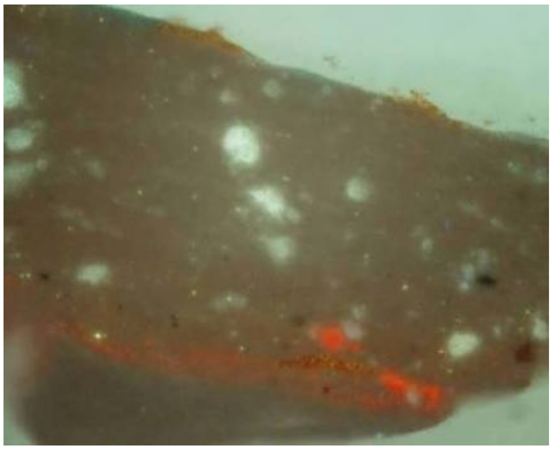


Figure E.F36.3 Detail of dust fibres on white circle, with spots of orange and blue spray also

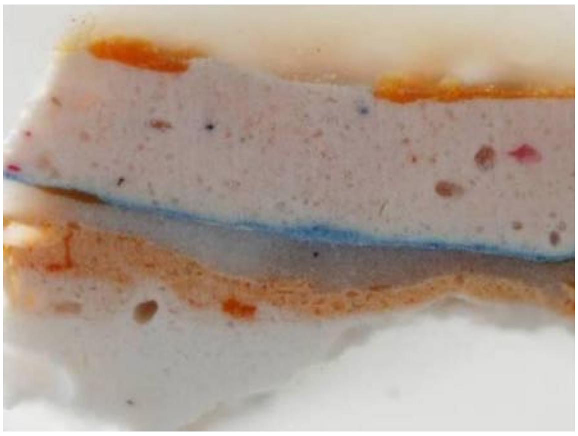


F36-1 Blue spray over white (over pink– left behind?)

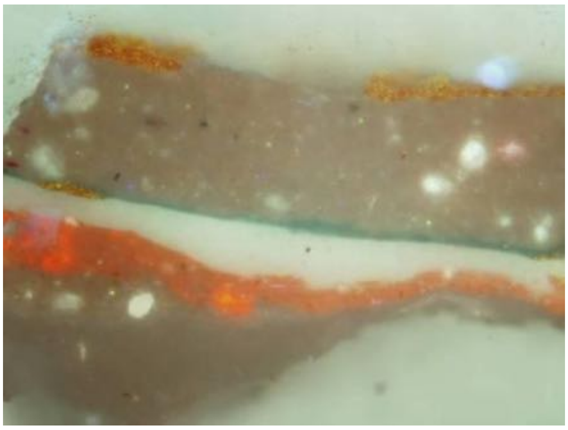

Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F36-2 Pink over white, from figure

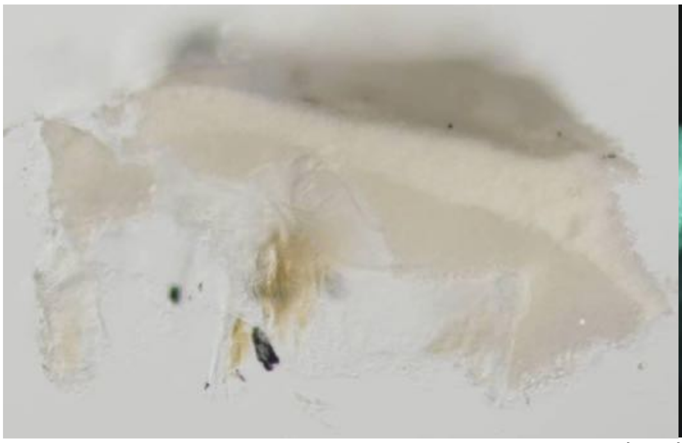


Normal light (taken at x200 magnification)

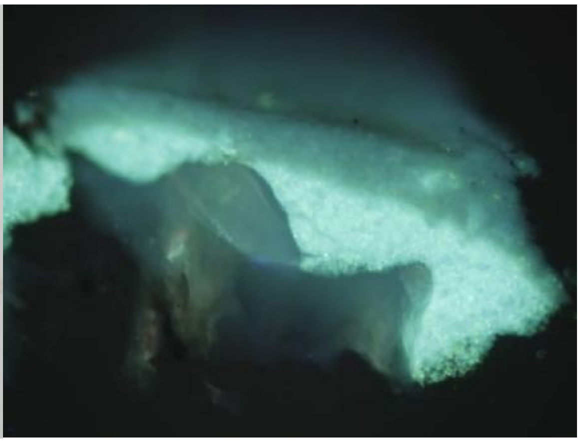


Ultraviolet (x200 magnification)

F36-3 Priming from back



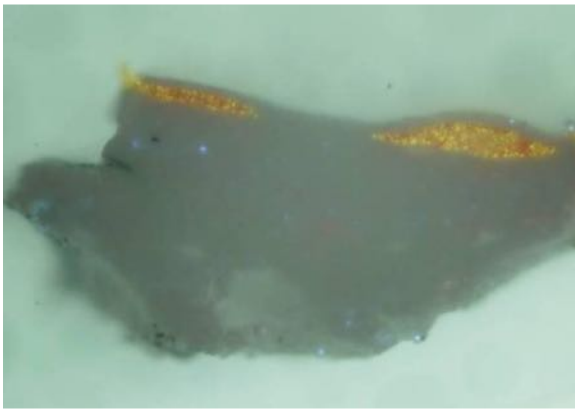
Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

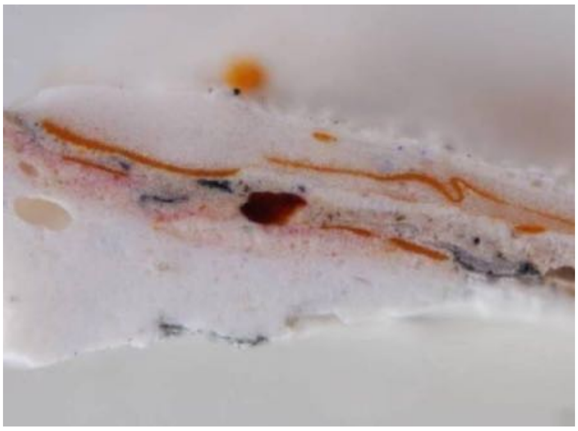
F36-5 White with pink spray

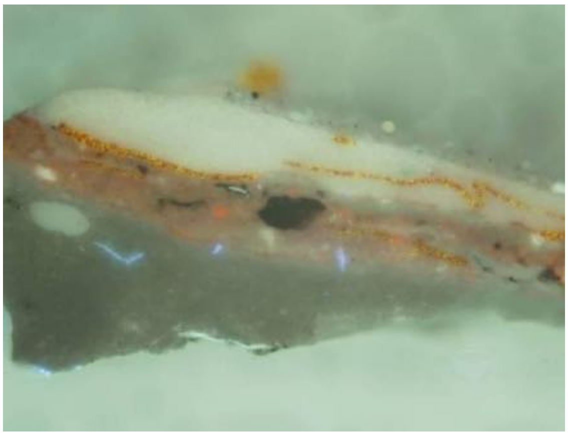
Normal light (taken at x200 magnification)



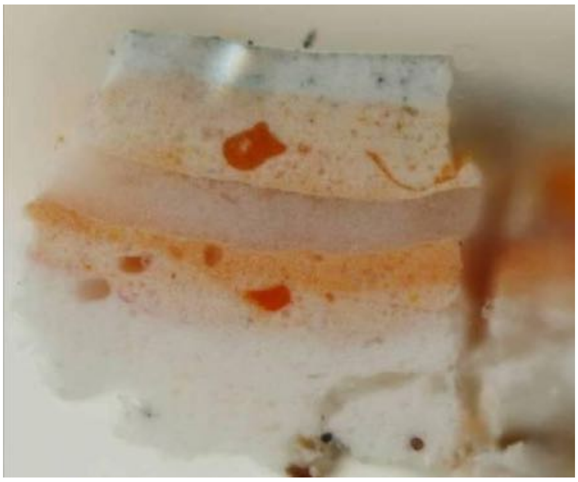
Ultraviolet (x200 magnification)

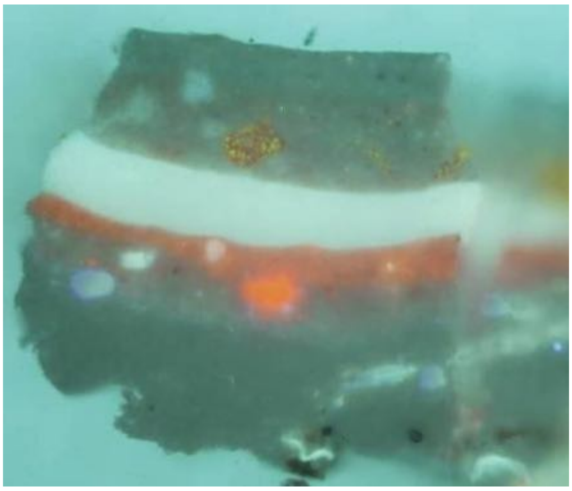
F36-6 Pale pink, from forehead


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

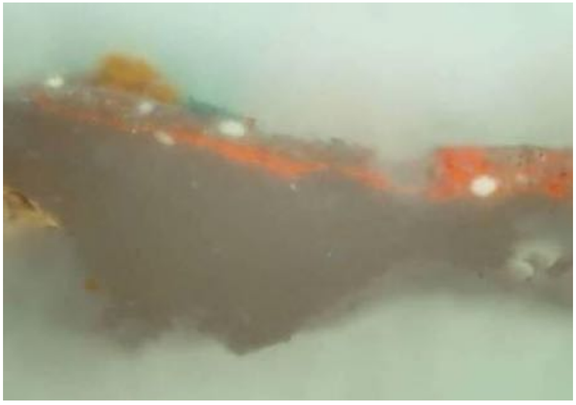
F36-7 Grey over pink-white, from figure


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F36-8 Pink over white, from figure


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Black background	4	GCMS, FTIR	Alkyd (P/S = 3.38, Az/P = 0.18)
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Kaolin
White square	5, 7	PyGCMS	Acrylic MMA-EHA copolymer
		SEM-EDX	Titanium white
		SEM-EDX	Kaolin
		SEM-EDX	Chalk
Pink-white flesh paint	1	FTIR, GCMS	Oil (P/S = 4.01 Az/P = 0.13)
		FTIR	Titanium white
		FTIR	Magnesium carbonate
		FTIR	Barium sulphate
Orange spray	2	FTIR, PyGCMS	Nitrocellulose-alkyd
Pink flesh paint	2	FTIR, GCMS	Oil (Az/P = 1.44, P/S = 3.02)
		SEM-EDX	Titanium white
		SEM-EDX	Zinc white
		SEM-EDX	Cadmium pigment
		SEM-EDX	Magnesium carbonate
Blue/red? spray	1, 2, 7	FTIR, PyGCMS	Styrene medium (U-spray paint)
Priming	3	FTIR, GCMS	Oil (P/S = 2.23 Az/P = 0.78)
		PyGCMS	Acrylic (MMA-BA)
		FTIR, SEM-EDX	Barium sulphate
		FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Titanium white

Conclusions

Oil paint was found in samples 1 and 2, in layers of (mainly white) flesh paint. This paint has the same extenders found in Winsor & Newton titanium white paint, including fluorescent particles of magnesium carbonate. It’s probable that all of figure is painted in oil, but is applied over acrylic paint in some areas. The white layer at the base of many samples (1, 2, 6, 7, 8) has large amounts of chalk and kaolin extenders and an acrylic medium, so appears to be a white household paint. It appears that this is the white paint used for the square in the background.

Below the area of the white square bare canvas is visible and it appears that the paint of the figure (presumably oil) has been applied directly on to the canvas, as in Bacon’s usual practice. The white circle appears to have been filled in after the lower part of the figure, with white paint applied around the foot and stool. This may mean that the figure was first painted onto the canvas, then the upper part was covered by the white square, before further working of the upper part of the figure on top. However, no evidence of a first oil paint layer has been found in any of the samples taken from the area of the white square – maybe because the layer is thin and fragmentary. It appears that a transparent coating material has been used over some layers of flesh paint – not identified. Both styrene and alkyd-nitrocellulose spray paints are indicated by pyrolysis.

The black paint in the background appears to be an alkyd – household gloss paint? Large amounts of chalk suggest blackboard paint, or other non-artist paint. Chalk is used as an extender and possibly as a matting agent.

Untitled (Figures on carpet)

Identification details	
Title: F39 Figure study (figures on carpet)	*Date:* c.1959-63
Dimensions (hxwxd): 142 x 164.8 x 2 cm	*Location/owner:* Hugh Lane Gallery (RM98F39)

Marks/Inscriptions:

Stamp on vertical stretcher bar: ‘118’
Stamp on vertical stretcher bar: ‘Prepared / ...oberson& Co Ltd./ 71 Parkway, London NW1’

Dark pencil(?): ‘32½ x’ on right hand horizontal cross-member, ‘56’ on vertical cross member.

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
7-member softwood stretcher, mitred mortise and tenon joints. Outer members width 2 (1/8)“ (5.3 cm), depth ¾ “ (1.9 cm), Cross bars width 2 (1/8)“ (5.3 cm), depth 5/8” (1.5 cm)

Light grey metal tacks, 9-11 cm spacing, 7mm diameter. Canvas is stapled to back of stretcher, 22-25 cm spacing.

Linen, plain weave canvas, 16 x 22 threads/cm^2, 16 warp, 22 weft. Canvas is somewhat yellowed

Paint and ground

Priming: on reverse, off-white

Paint description:

Dark blue stain to canvas in upper background – may have been applied first over whole surface. At cut edges, the canvas fibres appear to be stained blue. Gritty sandy-coloured paint with light blue irregular ring shapes forms carpet. Figures in black, grey and pink paint, with dark blue smears, very thick in places. Upper part of figures cut out and removed leaving an irregular shaped hole. Thickness of paint can be seen at cut edges. Paint appears quite brittle and has flaked off in places – may indicate it was destroyed some time after completion. Several other cuts into canvas also. Canvas revealed where paint has flaked away appears blue, with white in interstices.

Stippled texture on pink in figures, with swirls of black and glossy pink paint. There is a pink-purple shape in gritty paint to the upper right of the figures, possibly painted over a change in composition (figure E.F39.2). Pink smeared with beige colour in carpet.

Black lines on top of beige form framework and steps. Dark red, pink and white lines over dark blue in upper background – may remain from earlier composition (in portrait format?), see figure E.F39.1.

Surface coatings/gloss

Thick layer of dust on back

Samples taken

No.	*Colour*	*Location*
1	Pale blue over beige	Left cut edge, 48.5 cm from left, 47.5 cm from top
2	Dark blue over pink	Thick paint, edge of cut canvas, loss, 72.4 cm from left, 67.5 cm from top
3	Sandy colour over pink	Right cut edge, edge of loss, 87.5 cm from right, 46.5 cm from top
4	Dark red-pink spot at base of figures	Cut edge,79 cm from left, 97 cm from top
5	Pale pink, glossy paint over blue/white canvas	Thick paint, loss at edge of cut, 64 cm from right, 66 cm from top
6	Priming	Off-white priming from reverse.

Notes

The blue background in this work is similar to that used in some of the 1953 *Pope* series and 1954 *Man in Blue* series, with the white lines forming some sort of architectural feature. The lines also suggest the canvas was first used in the ‘portrait’ orientation, before being turned on its side, and the earlier composition was covered by the figures and beige carpet. Patches of a slightly different colour within the carpet area suggest an earlier figure composition which was painted over. The carpet with dappled pattern is used in several works including *Reclining Woman* 1961, *Man and Child* 1963.

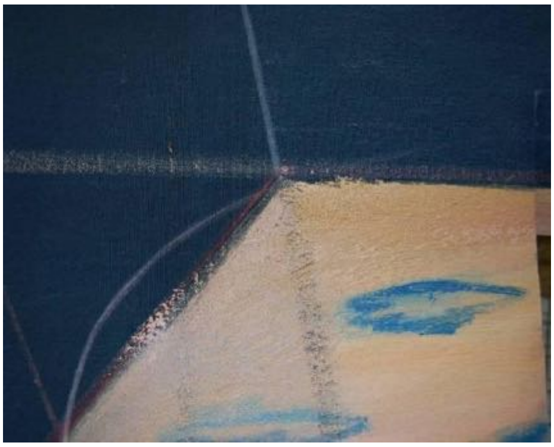
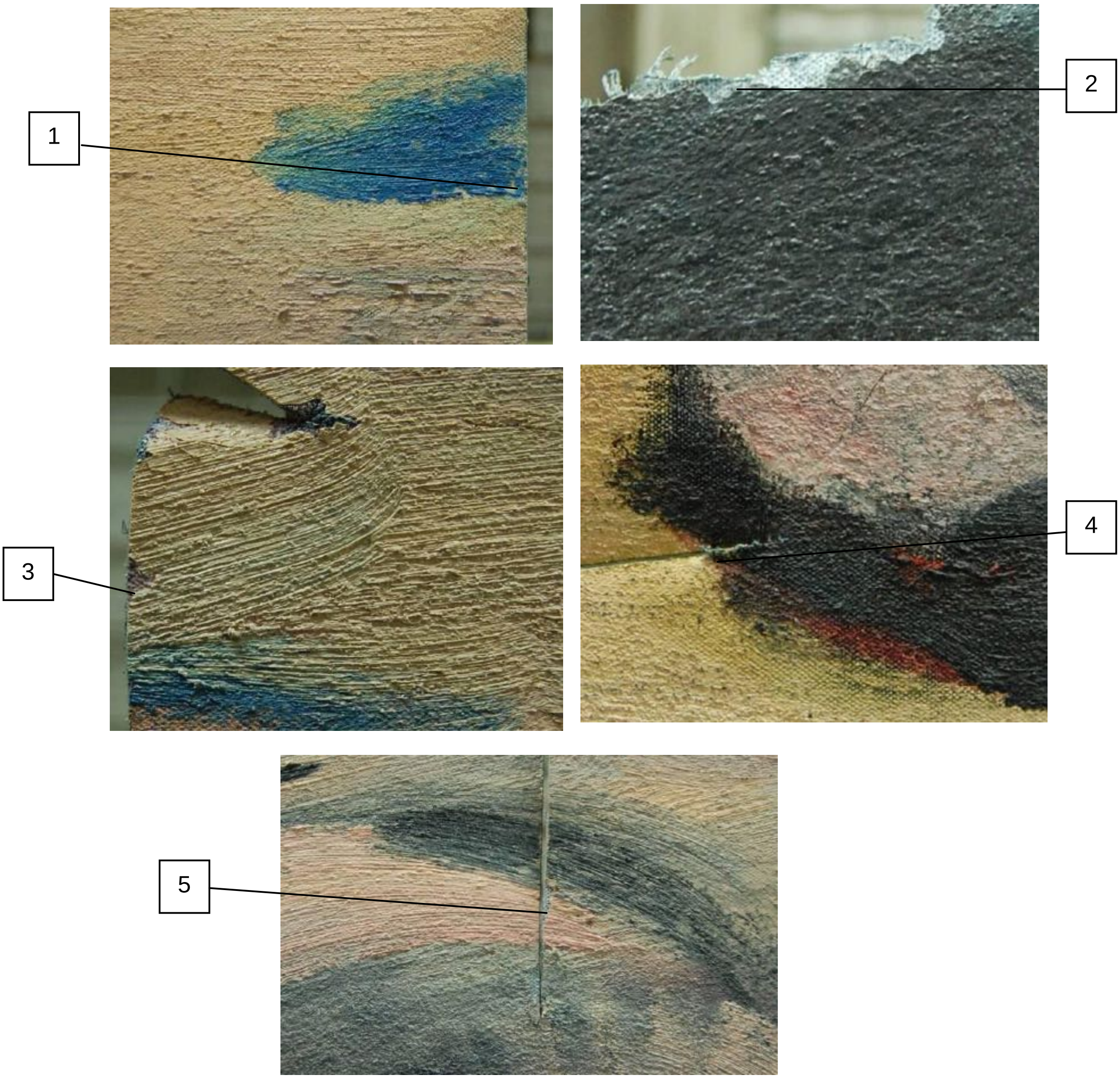
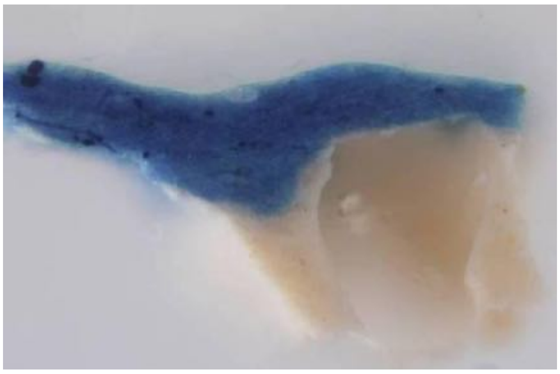


Figure E.F39.1 Detail with lines painted over dark blue to upper left of carpet corner. The curved line could be part of vaulting seen in many pope paintings.

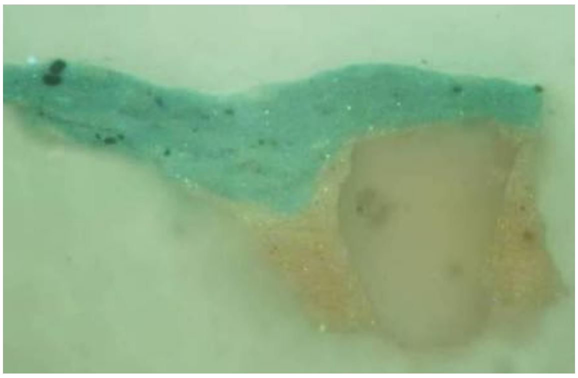
Figure E.F39.2 Area of pinkish paint in carpet to upper right of figures, possibly painted over change to composition



F39-1 Light blue over beige from carpet

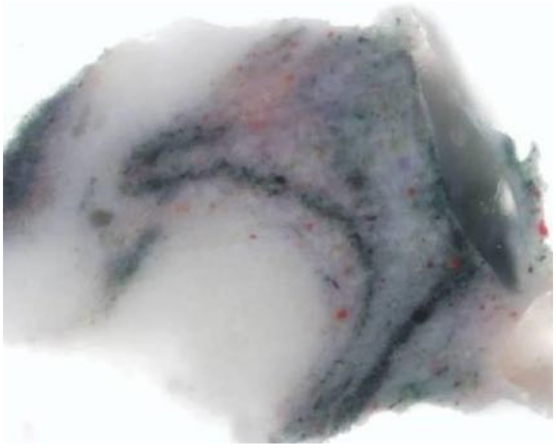


Normal light (taken at x200 magnification)

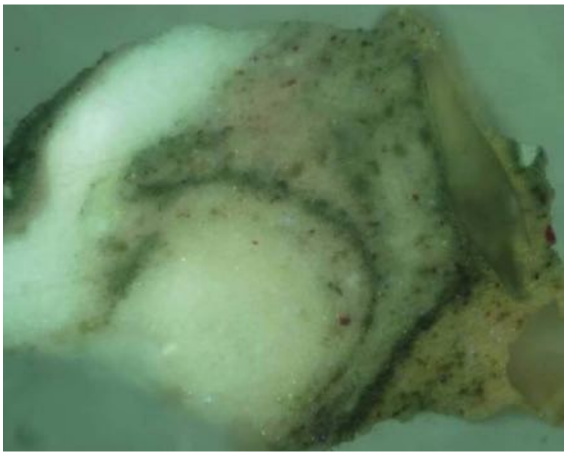


Ultraviolet (x200 magnification)

F39-2 Dark blue over pink



Normal light (taken at x200 magnification)

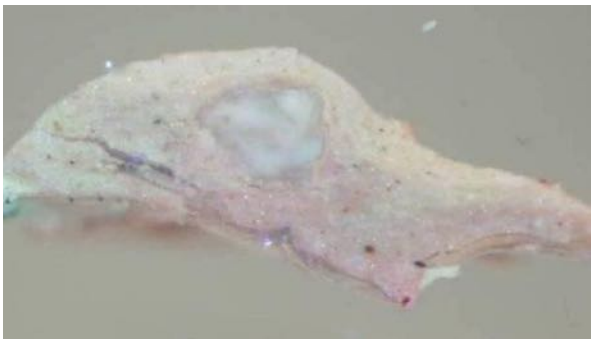


Ultraviolet (x200 magnification)

F39-3 Beige from carpet, over pink

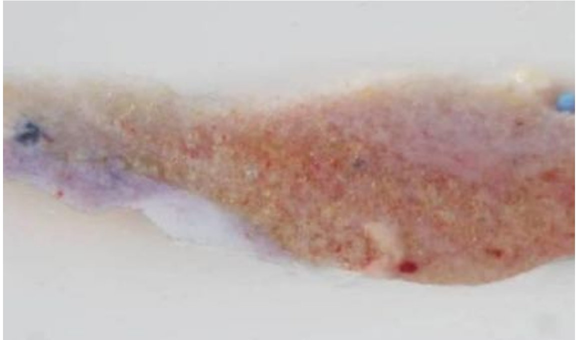
Sample a

Normal light (taken at x50 magnification)

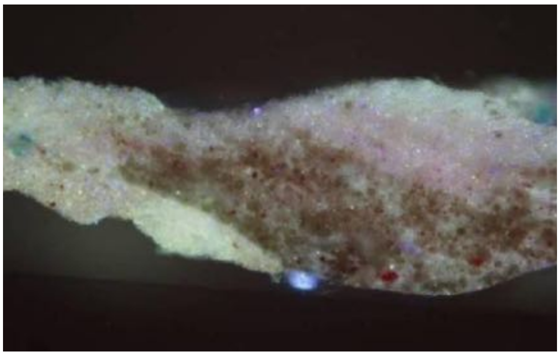


Ultraviolet (x50 magnification)

Sample b

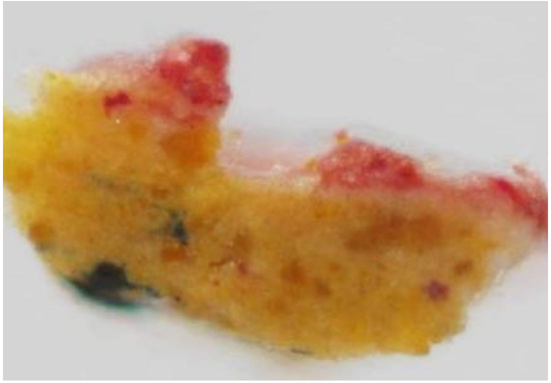


Normal light (taken at x200 magnification)

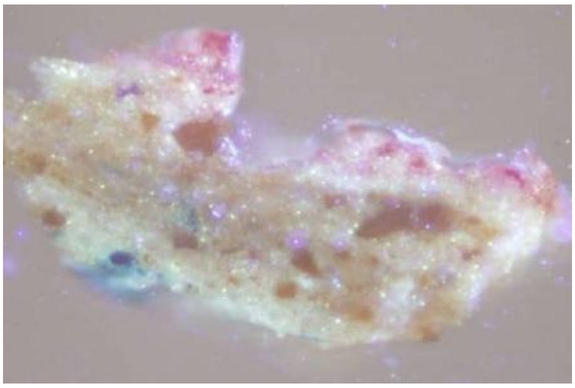


Ultraviolet (x200 magnification)

F39-4 Dark red-pink spot at base of figures

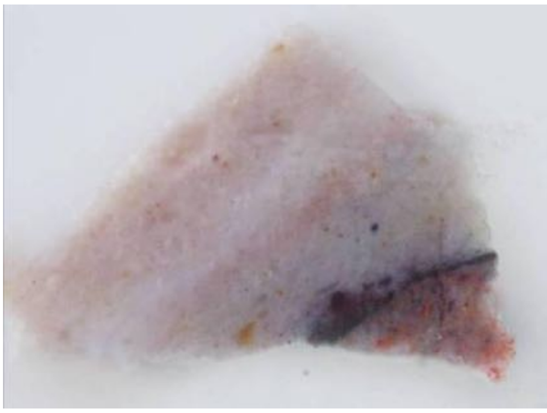


Normal light (taken at x200 magnification)

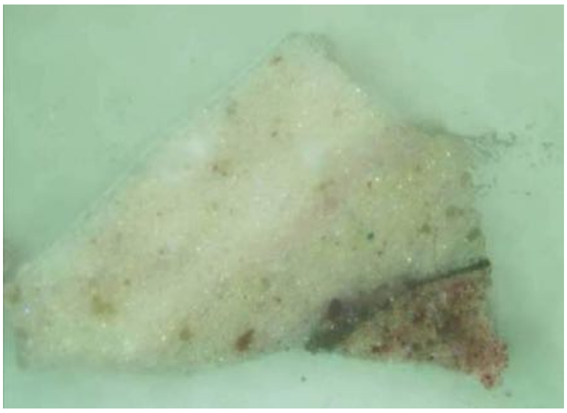


Ultraviolet (x200 magnification)

F39-5 Pale pink, glossy paint over blue/white canvas



Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*sample*	*Analysis*	*Materials identified*
Pale blue	1	FTIR	Oil
		FTIR, SEM-EDX	Prussian blue
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
Beige	1	FTIR, GCMS	Oil (P/S = 3.28 Az/P = 0.56)
	1, 3	FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Sand
Flesh paint under blue	2	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Sand
		SEM-EDX	Cobalt arsenate?
		SEM-EDX	Barium chromate
		SEM-EDX	Iron oxide
Pink under beige	3	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Barium chromate
		SEM-EDX	Alizarin crimson
Blue-black	2	SEM-EDX	Ivory black (one particle)
		SEM-EDX	Lead white
Dark blue stain	4, 6	SEM-EDX, FTIR	Prussian blue
Dark yellow	4	SEM-EDX	Yellow ochre
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
Pale pink flesh	5	FTIR, GCMS	Oil (Az/P = 1.75, P/S = 3.75)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
Dark pink	5	SEM-EDX	Vermilion
		SEM-EDX	Cobalt arsenate
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
Dark layer	5	SEM-EDX	Alizarin?
		SEM-EDX	Cadmium red?
Red	4	SEM-EDX	Lead white
		SEM-EDX	Organic red?
Priming	6	FTIR, GCMS	Oil (P/S = 2.20, Az/P = 2.05)
		FTIR	Protein size layer
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Aluminosilicate

Conclusions

The binder was analysed in two samples and in both cases found to be oil.

Prussian blue was used as a stain initially over the whole canvas. Lead white with a little zinc white is used as the white in all cases. Sand is added in the carpet and some areas of flesh paint.

The pigments cobalt arsenate, barium chromate, vermilion, cadmium red and probably alizarin crimson were found in different areas of flesh paint, with flake white. Some chlorine was found in red samples, possibly a chlorinated organic pigment.

Untitled (figure study)

Identification details	
Title: F41 Figure study (purple/black)	*Date:* 1960/70s
Dimensions (hxwxd): 198.5 x 145 x 2 cm	*Location/owner:* Hugh Lane Gallery (RM98F41)

Marks/Inscriptions:

‘78’ in dark pencil(?) on right vertical stretcher member
39x on vertical cross members, 57 on horizontal cross member.
Remnants of paper label on horizontal cross-bar, red printing: ‘...R/B? SO.. &.......d.

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
7-member softwood stretcher, mitred mortise & tenon joints. Outer members width 2“ (5 cm), depth ¾ “ (19 mm), Cross bars width 2“ (5 cm), depth 5/8” 1.5 cm.

Grey metal tacks, 9-10 cm spacing, 7 mm diameter. Canvas is stapled to back of stretcher with steel staples, 20-27 cm spacing.

Linen, plain weave canvas 16-7 x 22 threads/ cm^2, 16-7 warp, 22 weft. Canvas is somewhat yellowed.

Paint and ground

Priming: on reverse, off-white

Paint description:
Glossy purple paint in background, applied over white layer. Purple has slightly uneven colouring, with some more pink or more blue patches, gritty texture (probably from white layer beneath). Dark blue stain to canvas in central panel of background, with black textured gritty paint, applied on top (figure E.F41.1). A stripe of dark blue remains uncovered at the right side. Black appears to have been applied around figure. Beige gritty paint forms floor, with a stripe in darker beige gritty paint at base. Purple paint was applied after beige floor, as it crosses over onto this at left edge where areas meet. Black lines on canvas delineate areas, left in reserve. There are also black diagonal and horizontal lines applied on top of the beige floor, and red-brown lines forming a box shape. White lines applied over black form spaceframe around figure. Beige floor applied round figure.

The figure is thickly painted in black, white and pink, with touches of green also. Large cut out area to the immediate right of figure, including tacking edge, which suggests another figure/compositional feature was removed. Dark blue areas on feet, and smeared through beige background between feet. The beige paint may have been applied on top of blue drawing on the canvas. Thick gritty paint on figure, with the face area being particularly thick. Cloth texture in black in front of face area? White applied with impasto, smeared & mixed with red and purple on canvas. Bright green underlayer shows through in several areas in texture, under pink/grey surface layers.

Ten small holes through paint and canvas in purple and black areas, approximately in horizontal line, 46-48.5 cm from top, some in pairs.

Surface coatings/gloss

Slight sheen in flesh paint, black paint is fairly glossy, with sparkly appearance due to grit.
Dark blue stained area is very matt.
Thick layer of dust on curled-over edge of canvas at bottom of window.

Samples taken

No.	*Colour*	*Location*
1	Purple background, over white	Upper cut edge, 3 cm from right, 46.5 cm from top
2	Black textured paint	Upper left cut edge, 57.5 cm from right, 47.5 cm from top
3	Beige textured paint	Lower cut edge, right side, 0.5 cm from right, 68.5 cm from bottom
4	Dark blue over pink	Left cut edge, top of triangular loss, 58.5 cm from right, 66.5 cm from top
5	Green in texture in black	Figure, 66 cm from right, 66 cm from top
6	Priming	Off-white priming from reverse.

Notes

The figure appears similar in style to several ‘Figure Turning’ paintings made in 1962-3. In particular *Figure Turning,*1962 (203 in Alley) is particularly similar in composition, with the figure placed in front of a black doorway, with similar framing lines above and below. The lilac colour however appears to be more of a feature of works from the 1970s. The figure might therefore have been completed in the early 60s, but the purple background added considerably later, over another background colour, or over bare canvas. The cutting away of the area in front of the figure is interesting, as it suggests another focal point of the composition was here, unlike in the other *Figure Turning* works. Unusually, much of the figure has escaped destruction and remains intact.

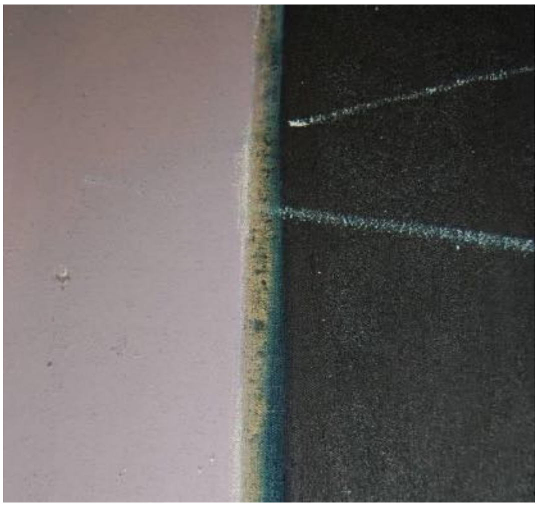
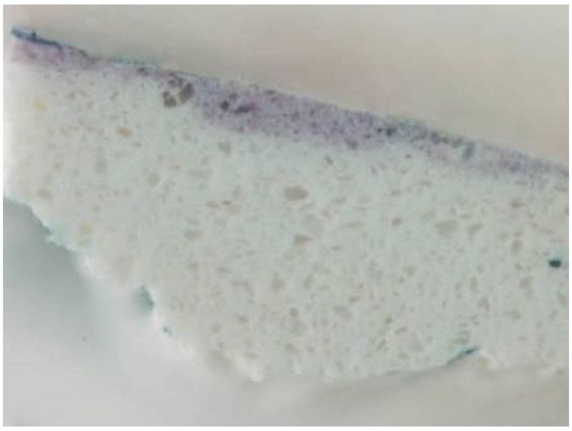
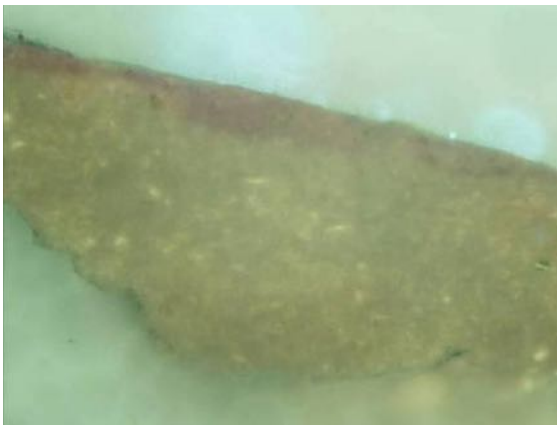


Figure E.F41.1 Upper left area of background showing line of bare canvas between purple and black areas, and edge of blue stain applied first to canvas under black layer

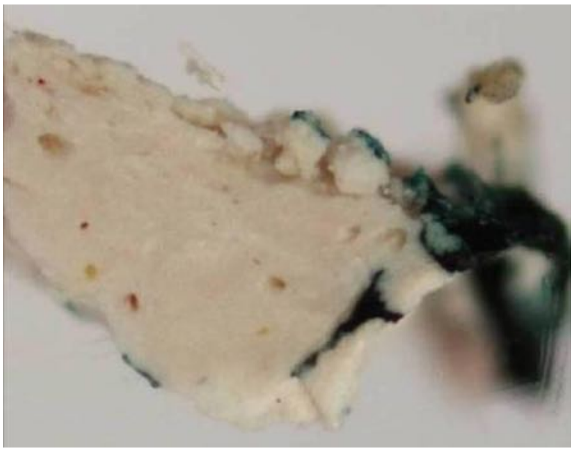
Figure E.F41.2 Detail of figure, showing brushstrokes in black/dark blue on leg

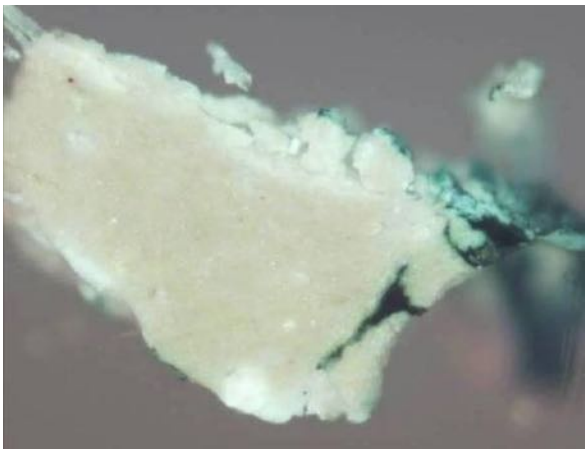
F41-1 Purple over white from background

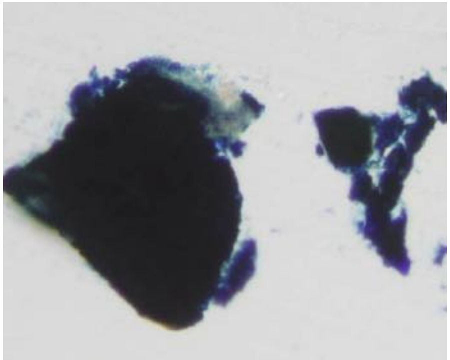

Normal light (taken at x200 magnification)

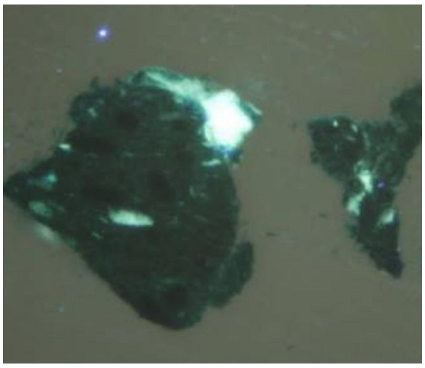

Ultraviolet (x200 magnification)

F41-2 Black over beige

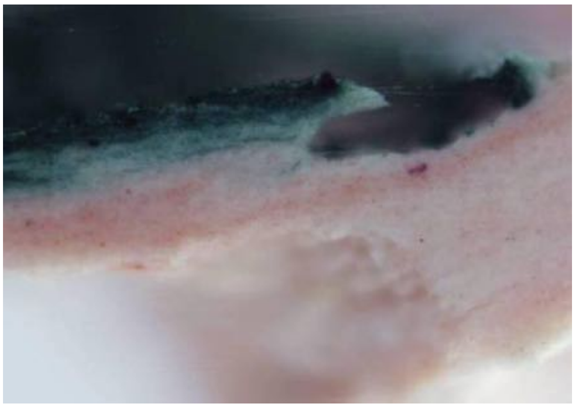

Normal light (taken at x200 magnification)

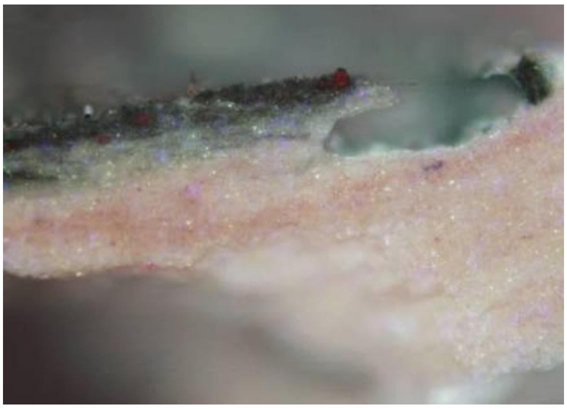

Ultraviolet (x200 magnification)


Normal light (taken at x200 mag.)

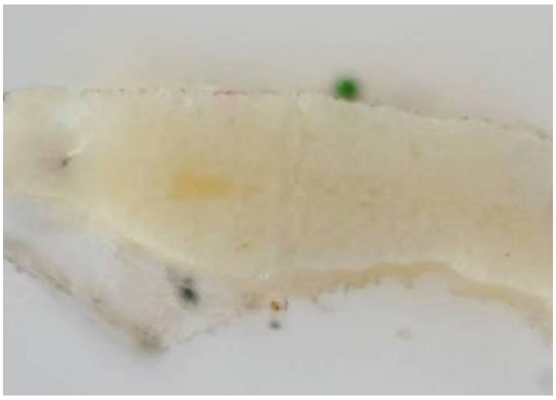

Ultraviolet (x200 magnification)

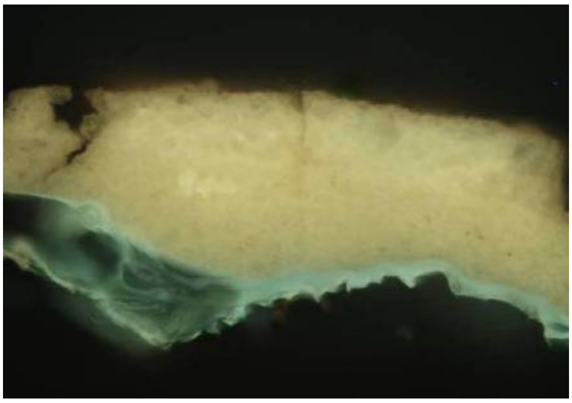
F41-4 Blue over pink


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F41-6 White priming on reverse


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*sample*	*Analysis*	*Materials identified*
White under purple in background	1	FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Titanium white
		SEM-EDX	Magnesium carbonate/dolomite?
Purple	1, JS1*	SEM-EDX	Chalk
		SEM-EDX	Titanium white
		SEM-EDX	Silica
	JS1*	SEM-EDX	Cobalt violet?
		SEM-EDX	Manganese violet?
Beige	3	FTIR, GCMS	Oil (P/S = 1.23 Az/P = 1.33) + additive?
		FTIR	Lead white
		FTIR	Silica
White under black	2	SEM-EDX	Lead white
		SEM-EDX	Zinc white
Blue-black	2	FTIR, GCMS	Oil (P/S = 2.02 Az/P = 0.61)
		FTIR, SEM-EDX	Prussian blue
		FTIR, SEM-EDX	Magnesium carbonate
Pink	4	FTIR, GCMS	Oil (P/S = 3.12 Az/P = 0.38)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Cobalt violet
	JS2*	SEM-EDX	Cadmium red
Blue	4	FTIR, SEM-EDX	Prussian blue
		SEM-EDX	Alizarin
Green	5	SEM-EDX	Phthalocyanine green
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
Priming	6	FTIR, GCMS	Drying Oil, linseed? (P/S = 1.61 Az/P = 1.61)
		FTIR	Protein size layer
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk

*Sample taken, mounted and analysed by Joanna Shepard, Head ofConservation at Dublin City Gallery The Hugh Lane.

Conclusions

An oil medium was detected in three samples – from flesh, black and beige areas of background. The purple paint was thought to be a household paint with a synthetic medium, but this was not identified. Both white and purple layers were mainly titanium white with chalk and silica extenders. Other samples had lead white pigment and appear to be artists' oils. Prussian blue was present in flesh paint and black background. Sand appears to be mixed into the beige paint and probably also in the black area, but this was not detected in the sample.

The commercial oil priming has two layers of chalk and lead white over a protein size layer.

F48 Figure study, c.1965

Identification details	
Title: F48 Figure study (orange background)	*Date:* c.1965
Dimensions (hxwxd): 198 x 147 x 2 cm	*Location/owner:* Hugh Lane Gallery (RM98F48)
Marks/Inscriptions: Pencil on horizontal x-member: ‘58’ Pencil on vertical cross members: ‘39x’	
Support	
Type: Canvas / Board / Paper / Stretcher / Strainer	
Description: 7-member softwood stretcher, mitred mortise and tenon joints. Outer members width 2“ (5 cm), depth ¾“ (1.9 cm). Cross bars width 2“ (5 cm), depth 5/8” (1.5 cm). Grey metal tacks, 9-11 cm spacing, 6-7 mm diameter. Canvas is stapled to back of stretcher with steel staples, 17-20 cm spacing. Orange splashes on tack heads. Linen, plain weave canvas 16 x 22 threads/cm^2, 16 warp, 22 weft. Canvas is yellowed	
Paint and ground	
Priming: on reverse, off-white	

Description:

Rusty orange paint in upper background, fairly thin, slightly uneven application (applied using broad brush?). The rest of the canvas is largely unpainted. Canvas may have been roughened before orange was applied. Difficult to tell if unpainted canvas has the same texture. Two rectangular cut-out areas remove a large amount of central section of canvas 33 x 61 cm and 90-96 x 65 cm in dimension. Several other cuts to canvas in lower area.

Thin pink lines sketch lower part of figure below left hand cut-out. Lines in darker red/pink at left side of figure. There is also a horizontal line in orange, which appears to be the same as the background colour. Several vertical drips of orange on bare canvas. Thin black lines outline bench/platform?. Some lines in dry paint dragged over the canvas surface, others in wetter paint absorbed into canvas like stain. Lines appear to show changes in positioning of legs and bench.

Black outline of foot protrudes below right hand cut-out area, with a small area of pale pink dry paint to the left of this. There was probably a figure in this area, now almost entirely cut away. Small peaks of impasto in pale pink, textured, may have sand sprinkled on top.

A thin black line separates the orange background from the unpainted canvas below, at left side.

Surface coatings/gloss

Some dust on curled-over edge of canvas at bottom of windows.

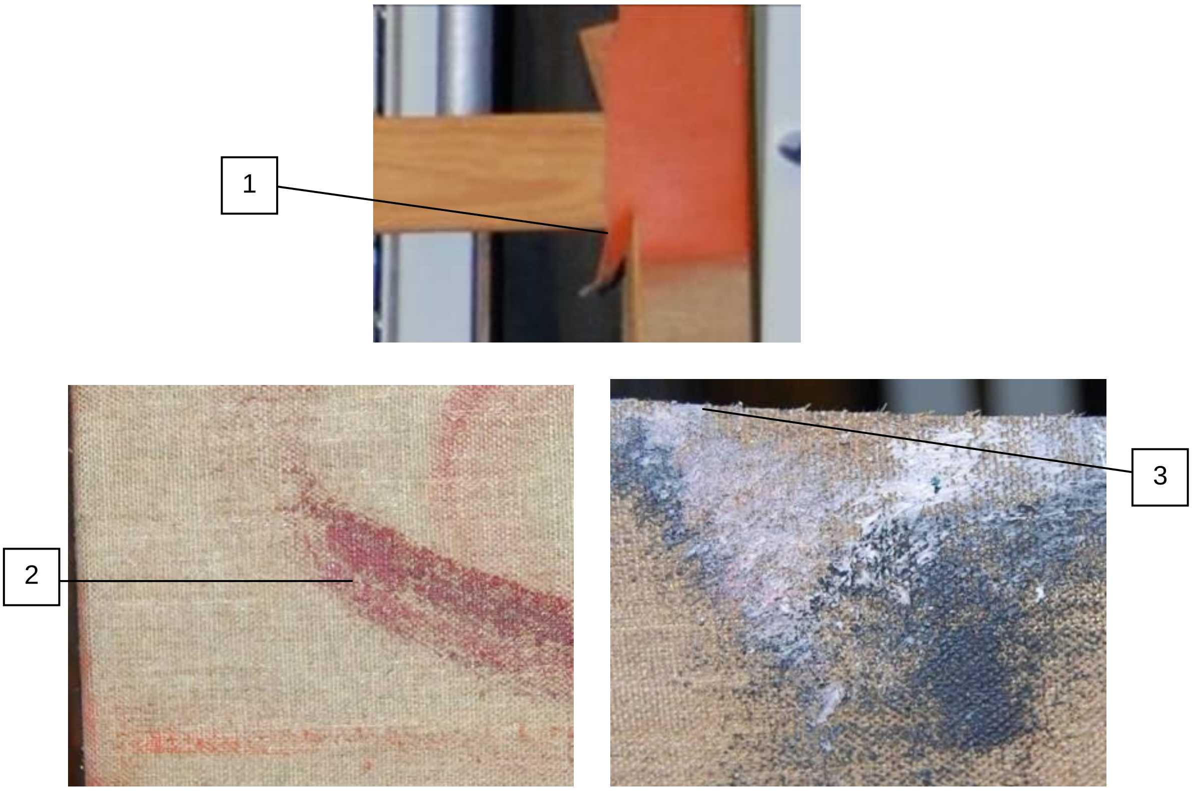
Samples taken

No.	*Colour*	*Location*
1	Orange background	Right edge of right hand cut window, 6.3 cm from right, 99.5 cm from top
2	Dark red scraping	Dark red stroke left edge of sketchy figure. 4 cm from left, 100 cm from top
3	White/pale pink	Pale pink area left of foot outline, fleck with fibrous material(?) 49 cm from right, 44 cm from bottom
4	Priming	Off-white priming from reverse.

Notes

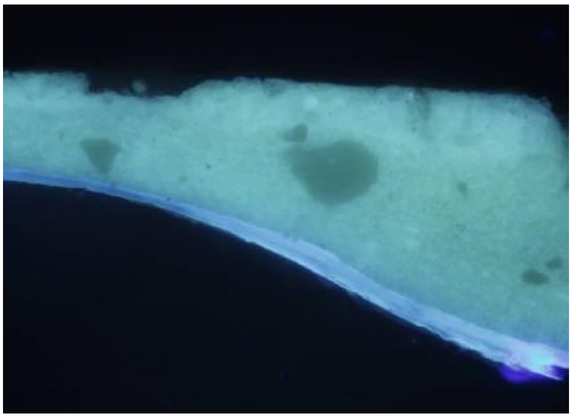
Pink/black sketchy lines very thin – sampling difficult

Painting may be first (or alternative) version for left hand panel of Crucifixion 1965



F48-4 Priming from verso

Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Orange background	1	GCMS, FTIR	Oil (P/S = 2.75 Az/P = 0.41)
		FTIR, SEM-EDX	Magnesium carbonate
		SEM-EDX	Vermilion
		SEM-EDX	Zinc white?
Dark red	2	SEM-EDX	Cadmium red
		SEM-EDX	Organic red – alizarin crimson?
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Magnesium carbonate?
White/pink	3	FTIR	Oil
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Sand
Priming	4	FTIR, GCMS	Oil? (P/S = 2.07 Az/P = 0.57)
		FTIR	Protein size
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Aluminosilicate
		FTIR, SEM-EDX	Titanium white

Conclusions

All samples have an oil medium. Vermilion is present in the red-orange background, with magnesium carbonate extender (also found as an extender with vermilion in samples from several other works, e.g. F50, F51). The dark red appears to be a mixture of cadmium red with alizarin crimson. Lead white and zinc white were found in the white paint, presumably part of a figure, with sand mixed in.

The commercial oil priming consists of two white layers over a protein size layer. The priming is principally lead white in the upper layer, with a mixture of lead white, titanium white and aluminosilicate in the lower layer.

F50 Figure on blue couch, c.1962

Identification details		
Title: RM98F50 (figure on blue couch)		*Date:* 1962
Dimensions (hxwxd): 164.4 x 142.7 x 2.1 cm	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F50)	
Marks/Inscriptions:		

Support
Type: <u>Canvas</u> / Board / Paper / <u>Stretcher</u> / Strainer
Description: 7-member stretcher, fairly knotty wood. Horizontal and vertical cross bars, mitred mortise and tenon joints. Outer members 6.3 cm wide, 1.7cm deep, cross members 6.3 cm wide, 1.3 cm deep. Steel tacks 6-7 mm diameter, 10-12 cm spacing. Plain weave linen canvas, 22 x 16 threads/cm^2.

Paint and ground

Priming:

Commercial priming on reverse, off-white

Paint description:

A very thinly applied black paint is used to stain the canvas to form the background. Similarly thin dark blue paint is used for couch, with reserve of bare canvas between this and the black background.

Rapid brushstrokes in dry black/dark green paint used to outline legs of figure. Overlapping strokes show changing position of legs. Thicker white-pink strokes are used on top, the colours mixing on the canvas. There are strokes of an opaque grey paint here also. Some impasto in the white and pink paint. In a few areas the pale pink colour is smeared into the canvas texture, leaving a smooth surface, may be chalky pastel or dry paint. There also appears to be some dust mixed in/under the white-pink paint strokes in some areas (right of centre).

Thin dry strokes of black paint used to outline floor, width of stroke 4-5 mm, may have been ruled. In the figure strokes vary in width, some 1”, some ½“. Several patches/stokes of paint over the black background in upper left area – white, grey-blue, bright red and maroon. These have the appearance of accidental accretions/brush wipings. Large thick blobs of red-brown and white in lower centre over bare canvas may be accidental. The medium from the brown paint has soaked into the canvas, forming a dark halo.

Faint curved and straight lines in pale blue and pink can be seen towards the top of the canvas. Another curved line just above the centre could outline the contours of the interior.

Surface coatings/gloss

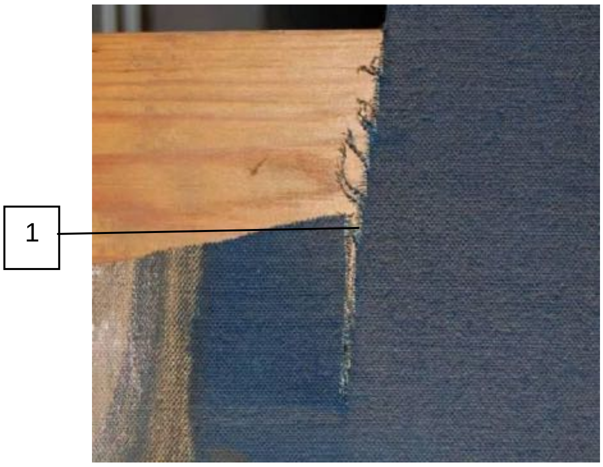
Thick layer of dust over the surface, particularly noticeable on the black and dark blue areas. Presumably from undisturbed storage, rather than intention.

Samples taken

No.	*Colour*	*Location*
1	Dark blue stained canvas fibre	Cut edge of canvas centre right, couch. 59 cm from right, 83 cm from top.
2	Pink	Edge of horizontal cut. 72 cm from right, 85.5 cm from top.
3	Bright pink (+red fleck from same area?)	Bright red-pink stroke, scraping. 82 cm from right ~64 cm from bottom
4	Pink-white impasto	Scraping from near cut edge. 47 cm from left, 86 cm from top.
5	Bright red splodge in background	Upper left, 29.5 cm from left, 60 cm from top
6	Priming	Back of canvas

Notes

Couches of similar design appear in several other works. Similar blue couch seen in central panel of *Three Figures in a Room,* 1964. Similar red couches in double portrait of Lucien Freud and Frank Auerbach 1964. Figure appears fairly incomplete below waist, seems to have been painted on reserve of bare canvas. Presumably figure was more completed in area cut out. Most of background painted in – black room and upper part of blue couch – said to be normally painted in after figure. Rest of couch not painted due to uncertainty about positioning of legs?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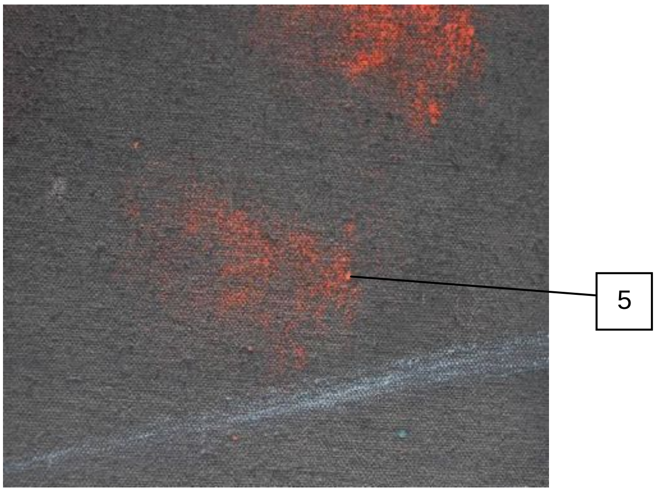
2


3


4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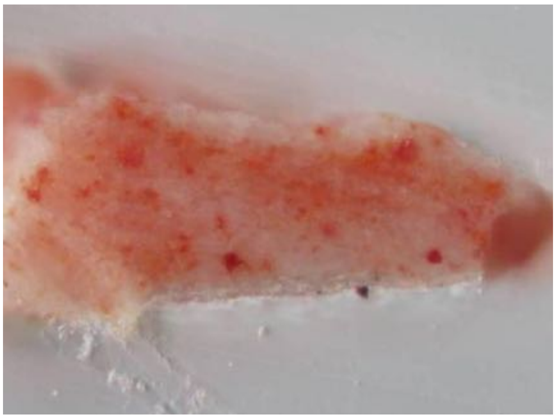
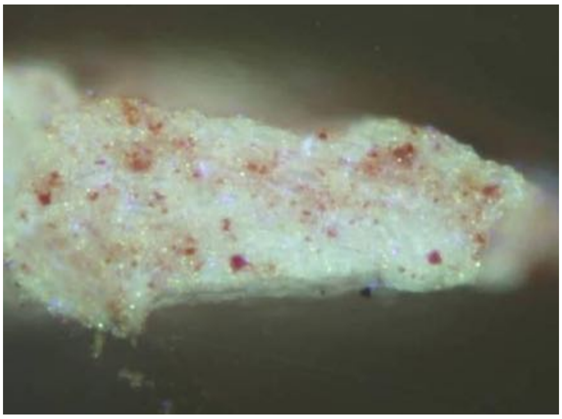
F50-3 Pale pink/white over black

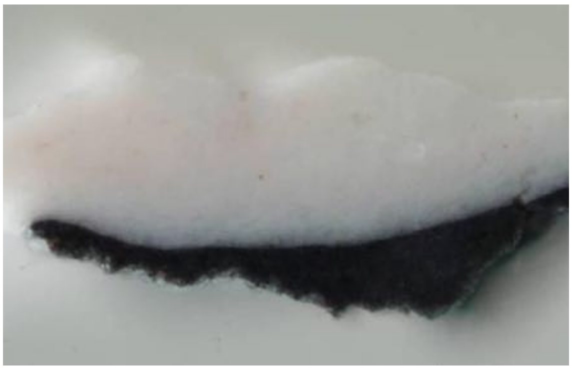


Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

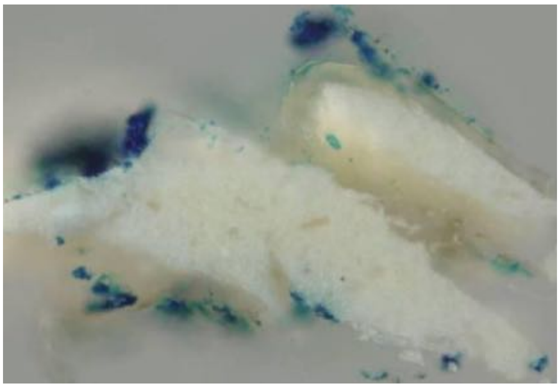
F50-4 Pale pink/white over grey



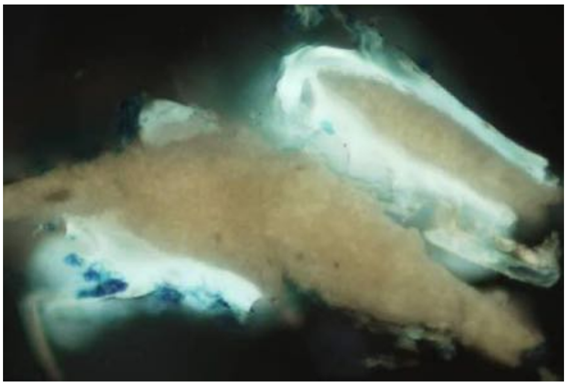
Normal light (taken at x200 magnification)

Ultraviolet (x200 magnification)

F50-6 Priming from reverse



Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Dark blue	1	FTIR	Oil
		FTIR, PLM	Prussian blue
White/pink	4	FTIR, GCMS	Oil (P/S = 2.62 Az/P = 0.52)
		SEM-EDX	Zinc white
	2, 4	SEM-EDX, FTIR	Lead white
Pink	3	FTIR, GCMS	Oil (P/S = 3.52 Az/P = 0.95)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Vermilion
		FTIR, SEM-EDX	Sand
		SEM-EDX	Zinc white
Black/grey	4	SEM-EDX	Carbon black?
		SEM-EDX	Lead white
Red	5	SEM-EDX	Vermilion
		FTIR, SEM-EDX	Magnesium carbonate
Priming	6	FTIR, GCMS	Oil (P/S = 2.75 Az/P = 0.48)
		FTIR	Protein size layer
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Kaolin
		SEM-EDX	Barium sulphate

Conclusions

Oil medium was found in all samples tested. Thin stain of Prussian blue oil paint is used directly on the canvas for the couch. The binder of the black paint also used thinly as a stain was not tested. Strokes of lead white & zinc white with vermilion are used for flesh.

The oil priming has a lead white-based upper layer, with chalk, kaolin and barium sulphate in lower layer. A protein size layer was also detected.

Untitled (Figure)

Identification details	
Title: RM98F51 figure	*Date:* 1960s
Dimensions (hxwxd): 155 x 140.3 x 2 cm	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F51)
Marks/Inscriptions:	

Support
Type: Canvas / Board / Paper / Stretcher / Strainer
Description: 7-member stretcher, mitred mortise and tenon joints. Outer members 2.25” wide, ¾” deep, cross bars 2” wide, ½“ deep. Bluish grey metal tacks, approx 6 mm diameter, 9-10 cm spacing. Plain weave linen canvas, 16 x 22 threads/cm^2.

Paint and ground
Priming: Commercial priming on reverse, off-white

Paint description:

Unfinished, much of canvas is unpainted. Faint lines in green are used to sketch out couch(?), some dry in application, others more wet, where faint green stain has spread out from the line into bare canvas (figure E.F51.1). A thin dark blue is used (like a stain) to form a shape at lower right of figure. A pale pink paint (possibly pastel?) is applied over this. Some areas have a quite chalky appearance. The same dark blue is used to form the knee. Bright pink and pale orange paints used to form legs and feet, some strokes with dry pastel-like appearance. Several vertical strokes are smeared horizontally into canvas texture – a series of horizontal texture marks possibly made by a coarse bristle brush (figure E.F51.1).

A bright red and pink shape appears above the cut-out area. It appears that paint has been scraped off from here in horizontal strokes. There is a rough texture in the dark blue/cloudy area – could be from roughened canvas or added dust.

Surface coatings/gloss

No coating apparent

Samples taken

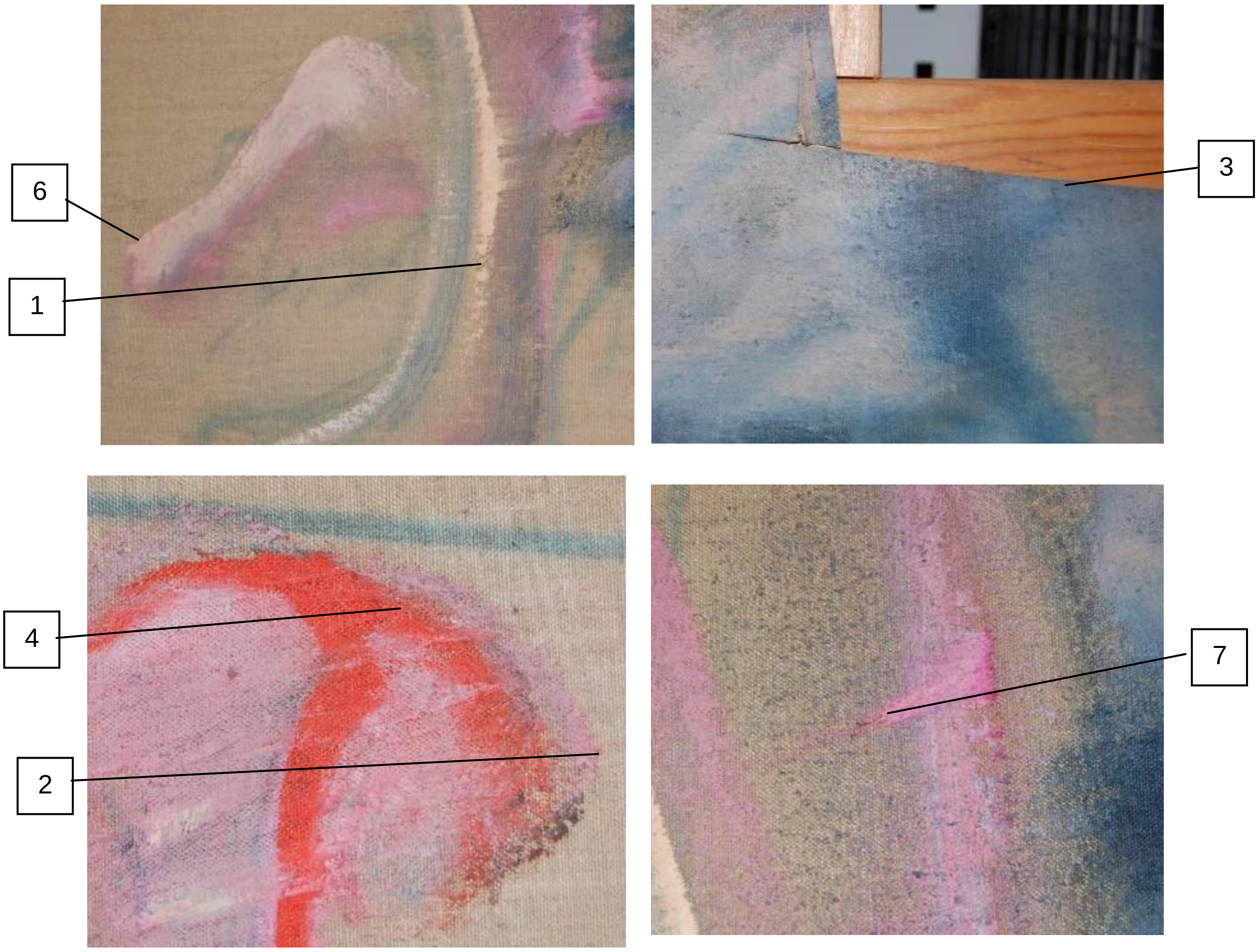
No.	*Colour*	*Location*
1	Pale orange	Stroke down leg, 53cm from bottom, 56cm from left
2	Bright pink	Impastoed stroke, pink shape above cut-out. 42 cm from right, 21cm from top.
3	Pink-blue	Cut edge, 71.5 cm from right, 76 cm from top
4	Bright red	Pink shape above cut-out. 47 cm from right, 18 cm from top.
5	Priming	Back of canvas
6	Orange over pink	Foot, 37.5 cm from left, 53 cm from bottom.
7	Bright pink	Bright pink on leg, 59 cm from left, 68.5 cm from bottom.

Notes

Appears to show a figure on a couch, like that in F50. Red-pink shape may be some form of ‘emanation’, like those seen in George Dyer *Triptych – August 1972*.

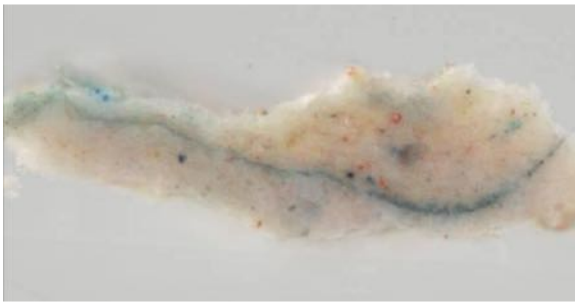
Figure E.F51.1 Left, top left corner of couch outline, showing wet and dry strokes. Right, stroke of orange on calf with horizontal bristle marks.

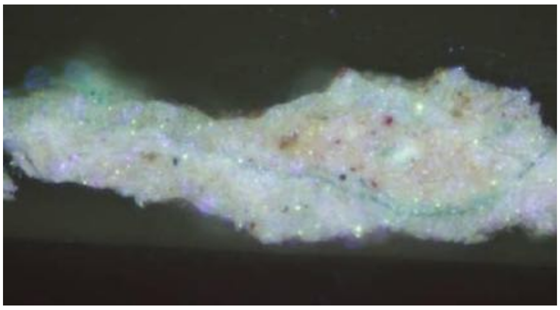
Sample sites



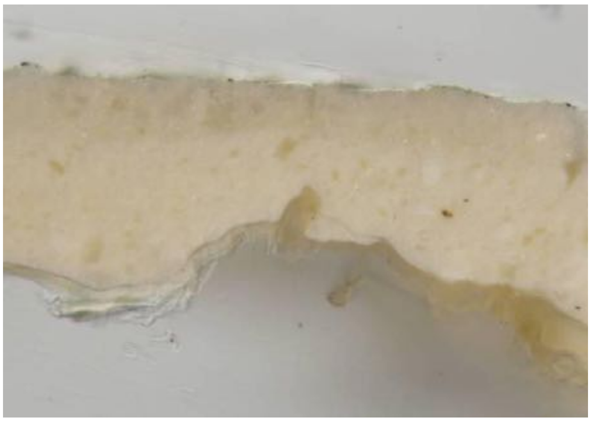
Cross sections

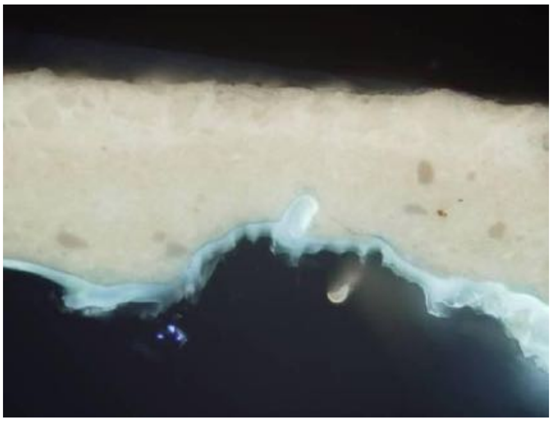
F51-3 Pink-blue smeared paint at cut edge


Normal light (taken at x200 magnification)

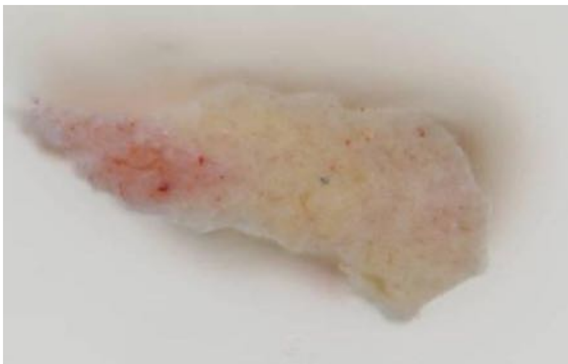

Ultraviolet (x200 magnification)

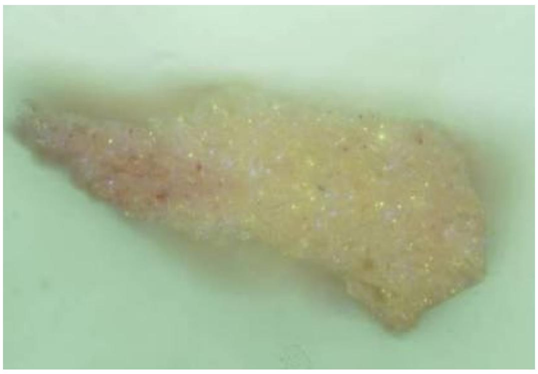
F51-5 Priming from back of canvas


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F51-6 Orange over pink from foot


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*sample*	*Analysis*	*Materials identified*
Pale orange	1	GCMS	Drying oil? (P/S = 5.27 Az/P = 0.06)
	1, 6	FTIR, SEM-EDX	Lead white
	6	SEM-EDX	Zinc white
Bright pink, above window	2	FTIR	Lead white
		FTIR	Magnesium carbonate
Pale pink	6	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Cadmium red/vermilion?
Bright pink from leg	7	FTIR, GCMS	Drying oil (P/S = 4.01 Az/P = 0.26)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Magnesium carbonate
		SEM-EDX	Zinc white
		SEM-EDX	Vermilion
Pink-Blue	3	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Vermilion
		SEM-EDX	Barium sulphate
		SEM-EDX	Iron oxide/Prussian blue?
Red	4	FTIR, GCMS	Drying oil (P/S = 3.74 Az/P = 0.35)
		FTIR, SEM-EDX	Magnesium carbonate
		SEM-EDX	Vermilion
Priming	5	FTIR, GCMS	Drying Oil, probably linseed (P/S=1.49 Az/P= 1.30)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Kaolin

Conclusions

The painting appears to be in a fairly early stage of completion. The shape of the figure and couch appear to have been sketched in a very thin green paint initially. While in some strokes the green appears very dry, other areas show the outline of a stroke done in a wet medium. The green was not sampled due to the extreme thinness of the layer. Strokes of bright pink then pale orange were used to form the contours of the legs and feet. The paint is very dry and chalky and appears to have been swept across with a brush while still wet to form ridges visible in raking light. Dark blue paint appears to have been used to form the body, and was also used on the top of the knee. The blue appears to have been smeared with pink, obliterating individual strokes, and possibly paint has been removed from this area. The canvas is roughened in the area of the figure, with raised fibres. The red-pink shape above the cut window appears to have scrape marks as though thicker paint was removed from here using a palette knife or similar. Bacon may have tried to remove paint from areas he was unhappy with in order to try and salvage the work, before giving up, cutting and discarding the canvas.

Medium analysis on three samples from this work showed oil in all cases, all with very high p/s and very low az/p ratios. Possibly these ratios in part result from the underbound nature of the paint.

Untitled (Yellow/green portrait), c.1964

Identification details		
Title: F54 yellow/green/red portrait		*Date:* c.1964
Dimensions (hxwxd): 165 x 142 x 2 cm	*Location/owner:* Hugh Lane Gallery (RM98F54)	
Marks/Inscriptions: Stamp on vertical stretcher bar: 118 Stamp on vertical stretcher bar: ‘Prepared by/ Roberson& Co Ltd./ ..Parkway, London NW1’ Dark pencil(?): 32 (?9) ½ x on both vertical cross members, 56/7 on horizontal cross member.		

Support
Type: Canvas / Board / Paper / Stretcher / Strainer
Description: 7-member softwood stretcher, mitred mortise and tenon joints. Outer members width 2 (1/8)“ (5.3 cm), depth ¾ “ (1.9 cm). Cross bars width 2 (1/8)“ (5.3 cm), depth 5/8” (1.5 cm). Dark blue-grey metal tacks, 10-11 cm spacing, 5 mm diameter. Canvas is tacked to back of stretcher, same tacks, 36-44 cm spacing. Linen canvas, plain weave 16 x 22 threads/ cm^2, 16 warp, 22 weft. Canvas is yellowed.

Paint and ground

Priming: on reverse, off-white

Description:

Textured, stippled green paint in lower background, traces of yellow in some areas, especially in upper left corner of region (figure E.F54.2). Bright yellow in upper part of background, possibly over roughened canvas. Could be the same yellow as in F65 but appears darker due to greater build-up of dirt. Bright red chair/couch painted on bare canvas. Area of chair behind sitter's head has thicker, gritty textured red paint (figure E.F54.1). Gritty pink and grey paint in figure, light-coloured particles of sand on top of paint visible in one area. Light green outlining on arm.

Reserve of bare canvas at base, thin lines of red-orange outline foot, partly filled with thicker pink paint. Dark red shape outlined below foot. Oval shape outlined in black at right side, painted round with green – ashtray? Paler green stripe across bottom of flesh-painted area

Canvas slashed in many places. Upper part of figure cut out and removed, other parts of canvas slashed and canvas folded back on itself. Badly water damaged in vertical section just left of centre. Brown tide marks on lower part of canvas, some parts of canvas shrunken and distorted. Priming on back is flaking badly, but paint on front appears relatively secure, possibly due to lack of size layer.

Drips of thin black/grey paint below figure, bleeding into canvas.
Two holes through paint and canvas in green background, 29.6 cm from left, 70 cm from bottom and 38.5 cm from right, 68 cm from bottom, approx 2 mm diameter.

Surface coatings/gloss

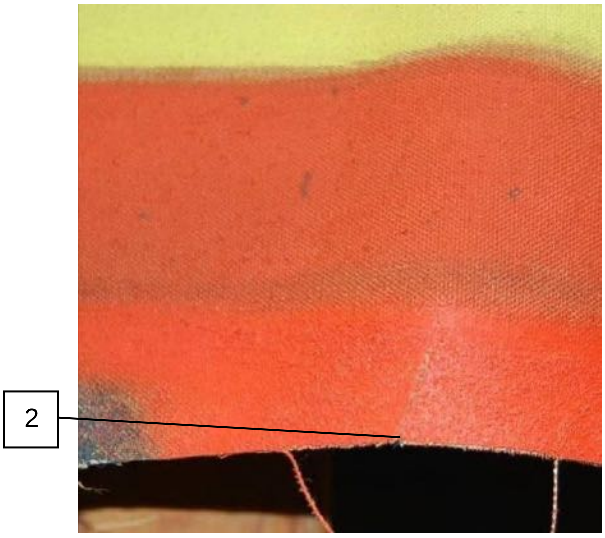
Appears very dirty, particularly on yellow background. Several dark drips/splashes in thin black paint over yellow.

Samples taken

No.	*Colour*	*Location*
1	Green background	Mixed yellow-green, left edge, 82 cm from bottom
2	Bright red gritty paint	Upper cut edge, 74 cm from left, 42 cm from top. Includes some priming
3	Bright yellow background	Right edge, 46 cm from top
4	Loose flakes pink and green	Cut edge, corner with dislodged threads 47.5 cm from left, 87 cm from bottom.
5	Grey over pink, loose flake	Bottom cut edge, 60.5 cm from left, 79.5 cm from top.
6	Pink paint with sand, loose flake	Edge of slash through pink, 47 cm from left, 83.5 cm from top
7	White stripe, loose flake	Left edge, 79.5 cm from top.
8	Priming	Off-white priming from reverse.

Notes

Very similar to double portrait of Auerbach & Freud, 1964, could have been originally intended to be triptych, with this as central panel.



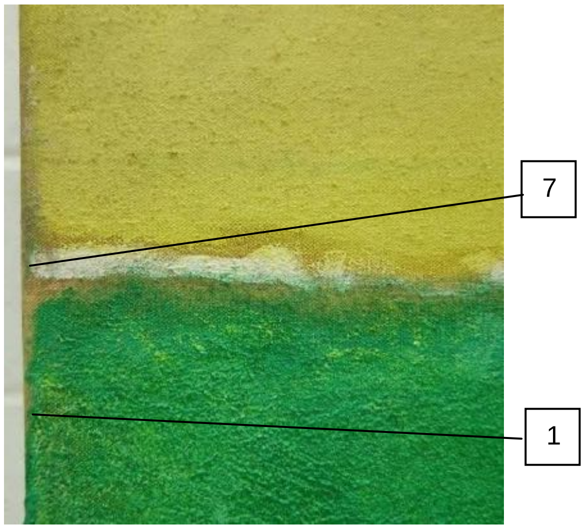
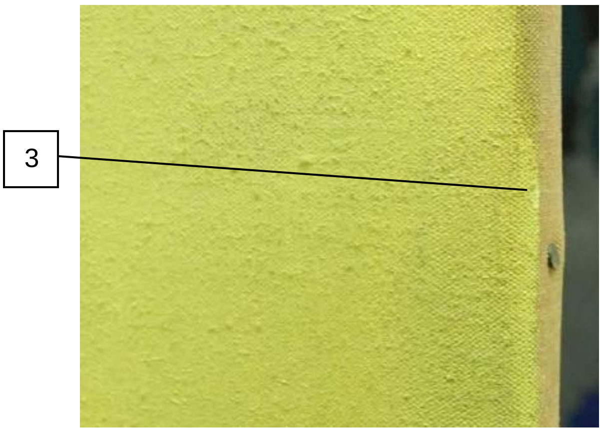
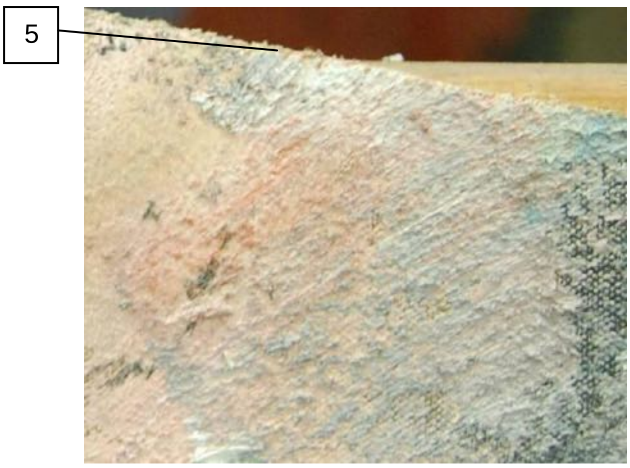
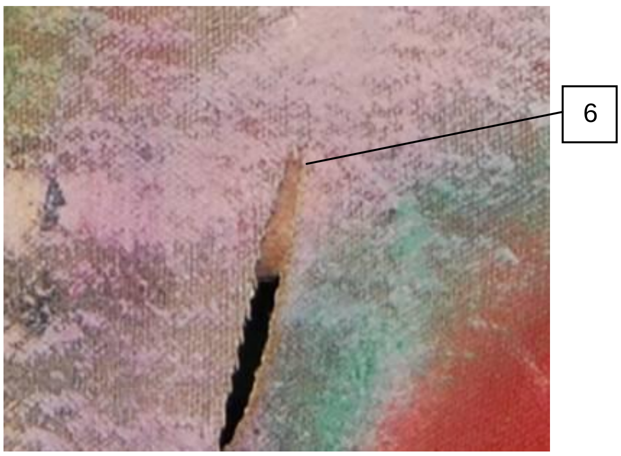


Figure E.F54.1 Detail of red couch showing thicker gritty red paint used over thin red stain. Reserve of bare canvas between couch and yellow background

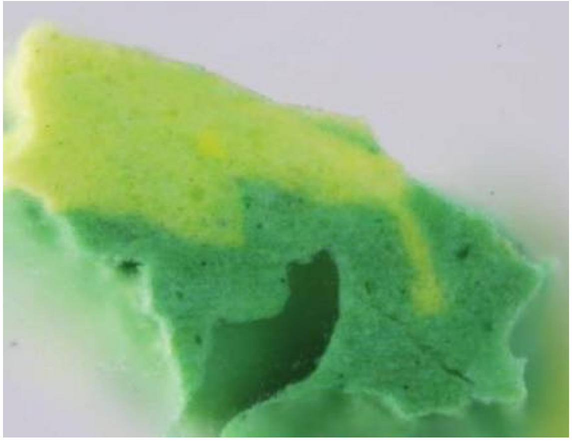
Figure E.F54.2 Detail of background showing roughened canvas beneath thin yellow paint and rough surface of green from the addition of sand.

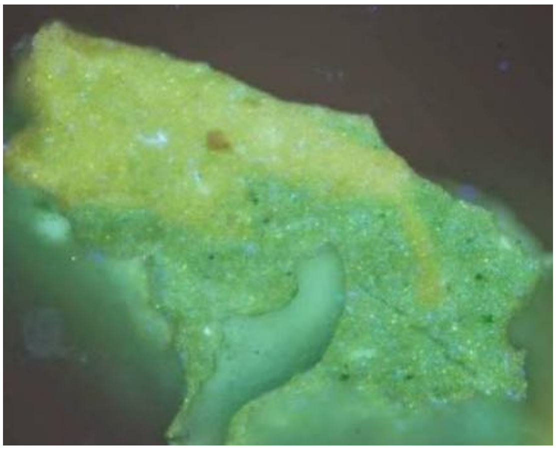






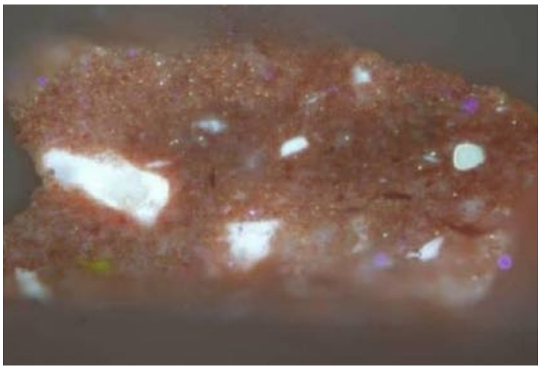
F54-1 Bright green-yellow


Normal light (taken at x200 magnification)

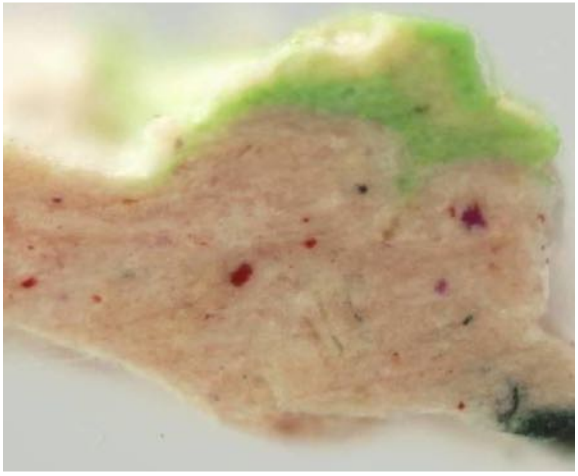

Ultraviolet (x200 magnification)

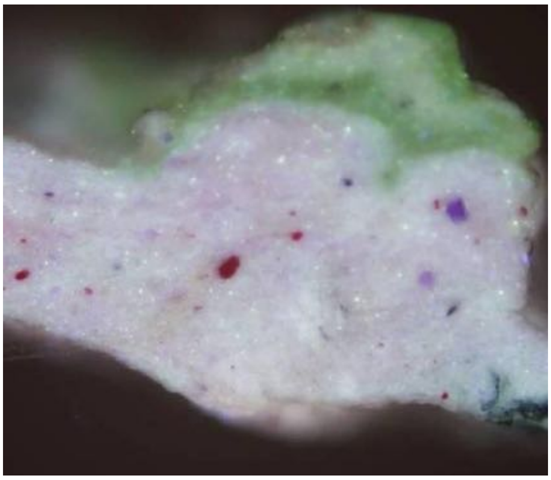
F54-2 Bright gritty red over red stain


Normal light (taken at x200 magnification)

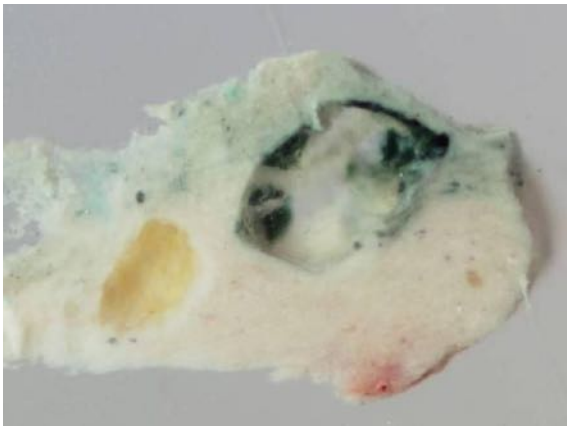

Ultraviolet (x200 magnification)

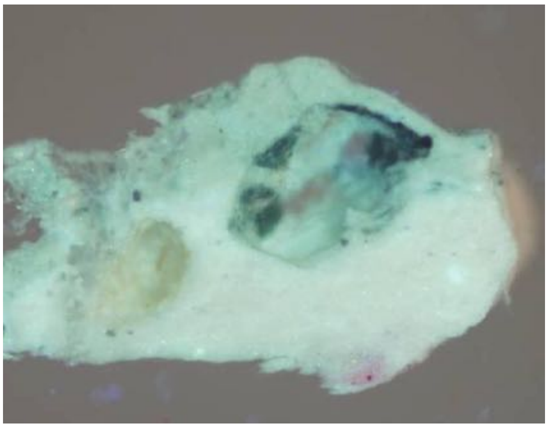
F54-4 Green over pink flesh paint


Normal light (taken at x200 magnification)

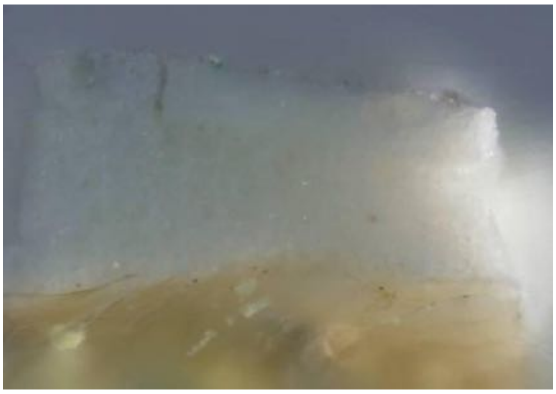

Ultraviolet (x200 magnification)

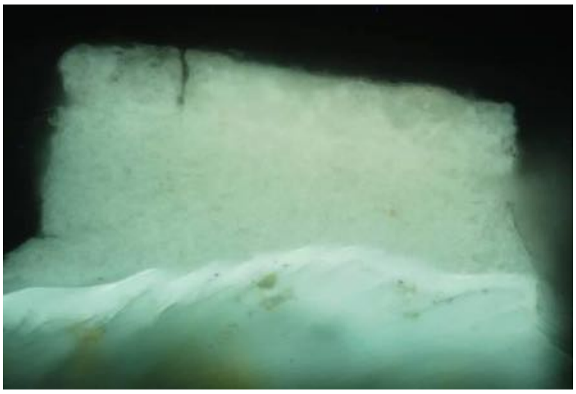
F54-5 Pale pink flesh


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F54-8 Priming


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Green-yellow background	1	GCMS, FTIR	Oil (P/S = 2.90 Az/P =0.72)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Cadmium yellow
		SEM-EDX	Sand
		PLM	Phthalocyanine green
Red gritty paint	2	FTIR, GCMS	Drying Oil (P/S = 2.51 Az/P =0.79)
		SEM-EDX	Cadmium red
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		FTIR	Silica/sand
		FTIR, SEM-EDX	Magnesium carbonate
Yellow background	3	FTIR, GCMS	Oil (P/S = 3.63 Az/P =0.20)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Cadmium yellow
White stripe	7	FTIR, GCMS	Oil (P/S = 2.22 Az/P =0.91)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
Pink flesh	4	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Cobalt violet (phosphate)
		SEM-EDX	Alizarin
Grey-pink	5	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Sand
		SEM-EDX	Cadmium red?
Gritty pink	6	FTIR, GCMS	Oil (P/S = 1.81 Az/P =0.90)
		FTIR	Lead white
		FTIR	Sand
Priming	8	FTIR, GCMS	Drying Oil (P/S = 2.04, Az/P =1.82)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Kaolin

Conclusions

An oil medium was detected in all samples tested, including the green, yellow and red areas of background and pink flesh paint. Lead white with zinc white found in all cases. Cobalt violet and alizarin crimson found in flesh paint. Cadmium red and yellow identified in background areas, probably with phthalocyanine green. Sand appears to have been added to red, yellow-green and some areas of flesh.

Untitled (Yellow figure study)

Identification details	
Title: F65 Untitled (Yellow figure study)	*Date:* c.1971
Dimensions (hxwxd): 198.3 x 147 x 2.2	*Location/owner:* Hugh Lane Gallery (RM98F65)
Marks/Inscriptions: Pencil numbering on stretcher bars: ‘58’ on horizontal cross bar ‘39x’ on vertical cross bars. ‘78’ on right vertical outer member.	

Support
Type: <u>Canvas</u> / Board / Paper / <u>Stretcher</u> / Strainer
Description: 7-member softwood stretcher, square mortise and tenon joints. Outer members width 2 ¾ “ (7 cm), depth ¾”. Cross bars width 2 5/8 “ (6.8 cm), depth 5/8 “. Grey metal tacks, 9-10 cm spacing, some rusting slightly, 6-7 mm diameter. Canvas is stapled to back of stretcher with steel staples, 20-25 cm spacing. Linen, plain weave canvas 16 x 22 threads/cm^2, 16 warp, 22 weft. Canvas somewhat yellowed.

Paint and ground
Priming: on reverse, off-white

Paint description:
Bright yellow paint in upper background, with matt appearance. Canvas may have been roughened before yellow was applied. Difficult to tell if unpainted canvas has the same texture. The rest of the canvas is largely unpainted. Large rectangular cut-out area removes much of the upper half of the canvas (approx. 69-80 x 132 cm in dimension).

Lower part of figure seated on square stool is sketched in thin green paint, with a few lines of thin black also. Slight variation in shade of green. Numerous changes to position of foot. Shape of shadow/emanation extends from feet towards lower left corner. Thin black line separates yellow background from unpainted canvas. Lines are all very thin, some in dry paint dragged over the canvas surface, others in wet diluted paint absorbed into the canvas, like a stain. Width of lines 0.8, 1, 0.2 cm.

Surface coatings/gloss
Thick layer of dust on curled over edge of canvas at bottom of window.

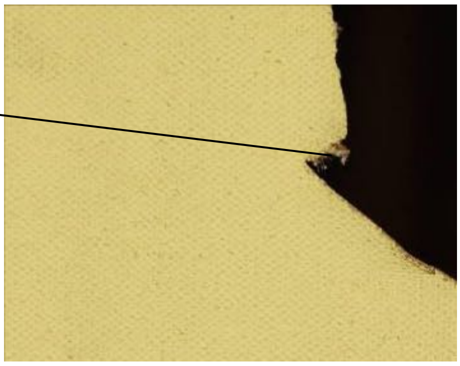
Samples taken

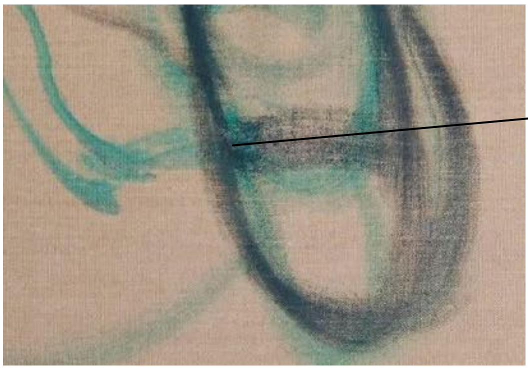
No.	*Colour*	*Location*
1	Yellow background	Lower left corner of cut window, point of triangle, 8 cm from left, 81 cm from top
2	Dark green scraping	Dark green over lighter green, foot outline, 60 cm from right, 48 cm from bottom
3	Priming	Off-white priming from reverse of site 1. May include yellow fragments from front

Notes

Green/black sketchy lines very thin – sampling difficult

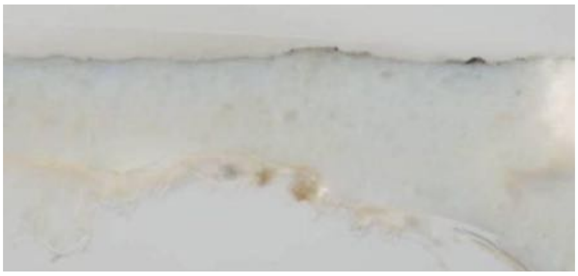
1



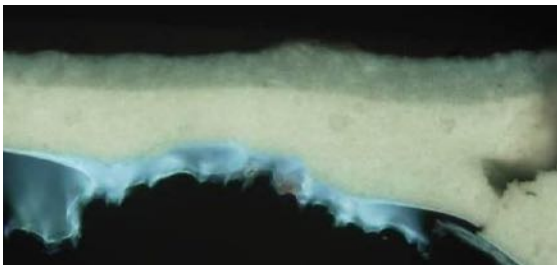


2

F65-3 Priming from reverse



Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Yellow background	1	FTIR, PyGCMS	PVAc (+ 2-EHA acrylic?)
		FTIR, SEM-EDX	Kaolin
		FTIR, SEM-EDX	Titanium white
		SEM-EDX	Zinc white
		FTIR, PyGCMS	Organic yellow PY1
Dark green scraping	2	FTIR, GCMS	Drying oil (P/S = 4.49, Az/P = 0.72)
		SEM-EDX	Zinc white
		SEM-EDX	Phthalocyanine green
Priming	3	FTIR, GCMS	Ortho-phthalate alkyd (P/S= 1.50 Az/P= 0.53)
		FTIR, SEM-EDX	Kaolin
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Barium sulphate
		SEM-EDX	Titanium white

Conclusions

Little paint was available for analysis. The yellow background appears to be PVAc housepaint, with titanium white, kaolin extender and arylide yellow PY1. Green paint used to outline figure has an oil medium, probably with phthalocyanine green.

The priming layer has an ortho-phthalate alkyd medium. Two layers of priming can be seen in the cross section but components appear similar, with lead white, titanium white and kaolin in both layers. A little barium sulphate was also detected in the lower layer, and possibly some silica in the upper layer.

F85 Untitled (blue-green portrait)

Identification details	
Title: F85 Untitled (blue-green portrait)	*Date:* c.1984
Dimensions (hxwxd): 35.4 x 30.5 x 1.9 cm (14 x 12 x ¾)	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F85)
Marks/Inscriptions:	

Support
Type: Canvas / Board / Paper / Stretcher / Strainer
Description: 4-member softwood stretcher, mitred mortise and tenon joints. Bar width 5.2 cm, depth 1.7 cm (with bevel at front). No keys present. Plain weave linen canvas, 17 x 22 threads/cm^2. Attachment through pale grey metal tacks, diameter 6.5-7 mm, spacing 8-10 cm. Tacks present only on right and top edges, on left and bottom no tacks remain, though holes through canvas show tacks were once present (4 on each side). Canvas is stapled to back of stretcher. Canvas is slightly yellowed.

Paint and ground
Priming: Off-white, back. Very dirty
Description:

Very thinly painted portrait, with main part of face cut out. Black-blue thin stain for shoulders, green background appears to have been applied on top of this.

Strokes of pink and faint brown above the forehead in hair, with traces of white and pink strokes also at right edge of cut area. Smeary white-pink area below chin, mixed with dark blue stain (from canvas?). Paint appears thicker here and fairly brittle. Faint sweep mark at lower left of cutout area – fine lines from comb/brush. In one area at neck it appears canvas is bare beneath (not stained). Canvas appears stained at all cut edges.

Some smears of bright red and splashes of white over background. Watery brown smears centre and lower left.

Surface coatings/gloss

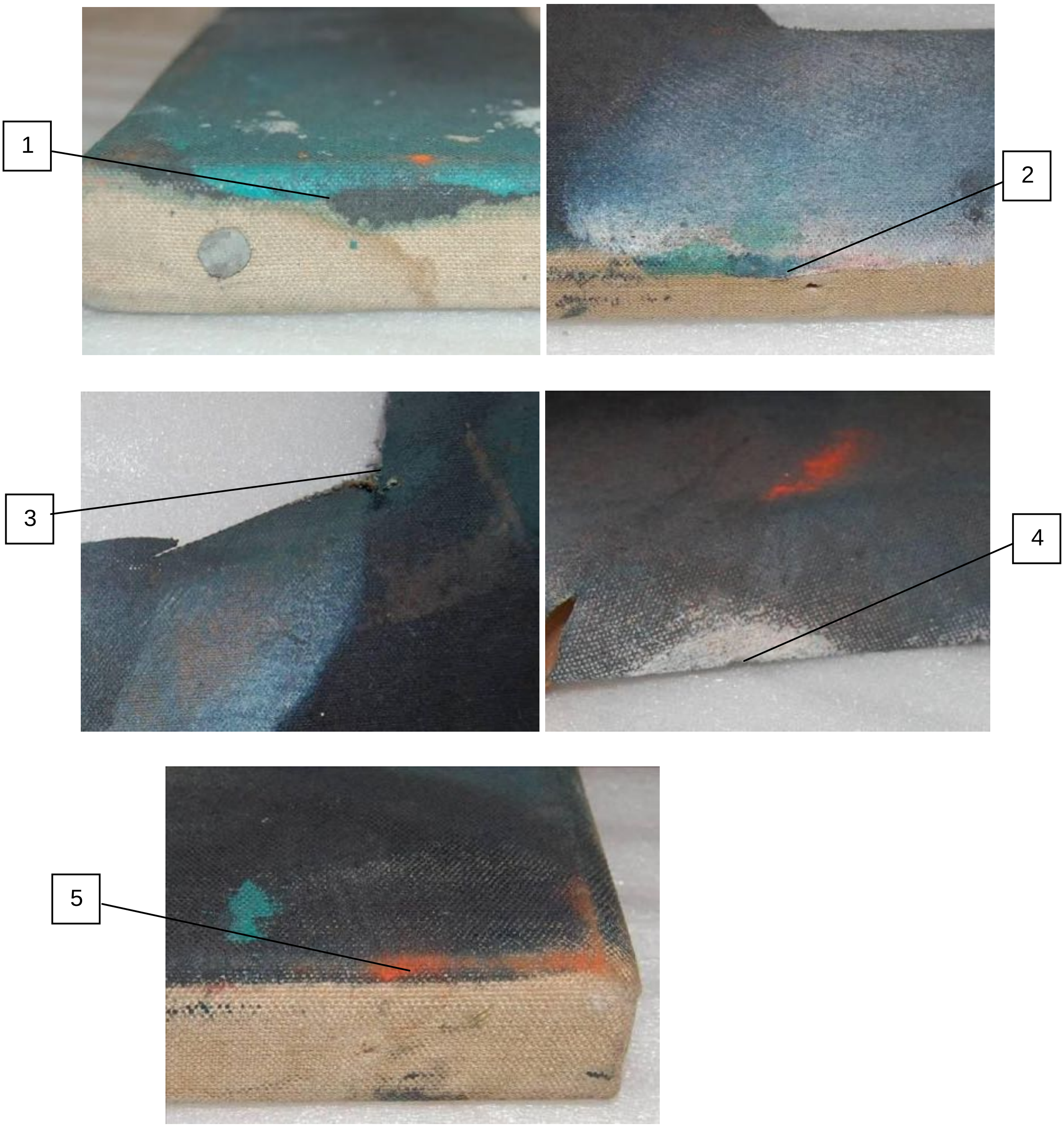
Surface very matt. Dirt has collected on turned edges.

Samples taken

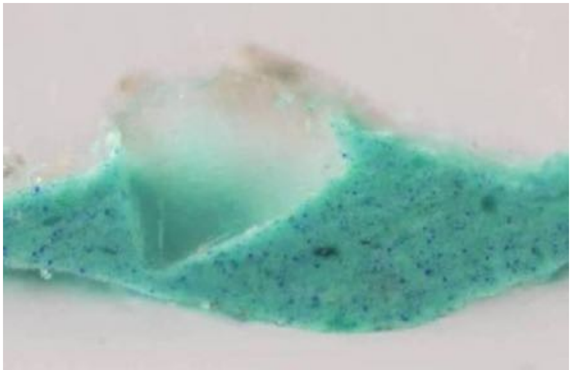
No.	*Colour*	*Location*
1	Green background	Top edge tacking margin, 2.4 cm from right
2	White/pink	Bottom edge, 11.3 cm from left
3	Dark blue stained canvas fibre	Cut edge, 8.2 cm from right, 6.8 cm from bottom
4	White over blue	Cut edge, 8 cm from bottom, 10.5 cm from left
5	Red pigment scraping	Bottom right corner, 3 cm from right
6	Priming	Flake from cut edge

Notes

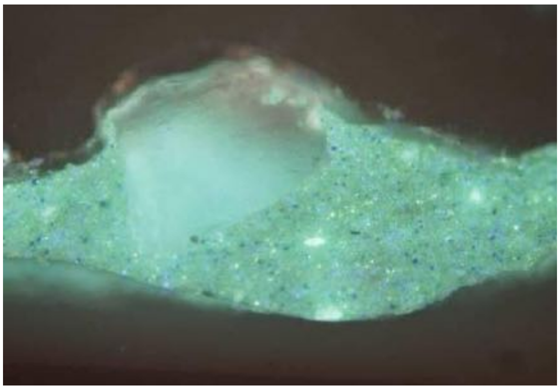
Notes from database suggest this may be portrait of Peter Beard or of Bacon himself. Date not known.



F85-1 Green background

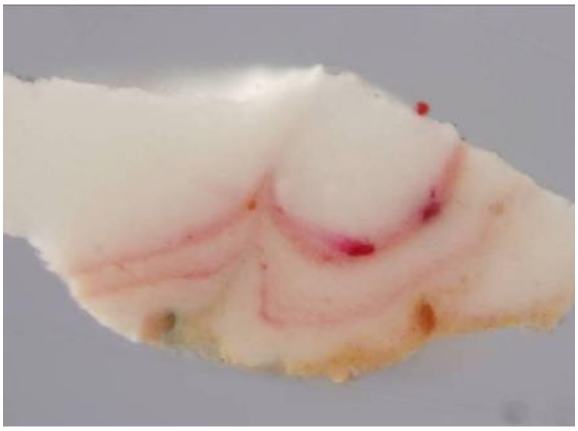


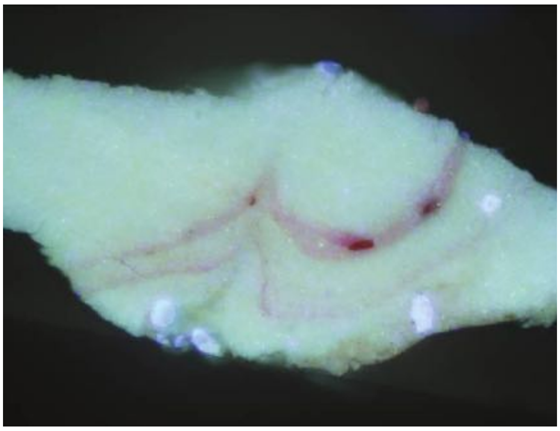
Normal light (taken at x200 magnification)



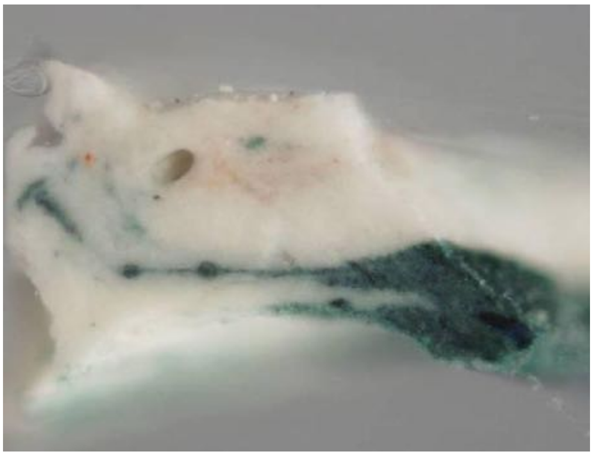
Ultraviolet (x200 magnification)

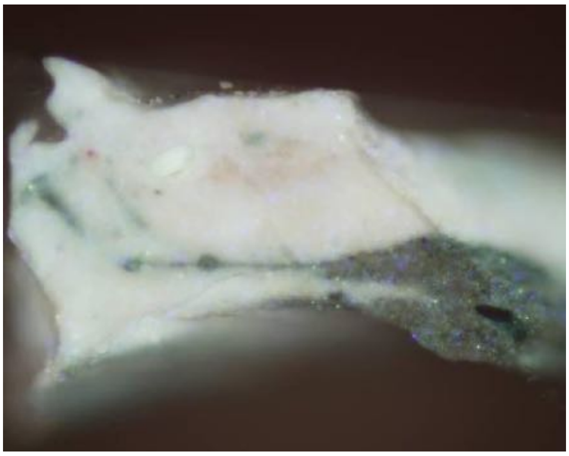
F85-2 White/pink from bottom edge


Normal light (taken at x200 magnification)

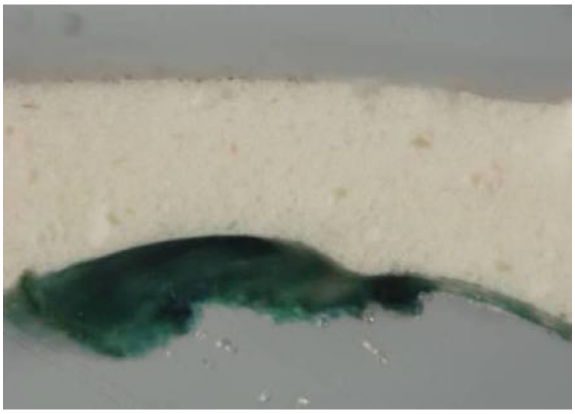

Ultraviolet (x200 magnification)

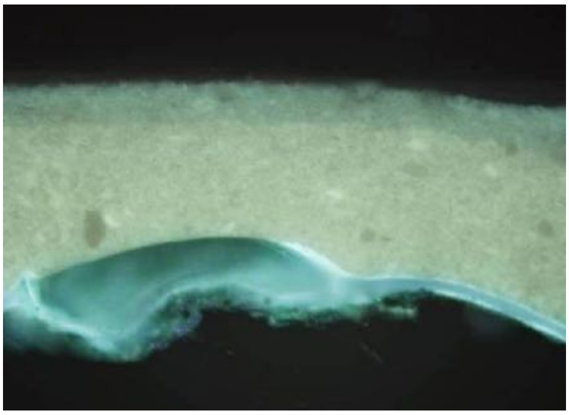
F85-4 White over blue from cut edge


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F85-6 Priming from reverse


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Green	1	FTIR, GCMS	Drying Oil (Az/P = 1.06, P/S = 2.32)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Ultramarine
		SEM-EDX	Sand
White-pink	2	FTIR	Oil
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Iron oxide?
Dark blue stain	3	FTIR, GCMS	Drying Oil (Az/P = 1.11, P/S = 3.14)
		FTIR	Lead white
		FTIR	Prussian blue
Dark blue swirl	4	SEM-EDX	Lead white
		SEM-EDX	Prussian blue
White-pink	4	FTIR, GCMS	Drying oil (Az/P = 1.02, P/S = 2.30)
		SEM-EDX, FTIR	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Vermilion
Red	5	SEM-EDX	Vermilion
Priming	6	FTIR, GCMS	Alkyd (Az/P = 1.46, P/S = 1.45)
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Kaolin
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Barium sulphate

Conclusions

An oil medium was found in all paints analysed. Lead white was found in most samples. A dark blue stain of Prussian blue appears to have been applied to the whole canvas initially, with a light green paint applied on top containing lead white and ultramarine, and possibly a little phthalocyanine green. The flesh paint was mainly lead white with zinc white, but one particle of vermilion was identified, and a particle of an organic red was also found. Vermilion pigment was also found on the edge of the canvas.

The priming has an ortho-phthalate alkyd medium, with two layers containing kaolin, lead white and titanium white, with a little barium sulphate in the lower layer. A fluorescent protein size layer is also present.

Untitled (black portrait)

Identification details	
Title: RM98F98 (black portrait)	*Date:* c.1989-90
Dimensions (hxwxd): 36.1 x 30.5 x 2 cm	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F98)

Marks/Inscriptions:

Stamp, left hand stretcher bar: ‘Prepared by / C. Roberson & Co Ltd. / 71 Parkway London NW1 7QJ’

Stamp on right hand stretcher bar: ‘118’
Stamp on right hand stretcher bar: ’11 MAR 1985’
Stamp on right tacking edge:’12x14’

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:

4-member softwood stretcher, mitred mortise and tenon joints. Width of members 5.3 cm, depth 1.8cm. 7 keys present.

Grey metal tacks, 6mm diameter, at 6-8 cm spacing.

Plain weave linen canvas, 19 x 19 threads/cm^2.

Paint and ground

Priming:
Commercial priming on reverse, off-white

Paint description:
The black background appears to have been applied as a stain first, then covered with a thicker layer of black paint. Thin pink paint is used to form the head, which appears to have been applied on top of the black stain (black is visible beneath the pink at the cut edge of the forehead. Canvas texture is more prominent in the head compared to the background – indicates that thin black stain was applied over whole canvas, then thicker black to background only.

Pink has powdery appearance. Raised spots of fluffy texture may be added dust, or roughened canvas fibres. Slightly darker red appearance on surface in neck area appears to be red spray paint on top of pink (figure E.F98.1). Pale pink/purple strokes used for hair, thinly applied over black. Fine spattered white spots over top right area of head.

Scuff marks to black background above cut edge at top left – lighter appearance appears to be due to transferred dusty material.

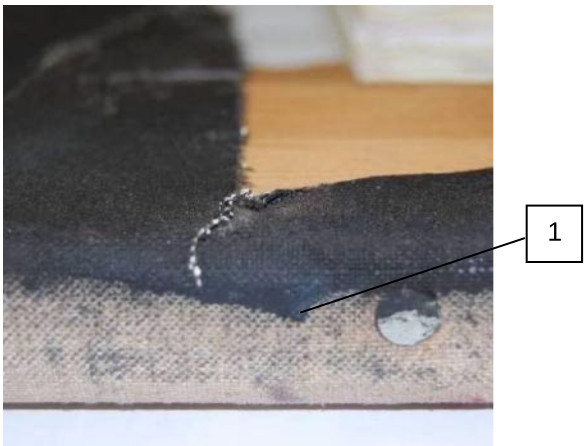
Surface coatings/gloss

Black has slight sheen, though dusty. Shiny area in bottom left corner from painting rubbing against something/transferred material.

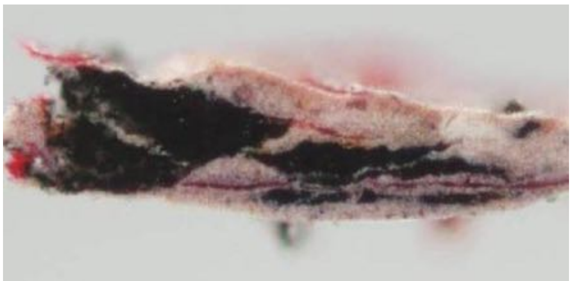
Samples taken

No.	Colour	Location
1	Black scraping	Drip at left tacking edge. 27.5 cm from top
2	Dusky pink fragments	Pale pink stripe below ear, cut edge. 15.5 cm from bottom, 9 cm from right.
3	Black	From jagged cut edge just below scuff. 8cm from left, 8 cm from top.
4	Pink scraping	Fragments from forehead – thicker pink paint. 6.5 cm from top, 13.3 cm from left.
5	Thin pink over black	From neck, cut edge. 9.5 cm from bottom, 13.5 cm from right
6	Priming	Back

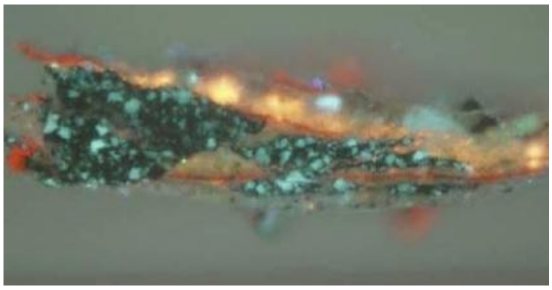
Figure E.F98.1 Detail showing thin pink over black forming shoulder, and red spray paint over neck



F98-2 Dusky pink fragments, pale pink stripe below ear

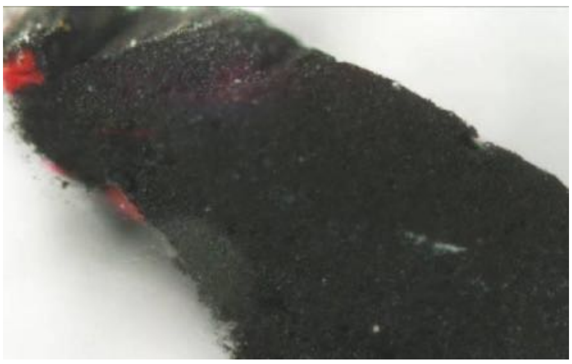


Normal light (taken at x200 magnification)

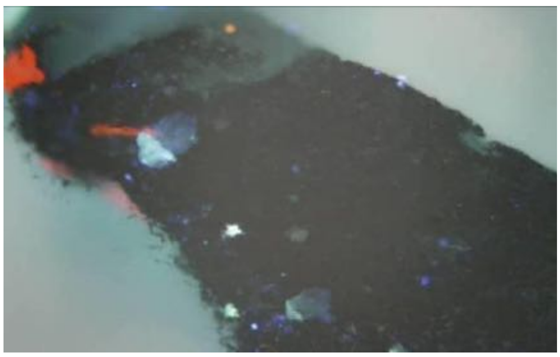


Ultraviolet (x200 magnification)

F98-3 Black background, edge of cut

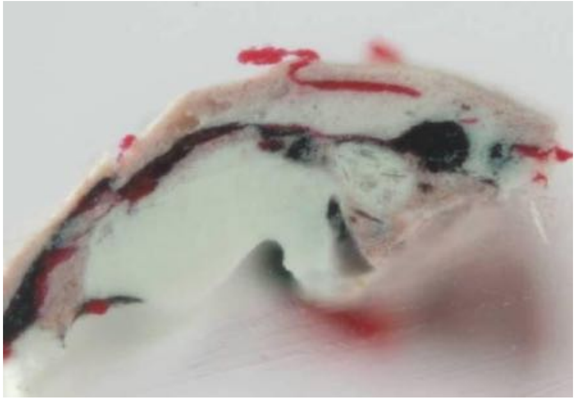


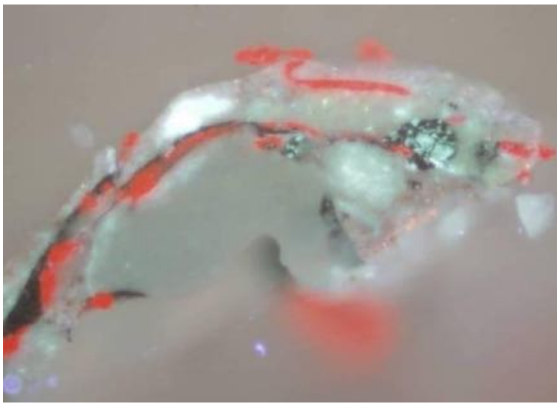
Normal light (taken at x200 magnification)



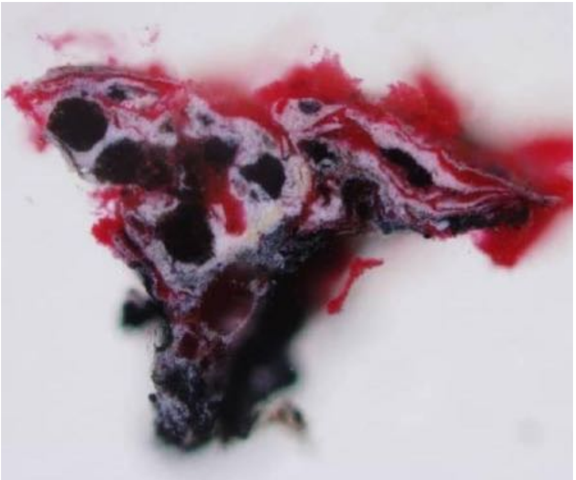
Ultraviolet (x200 magnification)

F98-4 Thin pink over black from forehead


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

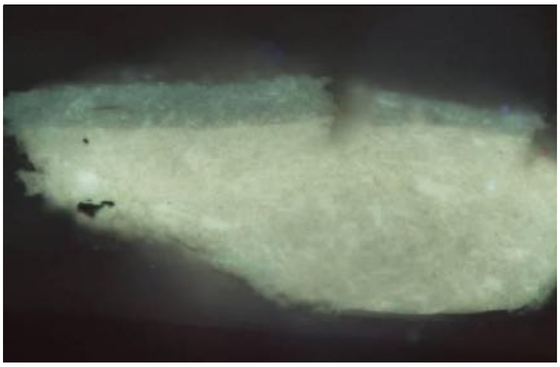
F98-5 Thin pink over black from neck


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F98-6 Priming from reverse


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Black background	1	FTIR, PyGCMS	PVAc with 2-EHA
	1, 3	FTIR, SEM-EDX	Chalk
		SEM-EDX	Carbon black
		SEM-EDX	Titanium white
		SEM-EDX	Kaolin
Pink forehead	4	FTIR, GCMS	Oil (Az/P = 0.97, P/S = 3.14)
		SEM-EDX	Titanium white
		SEM-EDX	Zinc white
		FTIR, SEM-EDX	Magnesium carbonate
		FTIR	Barium sulphate
Black with fluorescent particles	2, 5	SEM-EDX	Silica
Pink neck	2, 5	SEM-EDX	Titanium white
		SEM-EDX	Zinc white
		UVF, SEM-EDX	Rose madder
Bright red spray	2, 4, 5	SEM-EDX	Organic red / iron oxide?
	5	PyGCMS	Acrylic (MMA-BMA)
Priming	6	FTIR, GCMS	Isophthalate Alkyd (Az/P = 1.07, P/S = 2.01)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Talc
		SEM-EDX	Titanium white

Summary of analysis

A PVAc binder was found in the black background, with chalk extender, and probably carbon black. Titanium white was found in the flesh paint, with zinc white, magnesium carbonate and barium sulphate. Fluorescent pink particles are probably rose madder, from comparison with samples of this pigment found in the studio. The red spray paint appears to have an acrylic MMA-BMA medium, the same binder found in a sample of Humbrol Krylon spray paint from the studio.

The alkyd priming has titanium white and kaolin in the upper layer, over a lead white, chalk and titanium white layer.

Untitled (black portrait)

Identification details	
Title: F122 Portrait	*Date:* c.1989-90
Dimensions (hxwxd): 35.8 x 30.6 x 2 cm (14 x 12 x ¾)	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F122)

Marks/Inscriptions:

Stamp on right edge: ‘14 x 12’

Stamp of left hand stretcher bar: ‘PREPARED BY C. ROBERSON & CO. LTD./ 71 PARKWAY, LONDON NW1 7QJ’

Stamp on canvas, right edge: ‘118 11 MAR 1985’

Remains of inscription on white back of canvas – blue paint/felt tip, could be end of word ‘portrait’

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
4-member softwood stretcher, mitred mortice and tenon joints. Bar width 5.1 cm, depth 1.7 cm (with bevel at front). 6 keys present (2 missing).

Plain weave linen canvas, 20 x 19 threads/cm^2. Appears fairly springy, good condition. Attachment through dark grey metal tacks, diameter 6-7 mm, spacing 6.5-8.5 cm. 5 tacks on each side. Canvas is stapled to back of stretcher.

Paint and ground

Priming:
Off-white, on back.

Paint description:
Very thinly painted portrait, with main part of face cut out. Upper part cut out roughly with knife, at lower edge the canvas appears torn, with several loose threads pulled out. Thin black stain to canvas, with a thicker, more glossy black applied over the background, up to the edges of the face. Paint appears to have fractured in fairly brittle way where thicker, especially where the canvas is torn.

Watery pink applied over thin black to form shirt in lower left corner. Thicker areaof paint has collected on edge at corner (pale green traces also on edges in this area). Thicker pink is used for forehead and ear, also over black stained canvas (can be seen through scratch across forehead). Ear fairly dry and matt, traces of pale blue stripes, probably corduroy print (figure E.F122.1). Forehead paint appears glossier. Fine red spray visible over forehead and hair under microscope. Hair has more matt brown-black appearance than background, red spray only visible under magnification (figure E.F122.2), except towards cut edge where it becomes thicker.

Canvas may have been roughened, small lumps within background layer

Surface coatings/gloss

Slight sheen over black background, with areas of figure more matt.

Samples taken

No.	*Colour*	*Location*
1	Black	Fragment from cut edge, 3 cm from left, 13.3 cm from top
2	Pink scraping	Lower left corner, left edge, 0.5 cm from bottom
3	Pale blue over pink from ear	Cut edge, 4.2 cm from left, 13.3cm from top
4	Red spray over pink	Forehead, cut edge, 8.8 cm from top, 11.7 cm from left
5	Black scraping	Thicker blob of black on right tacking edge, 7.2 cm from bottom. Rubbery texture
6	Priming	Flakes from loose threads
7	Red spray over black from hair	Cut edge, 8.3 cm from left, 11.5 cm from top

Notes

Similar to Bacon's portraits of John Edwards on black background. Ear & hairline similar to Study for Portrait of John Edwards 1989 (Portraits & Self-portraits p169). Also similar to F98 slashed canvas.

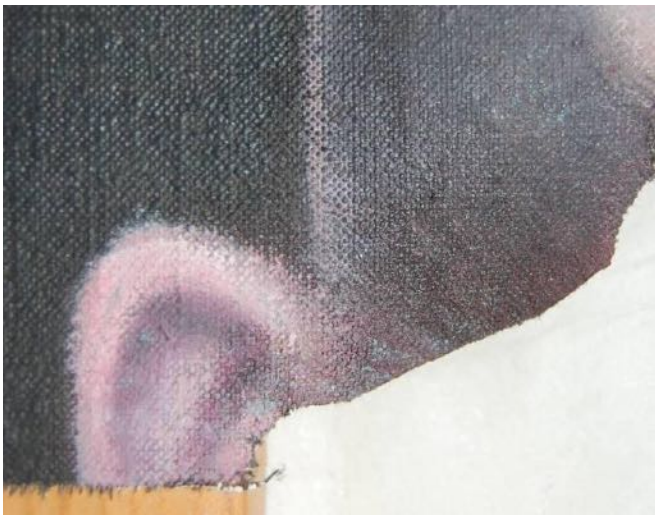


Figure E.F122.1 Detail of upper left area of head, showing ends of faint pale blue stripes

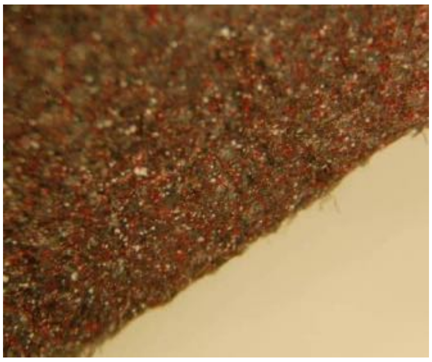
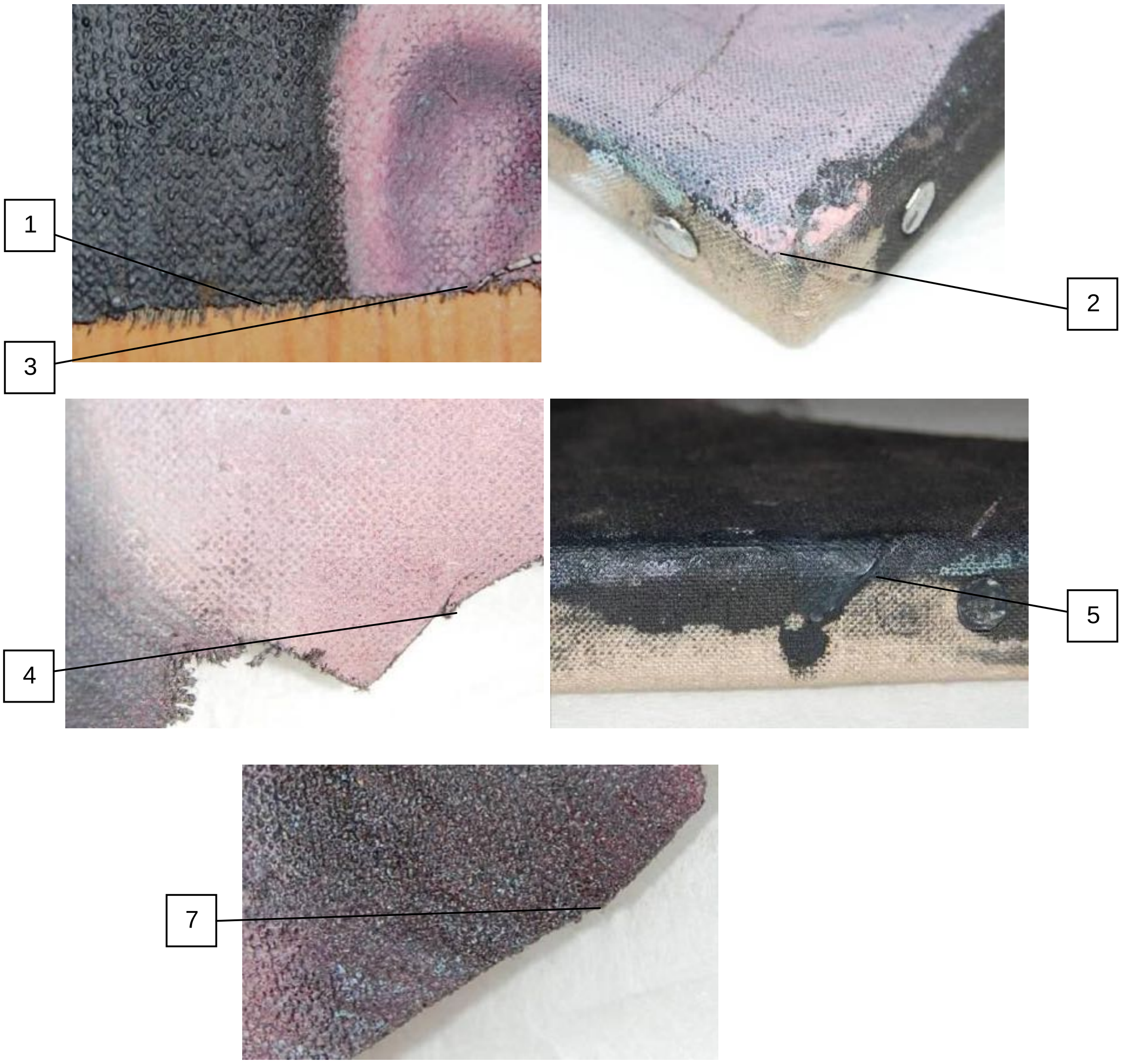
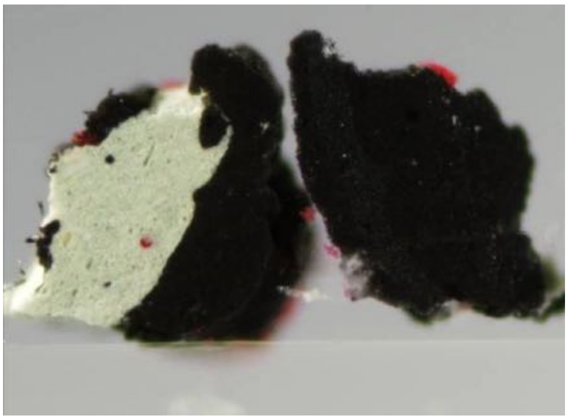
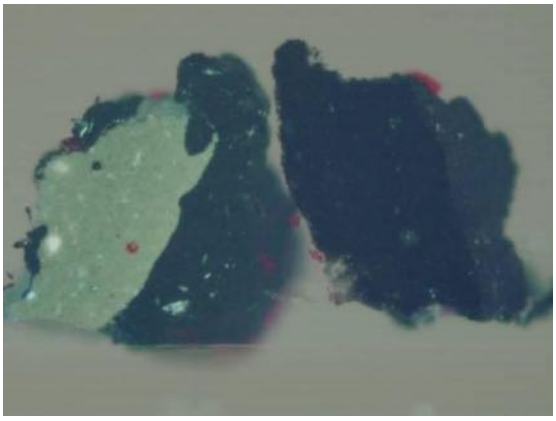


Figure E.F122.2 Close-up of cut edge from area of hair, showing droplets of red spray paint

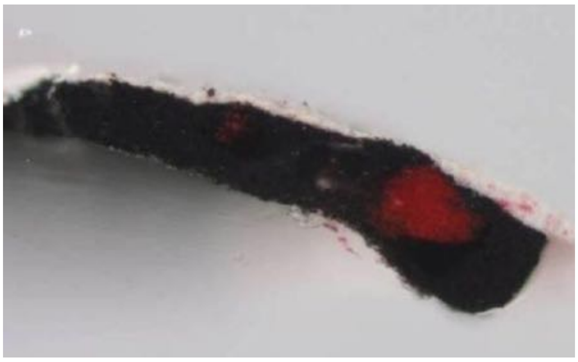


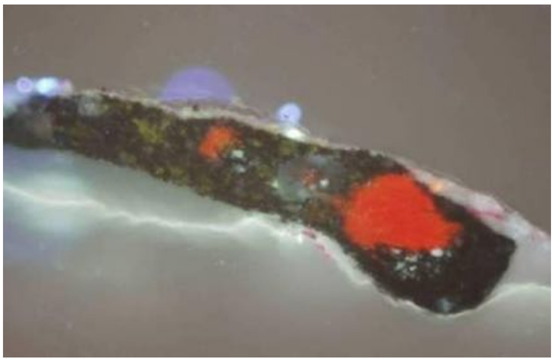
F122-1 Black


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

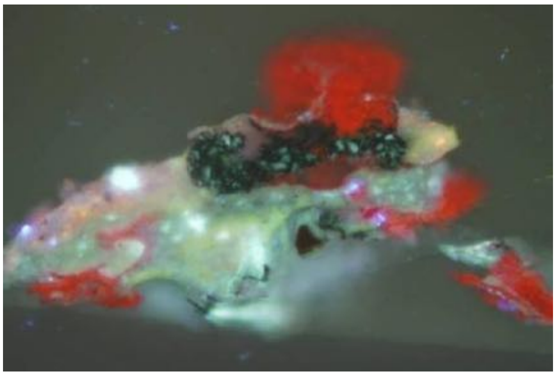
F122-2 Pink over black from corner


Normal light (taken at x200 magnification)

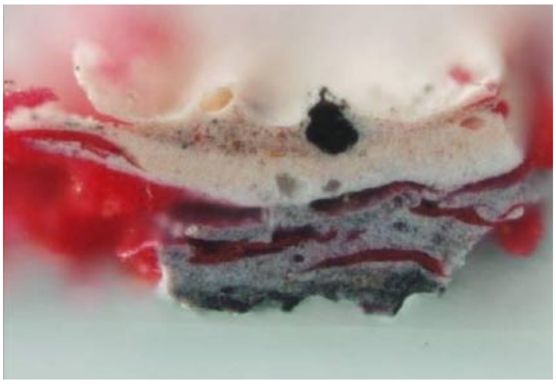

Ultraviolet (x200 magnification)

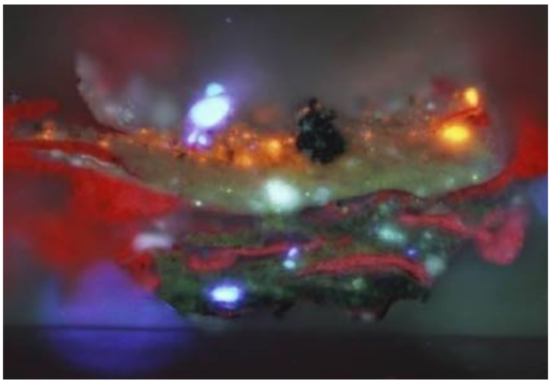
F122-3 Pale blue over pink from ear


Normal light (taken at x200 magnification)

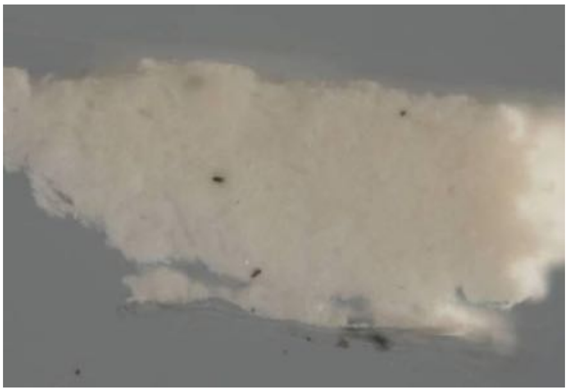

Ultraviolet (x200 magnification)

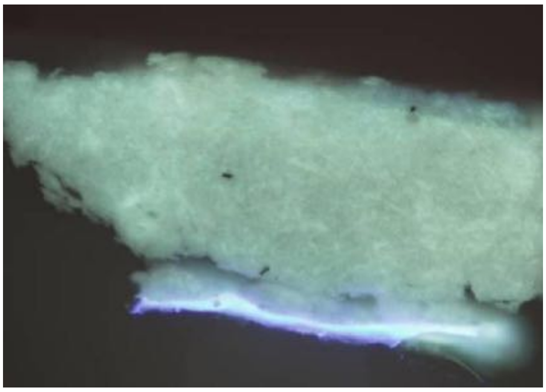
F122-4 Red spray over pink from forehead


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

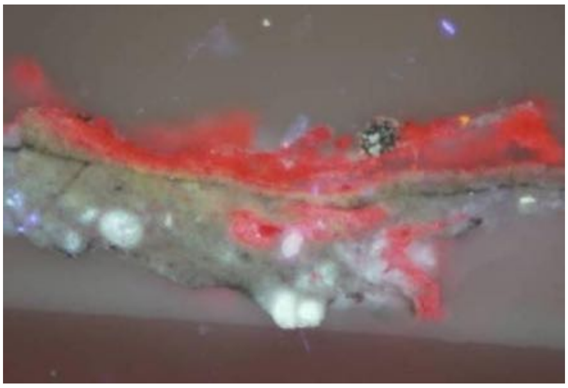
F122-6 Priming from reverse


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F122-7 Red over black from hair


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of Analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Black background	1, 2, 5	FTIR, PyGCMS	PVAc with 2-EHA
		FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Carbon black
Pale green	1	SEM-EDX	Titanium white
		SEM-EDX	Kaolin
		SEM-EDX	Chalk
Pink	2	FTIR, GCMS	Oil (Az/P =1.02, P/S =2.57)
		FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Barium sulphate
		SEM-EDX	Zinc white
Pink	3, 4	SEM-EDX	Titanium white
		SEM-EDX, UVF	Rose madder
		SEM-EDX	Zinc white
		SEM-EDX	Barium sulphate
Grey	4	SEM-EDX	Titanium white
		SEM-EDX	Barium sulphate
Red	7	PyGCMS	MMA-BMA copolymer
		SEM-EDX	Iron oxide red
Priming	6	FTIR, GCMS	Orthophthalate alkyd (Az/P= 0.55, P/S= 1.43)
		FTIR	Protein size layer
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Kaolin
		SEM-EDX	Talc
		SEM-EDX	Chalk

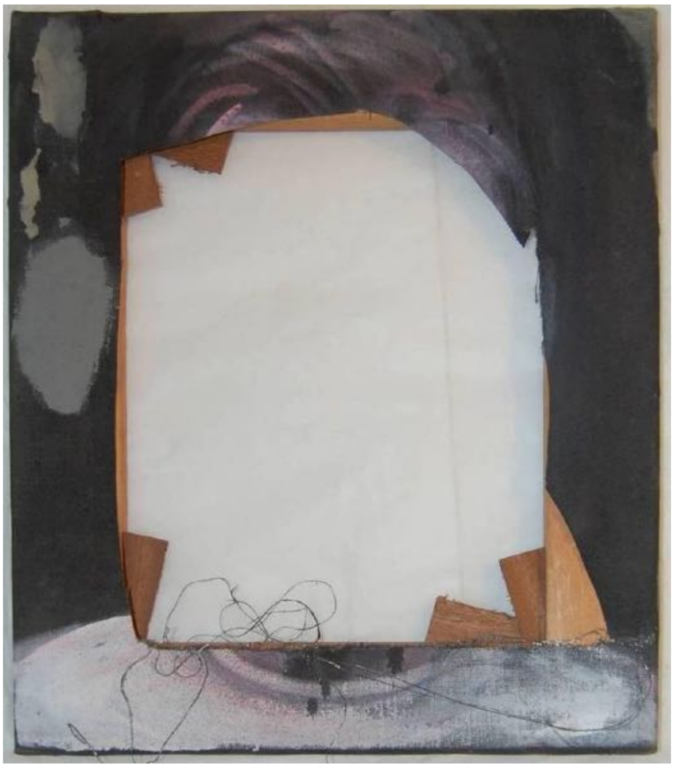
Conclusions

It appears that the canvas was first stained with a thin black paint, before a thicker black paint was applied around the outline of the head. A black PVAc paint was used for the thicker layer in the background, but this seems to have been applied over an earlier layer of pale green paint, which might indicate the background was first painted with this light colour, probably also a household paint.

The pink used on the shoulders was found to have an oil medium. The binder in the flesh paint was not tested but was thought likely to also be an oil paint from the pigments found. Titanium white with some pink fluorescent madder particles was used in flesh, with red spray paint. The materials are all very similar to those used in F98.

The alkyd priming has titanium white and kaolin in the upper layer, over a lead white, chalk and titanium white layer. Protein size layer.

Untitled (Portrait in white t-shirt)



Identification details		
Title: F133:9 Untitled (Portrait in white t-shirt)		*Date:* Post-1985
Dimensions (hxwxd): 35.7 x 30.5 x 1.9 cm (14 x 12 x ¾)	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F133:9)	

Marks/Inscriptions:

Stamp on right edge: ‘14 x 12’

Stamp of left hand stretcher bar: ‘PREPARED BY C. ROBERSON & CO. LTD./ 71 PARKWAY, LONDON NW1 7QJ’

Stamp on canvas, right edge: ‘118 11 MAR 1985’

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
4-member softwood stretcher, mitred mortice and tenon joints. Bar width 5.1 cm, depth 1.6 cm (with bevel at front). 6 keys present (2 missing).

Plain weave linen canvas, 21 x 19 threads/cm^2. Appears fairly springy, good condition. Attachment through pale grey metal tacks, diameter 6.5-7 mm, spacing 7-9 cm. 5 tacks on each side. Canvas is stapled to back of stretcher.

Paint and ground

Priming:
Off-white, on back.

Paint description:
Very thinly painted portrait, with main part of face cut out. Upper part cut out with knife, at lower edge the canvas appears torn, with many loose horizontal threads torn out. Thin black stain to background, with white painted on top to form t-shirt, and fine pink spray paint on top (figure E.F133:9.1). White appears to have been applied fairly wet in a thin layer which has filled canvas texture somewhat. Thin pink strokes used for hair above cutout (figure E.F133:9.2). A very thin, pale grey-green stain to the canvas is visible over tacking edges of canvas, visible on the front in the upper right corner.

Thick grey splodge on background and paler grey-brown splashes above. Canvas texture appears roughened, with standing threads. Several scratches to canvas, some indented above right of cutout area.

Surface coatings/gloss

Surface very matt. Droplets of red spray are glossy.

Samples taken

No.	*Colour*	*Location*
1	White/pink	Lower left cut edge, 6.8 cm from left, 5.2 cm from bottom
2	Priming	Flakes from loose threads
3	Black scraping	Blob on top edge, 4.5 cm from left
4	Pink scraping	Pink stroke, material embedded in canvas texture, 12.5 cm from left, 0.5 cm from top
5	Grey scraping	Grey splodge, left edge, 15.7cm from top

Notes

Possibly a self-portrait.

Figure E.F133:9.1. Detail of white paint of t-shirt over black, with red spray paint

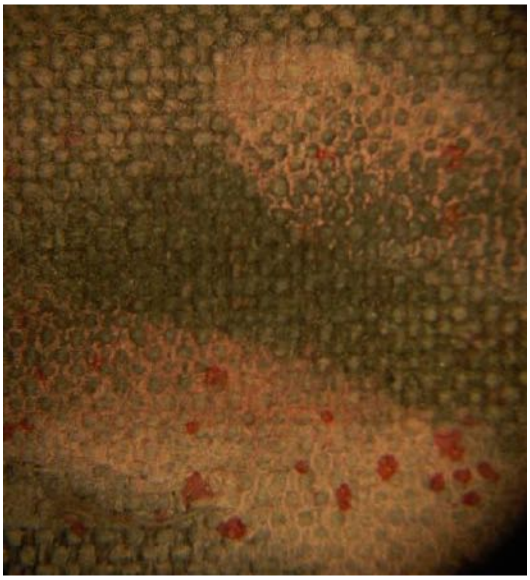
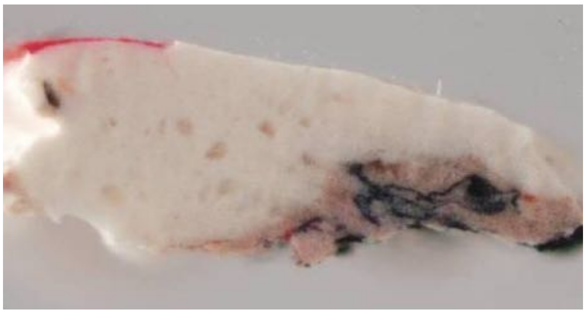
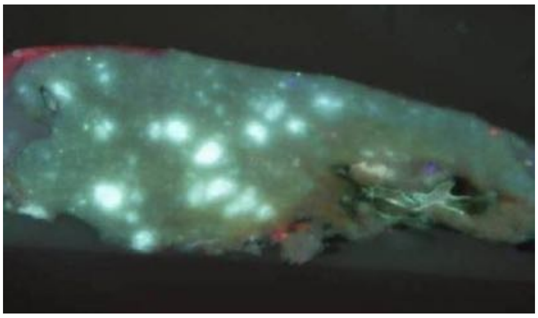


Figure E.F133:9.2 Detail of top edge, showng thin pink strokes over canvas texture forming hair, with spots of red spray paint

F133:9-1 White with red spots



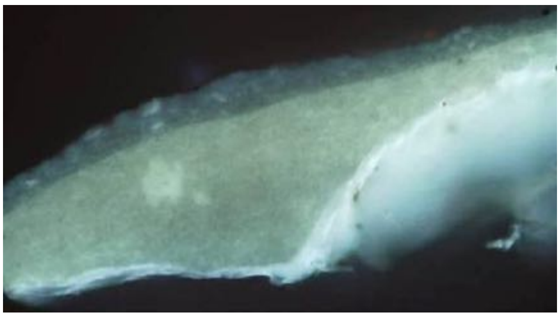
Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

F133:9-2 Priming from reverse

Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of Analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
White shirt	1	FTIR	Oil
		FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Zinc white
		FTIR, SEM-EDX	Magnesium carbonate
Red	1	FTIR, PyGCMS	Acrylic (MMA-BMA)
		SEM-EDX	Iron oxide red
Pink under shirt	1	FTIR, SEM-EDX	Titanium white
		SEM-EDX	Zinc white
Black	3	GCMS	Drying Oil (Az/P = 1.67, P/S = 2.45)
		FTIR, SEM-EDX	Carbon black
Pink hair	4	SEM-EDX	Titanium white
		SEM-EDX	Zinc white
		SEM-EDX	Cadmium red/orange
Grey	5	FTIR, PyGCMS	Acrylic – MMA/2-EHA
		FTIR	Titanium white
		FTIR	Kaolin
		FTIR	Chalk
Priming	2	FTIR, GCMS	Ortho-phthalate alkyd (Az/P= 0.82, P/S= 1.91)
		FTIR	Protein size layer
		SEM-EDX	Lead white
		SEM-EDX	Chalk
		FTIR, SEM-EDX	Kaolin
		FTIR, SEM-EDX	Titanium white

Conclusions

The canvas appears to have been stained all over with a lamp black oil paint initially. The white and pink paints used for the flesh and t-shirt also appear to be oil paints. The red spray paint appears to have an acrylic MMA-BMA medium, the same binder found in a sample of Humbrol Krylon spray paint from the studio. The grey paint has an acrylic MMA - 2-EHA binder, like the Dulux paints in the studio. A cadmium pigment was found in the sample taken from the hair.

The alkyd priming has titanium white and kaolin in the upper layer, over a lead white, chalk and titanium white layer. A protein size layer is at the bottom of the sample.

Untitled (black portrait)

Identification details		
Title: F204 Untitled (black portrait)		*Date:* Post 1985 (possibly c.1989-90)
Dimensions (hxwxd): 35.7 x 30.6 x 1.9 cm (14 x 12 x ¾)	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F204)	

Marks/Inscriptions:

Stamp on right edge: '14 x 12'
Stamp of left hand stretcher bar: 'PREPARED BY C. ROBERSON & CO. LTD./ 71 PARKWAY, LONDON NW1 7QJ'
Stamp on canvas, right edge: '118'
Stamp on canvas, right edge: 11 ... 1985'

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
4-member softwood stretcher, mitred mortice and tenon joints. Bar width 5.1 cm, depth 1.7 cm (with bevel at front). No keys present (8 missing).

Plain weave linen canvas, 20 x 19 threads/cm^2. Appears fairly springy, good condition. Attachment through pale grey metal tacks, diameter 6.5-7 mm, spacing 7.5-9 cm. 5 tacks on each side. Canvas is stapled to back of stretcher.

Paint and ground
Priming: Off-white, on back.
Paint description: Very thinly painted portrait, with main part of face cut out. The canvas is cut into a wavy shape at lower right. Thin black stain to canvas, apparently applied over whole surface, with some thicker traces at bottom right edge. Canvas appears to have been roughened before paint application. Thin pink strokes forming neck have a slight gloss. Thicker pink used for forehead, also over black stained canvas (figure E.F204.2). Ear very thinly painted, fairly dry and matt (figure E.F204.1). Thin purple lines used in hair. Splashes of blue-purple along left edge, splash of orange near ear. Faint orange surface colour over much of background, as though covered with a fine dusting of orange pigment. Microscope examination – surface is dusty with fine covering of red & orange powder.

Surface coatings/gloss
Fairly matt, slight sheen over black area in lower left

Samples taken

No.	*Colour*	*Location*
1	Black scraping	Bottom edge, 6.5 cm from right. Brittle texture
2	Pink from forehead	Forehead, cut edge,6.8 cm from top, 11.1 cm from left
3	Purple splash	Top left corner
4	Bright pink scraping from ear	Pink material caught in canvas texture, 6 from left 19 from top
5	Priming	From back

Notes

Appears similar to Three Studies for Self-Portrait 1983 (Portraits & Self-portraits p161-3), central panel.

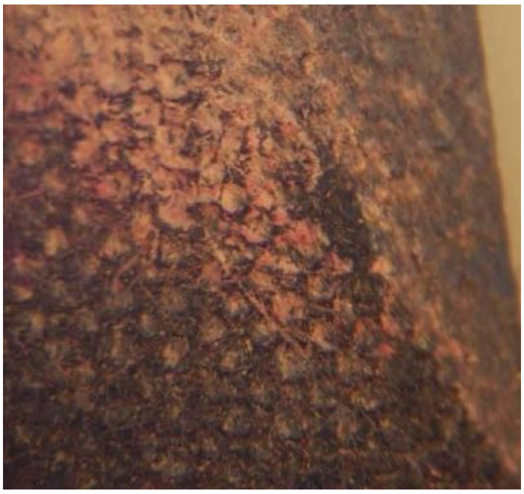
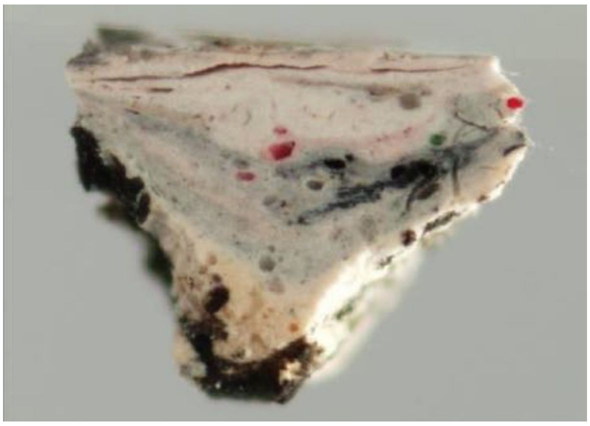
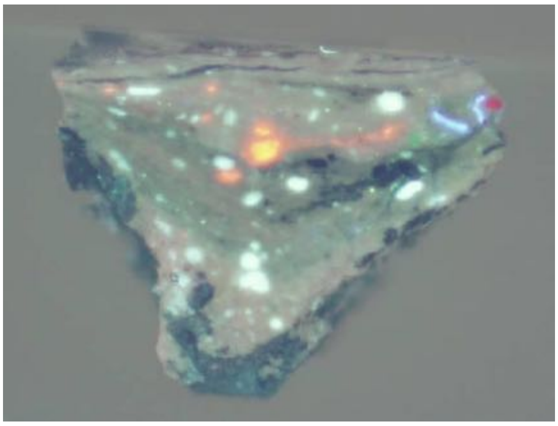


Figure E.F204.1 Detail from bottom of ear, taken under microscope, showing thin dry pink paint over black

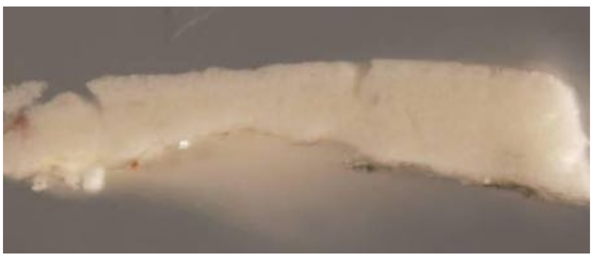
Figure E.F204.2 Detail showing thin strokes outlining hair and thicker pink paint

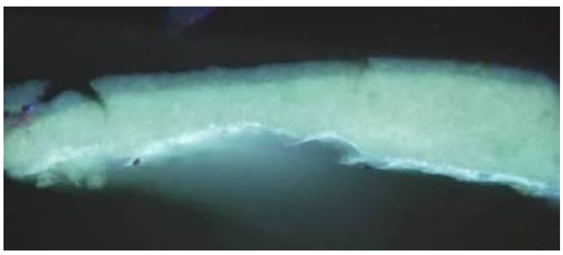
F204-2 Pink from forehead


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F204-5 Priming from reverse


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of Analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Black background	1	GCMS	Oil (Az/P = 1.30, P/S = 1.26)
		SEM-EDX	Carbon black?
Pink	2	SEM-EDX	Titanium white
		SEM-EDX	Zinc white
		SEM-EDX	Magnesium carbonate
		SEM-EDX, UVF	Aluminium lake base (madder)
Purple	3	FTIR, GCMS	Acrylic copolymer (MMA - 2-EHA)
		FTIR, SEM-EDX	Kaolin
		FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Chalk
			Organic purple?
Pink	4	FTIR	Oil
		FTIR, SEM-EDX	Barium sulphate
		FTIR, SEM-EDX	Titanium white
		SEM-EDX	Aluminium-based lake
		SEM-EDX	Zinc white
Priming	5	FTIR, PyGCMS	Alkyd (Az/P = 0.52, P/S = 1.67)
		SEM-EDX	Titanium white
		SEM-EDX, FTIR	Kaolin
		SEM-EDX	Lead white
		SEM-EDX	Talc

Conclusions

The canvas appears to have been stained all over with a carbon (lamp?) black oil paint initially, before pink paint was applied for the face. Flesh paint was mainly titanium white, with some zinc white, barium sulphate and magnesium carbonate. Fluorescent pink particles appear to be particles of rose madder, but another organic pink may also be present. Both the dry pink on the ear and thicker paint on the forehead appeared to have the same components.

The purple splashes appear to be of a household paint, the binder matches that found in tins of Dulux emulsion found in the studio.

The alkyd priming had titanium white and kaolin in the upper layer, over a lead white, talc and titanium white layer. A protein size layer is at the bottom of the sample.

Untitled (pale blue portrait)

Identification details	
Title: RM98F206 Untitled (pale blue portrait)	*Date:* 1980s
Dimensions (hxwxd): 35.2 x 30.8 x 2 cm	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F206)

Marks/Inscriptions:

Stamp on left stretcher bar: 'Prepared by C. Roberson & Co. Ltd... London....

Stamp on left stretcher bar: ...NOV 198(?)

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
4 member softwood stretcher, mitred mortise and tenon joints. Members 5.2 cm wide, 2 cm deep.
Shiny metal tacks 7 mm diameter, 7-9 cm spacing. Canvas stapled to back of stretcher.

Plain weave linen, 20 x 20 threads/cm^2.

Paint and ground

Priming:
Commercial priming on reverse, off-white

Paint description:

Pale blue in upper background, with dark blue stain in lower background. Numerous drips and splashes in black, red, buff and very bright orange (figure E.F206.1). The orange drips appear to be fairly liquid paint splashes, but are now very powdery. Pink paint from the face of the sitter is visible round the edges of the cut-out area. This is slightly glossy at the lower edge, but very thin at the right and top. There is a reserve of bare canvas between the pale blue background and face – the background may have been painted in afterwards.

Surface coatings/gloss

Fairly matt

Samples taken

No.	*Colour*	*Location*
1	Pale blue	Background, top right corner, right edge 2.4 cm from top
2	Bright orange	Splash over background top left corner, top edge, 3 cm from left
3	Pink	Flesh paint, lower cut edge, 15 cm from left, 5.2 cm from bottom.
4	Dark red spot	Splash over background top left corner, tacking edge, 0.5 cm from left
5	Dark blue	Area of thicker paint on left tacking margin, 1 cm from bottom
6	Priming	Back of canvas
7	Buff paint	Splash over background, top tacking edge, 19 cm from left

Notes

The year on the date stamp on the reverse cannot be read, but appears to show a date in the 1980s. The stamp appears similar to that on several other canvases, which are dated 1985 (although at least three of these are dated 11 March, rather than November).

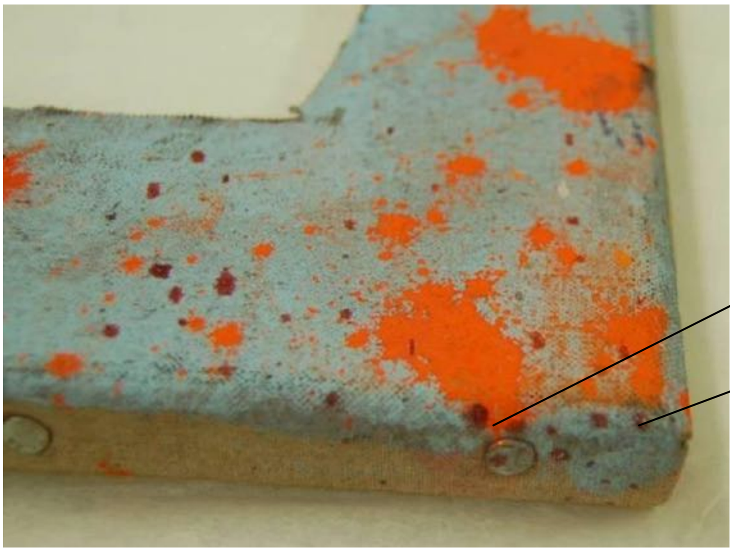
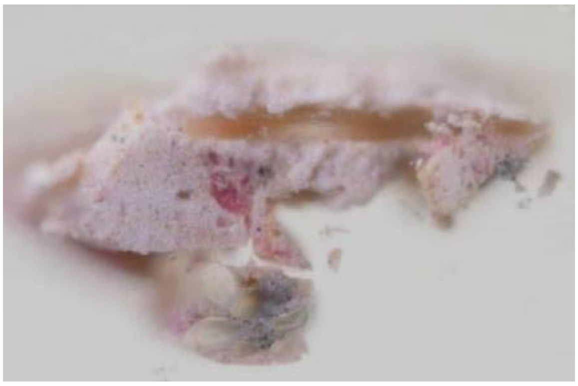
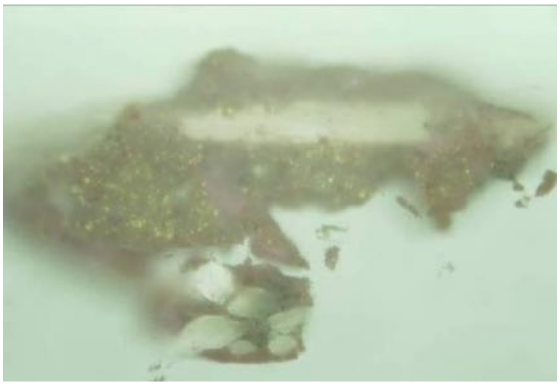


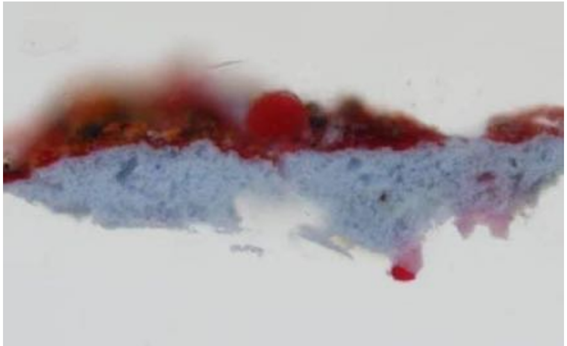
Figure E.F206.1. Detail of corner showing liquid splashes of orange

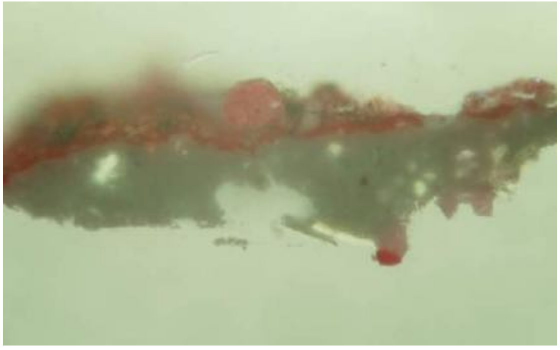
F206-3 Pink, from flesh


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

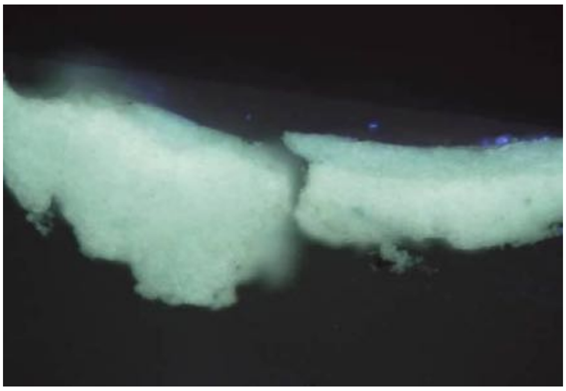
F206-4 Dark red spot over blue


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F206-6 Priming


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Pale blue background	1	FTIR, PyGCMS	PVAc with phthalate plasticiser
	1, 4	FTIR, SEM-EDX	Kaolin
		FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Chalk?
Dark blue stain	5	FTIR, GCMS	Drying Oil (P/S = 2.71 Az/P = 0.42)
		FTIR	Prussian blue
		FTIR	Magnesium carbonate
Pink flesh	3	GCMS, FTIR	Drying oil, poppy? (P/S = 3.88 Az/P = 1.36)
		SEM-EDX, FTIR	Titanium white
		SEM-EDX	Zinc white
		SEM-EDX	Aluminium-based lake?
		SEM-EDX	Magnesium carbonate
Red spot	4	SEM-EDX	Cadmium red
		SEM-EDX	Alizarin crimson
Orange spot	2	FTIR, SEM-EDX	Barium sulphate
		SEM-EDX	Cadmium orange (sulphide/selenide)
Buff spot	7	FTIR, PyGCMS	PVAc
		FTIR, SEM-EDX	Chalk
		FTIR, SEM-EDX	Titanium white
		SEM-EDX	Aluminosilicate
		SEM-EDX	Iron oxide
Priming	6	FTIR, Py-GCMS	Isophthalate Alkyd (P/S = 3.08 Az/P = 1.31)
		FTIR, SEM-EDX	Kaolin
		SEM-EDX	Titanium white
		SEM-EDX	Chalk
		FTIR, SEM-EDX	Lead white

Conclusions

The pale blue background is a PVAc housepaint (with phthalate plasticiser), and the buff spots of paint are also PVAc housepaint. The dark blue and pink paints appear to be oil. The bright orange is cadmium orange pigment and seems to have little or no medium. The flesh paint is mainly titanium white, possibly with an organic pink on an aluminium base. Prussian blue oil paint was used as a stain to the canvas, which was also found on many earlier works.

The alkyd priming has titanium white and kaolin in the upper layer, over a lead white, chalk and titanium white layer.

Untitled (green portrait)

Identification details	
Title: RM98F226:4 Untitled (green portrait)	*Date:* c.1967
Dimensions (hxwxd): 35.5 x 30.6 x 1.8 cm	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F226:4)
Marks/Inscriptions:	

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:

4-member wooden stretcher, mitred mortise and tenon joints. Members 3.1 cm wide, 1.5 cm deep. Steel tacks 6mm diameter, 6.5-8.5 cm spacing.
Plain weave linen canvas, 22 x 18 threads/cm^2

Two pin holes in lower left corner, 15 mm from bottom edge, one 12 mm from left, the other 30 mm from left.

Paint and ground

Priming:
Commercial priming on reverse, off-white

Paint description:

The composition shows a male sitter with brown hair and a white open-necked shirt, with his head apparently resting on his left arm. Dark green background, fairly thickly applied. A lighter green paint has been applied over this particularly to the left of the head. Several criss-crossing cuts into the green paint of the background in the upper right corner.

A large thick (accidental?) splodge of mustard yellow paint lies at the centre of the left edge The paint is fairly thick throughout, except at the lower edge where bare canvas is exposed. The paint layers are particularly thick in the face, as can be seen at the edge of the cut canvas toward upper left. Thick pink and white paint is used in the face, with a dusting of bright red pigment on top. Yellowish sand particles are visible on top of white paint and in hair above. Sand can also be seen in the area of the collar at the left side. Patterns in black and red in lower right corner may be from fabric imprints (figure E.F226:4.2). Thick impasto in white paint around face. The canvas appears to have been cut while paint was still relatively soft, as it has been sliced through cleanly, rather than cracking and flaking at edges (figure E.F226:4.1).

Surface coatings/gloss

Slight sheen on green. Other areas are mostly matt from added pigments/sand.

Samples taken

No.	*Colour*	*Location*
1	Light over dark green	Background, top tacking edge in top left corner, 4.5 cm from left.
2	Red pigment over white/pink	Forehead of figure, cut edge. 12.5 cm from left, 9.5 cm from top.
3	Dark purple	Shirt of figure, edge of horizontal tear, lower left. 5 cm from left, 9cm from bottom
4	Pink over green	Cut edge centre left, cheek of figure. 10 cm from left, 17.5 cm from bottom
5	Mustard yellow blob	Right edge, 20 cm from top
6	Pink over black/green	Upper edge of horizontal tear, lower left, pink stripe. 7 cm from left, 9 cm from bottom
7	Priming	Back of canvas
8	Loose fragments of dusky pink?	From thick area with cracks? 13.5 cm from bottom, 9 cm from left.
9	Dark green scraping	Background, left tacking edge. 7 cm from top

Notes

Thickly painted, possibly reworked which may have led it to being destroyed. Sand added throughout flesh.

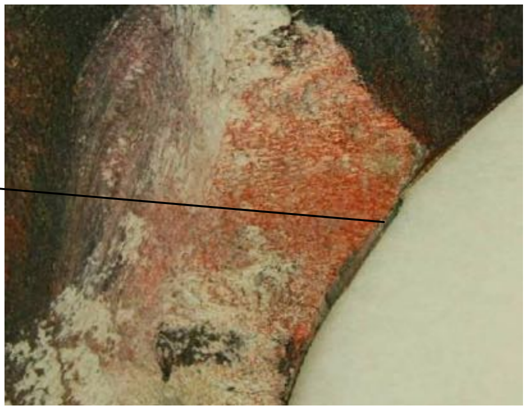
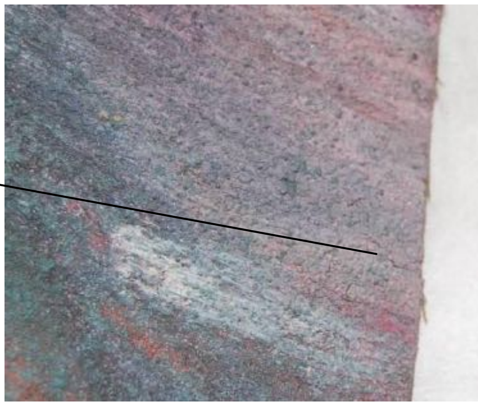
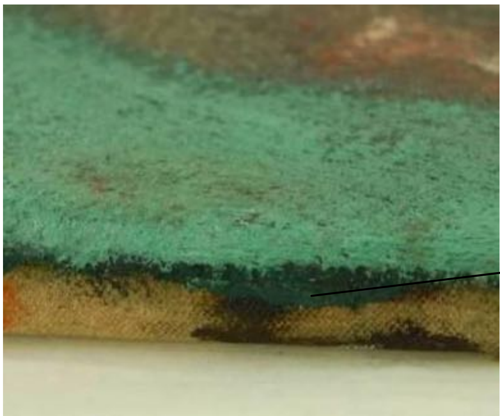


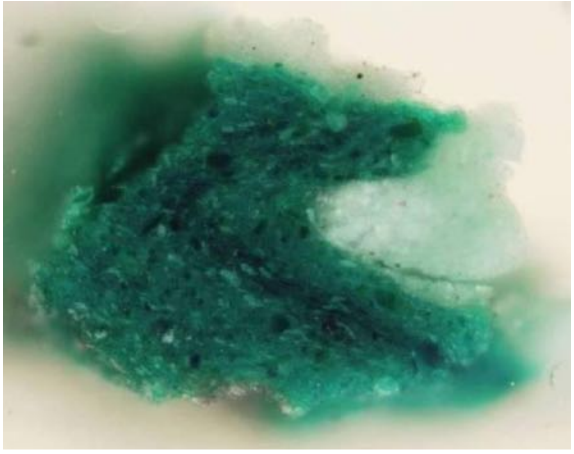
Figure E.F226:4.1 Detail of forehead showing cut edge of paint/canvas

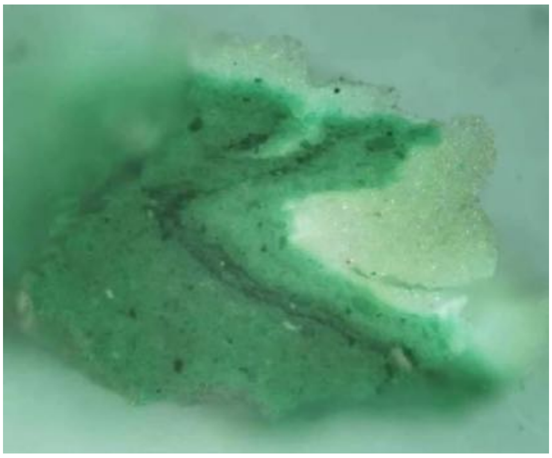
Figure E.F226:4.2 Lower right corner showing red and black printing



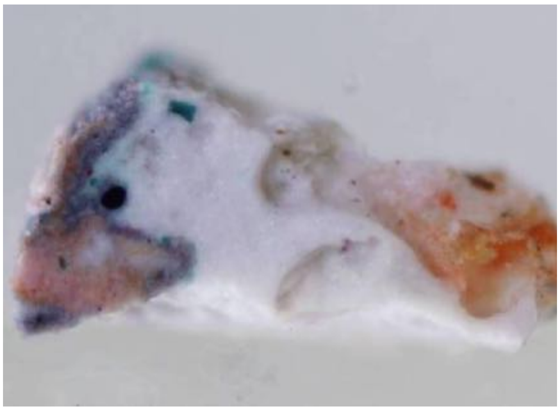


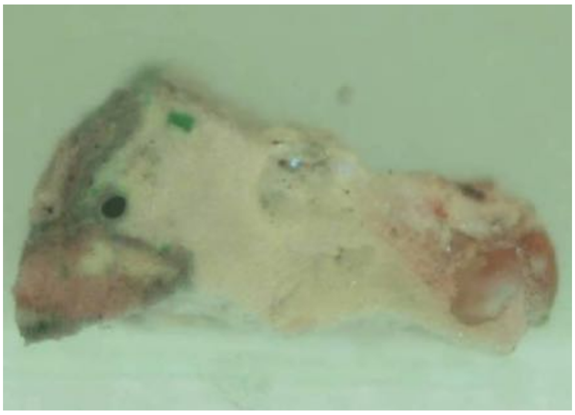
F226:4-1 Light over dark green, background


Normal light (taken at x200 magnification)

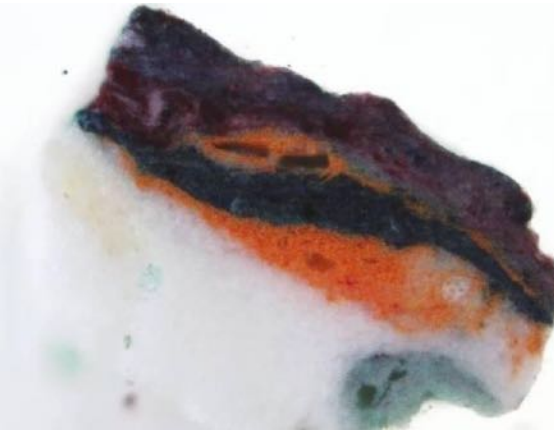

Ultraviolet (x200 magnification)

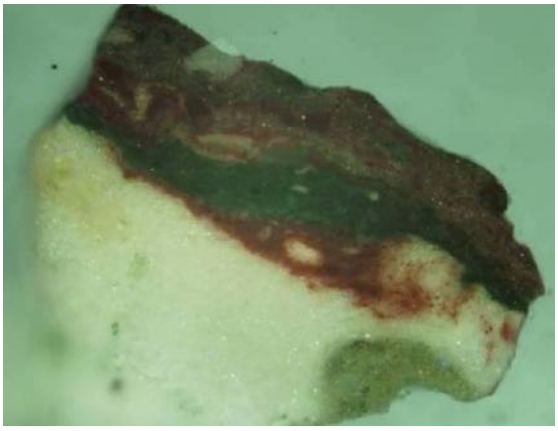
F226:4-2 Red over white, forehead


Normal light (taken at x200 magnification)

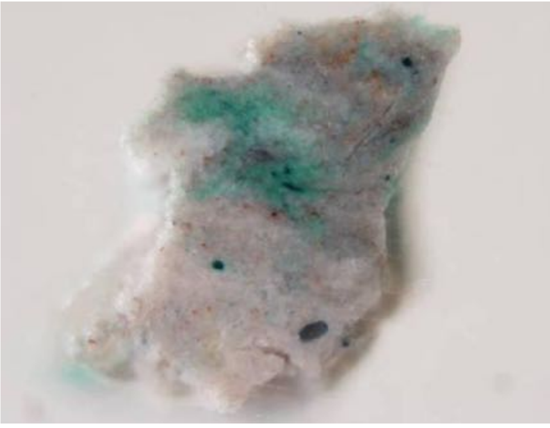

Ultraviolet (x200 magnification)

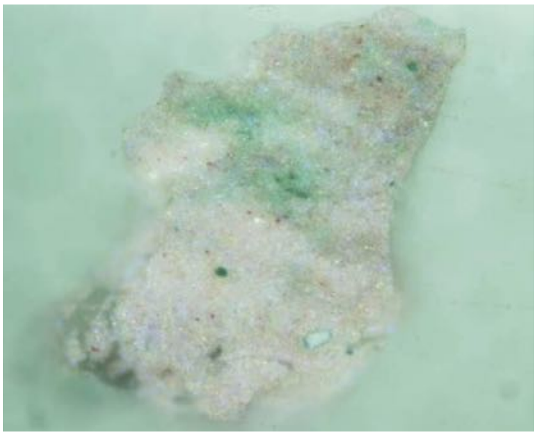
F226:4-3 Purple from collar


Normal light (taken at x200 magnification)

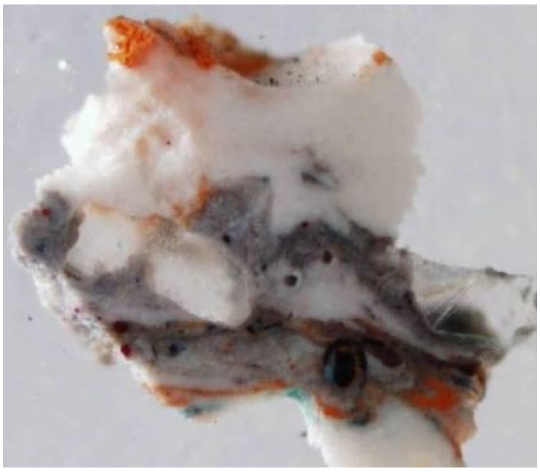

Ultraviolet (x200 magnification)

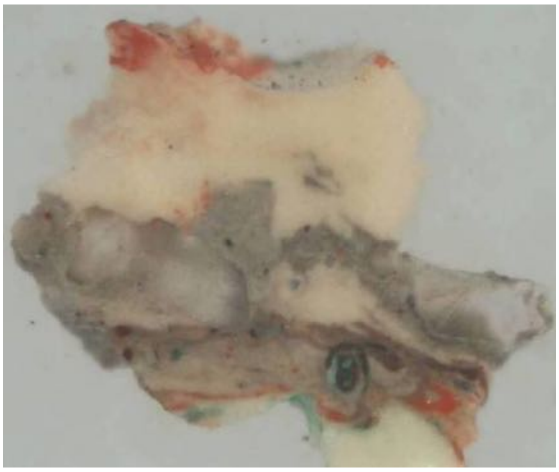
F226:4-4 Pink over green, cheek at centre left


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

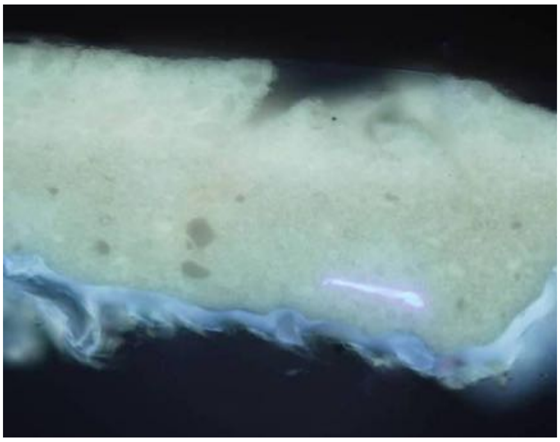
F226:4-6 Pink over black/green from collar


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F226:4-7 Priming from verso


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*sample*	*Analysis*	*Materials identified*
Green background	9	FTIR, GCMS	Drying oil, prob linseed (P/S =1.81 Az/P=0.80)
	1, 9	FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		FTIR, SEM-EDX	Viridian
		FTIR, SEM-EDX	Phthalocyanine green
White from face	2	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Sand
Red on forehead	2	SEM-EDX	Vermilion
Gritty pale pink	8	FTIR, GCMS	Oil (P/S = 3.06 Az/P = 0.61)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Zinc white
		FTIR, SEM-EDX	Silica/sand
Mustard yellow	5	FTIR, GCMS	Drying oil (P/S = 3.65 Az/P = 0.87)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Iron oxide (yellow ochre?)
Purple	3	SEM-EDX	Lead white
		SEM-EDX	Alizarin?
Orange	3	SEM-EDX	Vermilion
		SEM-EDX	Lead white
		SEM-EDX	Barium sulphate
Priming	7	GCMS	Oil (P/S = 1.87 Az/P = 1.28)
		FTIR	Protein size
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Kaolin
		SEM-EDX	Barium sulphate

Conclusions

The dark green, pink and mustard yellow have an oil medium. The mottled bright red over white used on the forehead is found on many of Bacon's portraits. In this case vermilion was used, over flake white (lead white & zinc white). It is uncertain whether the red is also bound in oil. Several layers appear to have been used in some areas, as though reworked – e.g. the samples from the purple/pink collar and forehead. This build-up of thick paint may have led to the painting's destruction. Transparent sand particles were found in several samples from flesh/costume.

The dark green appears to contain both viridian and phthalocyanine green. In sample 1 there appears to be a darker streak of phthalo green within the viridian paint, the incomplete mixing suggesting this was done by Bacon rather than being a commercial mixture.

Oil priming with lead white top layer, with additional titanium white and kaolin in lower layer, over protein size.

Untitled (orange canvas)

Identification details	
Title: F242 Orange canvas	*Date:* c.1980s
Dimensions (hxwxd): 198 x 147.2 x 2.3 cm	*Location/owner:* Hugh Lane Gallery, abandoned canvas (RM98F242)

Marks/Inscriptions:

Top of vertical cross-bar, stamp: 'PREPARED BY/ C. ROBERSON & Co. LTD/ ...PARKWAY, LONDON NW1 No.118'

Vertical cross-bars, top and bottom, black pen/pencil: '39x'

Outer vertical member, left and right: '78'

Horizontal cross-bar: '58'

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
6-member softwood stretcher, horizontal and vertical cross bars, square mortise and tenon joints. Outer member width 6.5 cm, depth 1.6 cm (with bevel at front), cross bars width 6.5 cm, depth 1.5 cm. One key missing from upper left corner.

Plain weave linen canvas, 19 x 19 threads/cm^2. Attachment through pale grey shiny metal tacks, diameter 6-7 mm, spacing 7-8.5 cm. Canvas is stapled to back of stretcher. Canvas seems fairly springy, in good condition.

Paint and ground

Priming:
Off-white, back. Very dirty

Paint description:

The canvas appears to have been roughened and a thin layer of dry orange paint/pigment applied thinly all over. The traces of some shapes can be seen which may relate to a composition. The orange here appears slightly flatter, as though slightly less friable, better bound. Could there be another paint layer underneath here? Possibly traces of black strokes underneath. Elsewhere the orange does not always cover the canvas completely, with some brown threads showing intermittently.

Surface coatings/gloss

Surface very matt and powdery.

Samples taken

No.	*Colour*	*Location*
1	Orange background	Left edge, 62 cm from top
2	Priming	Flake from back

Summary of analysis

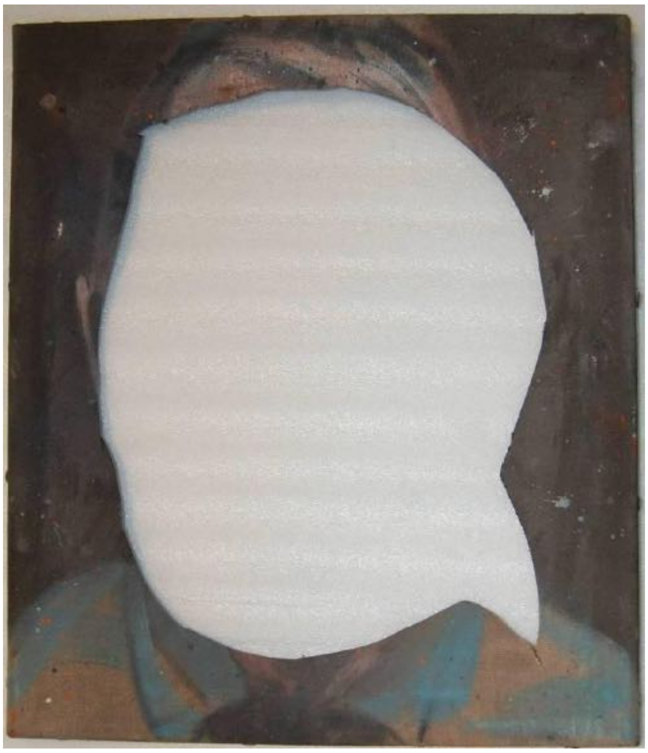
Paint	*Sample*	*Analysis*	*Materials identified*
Orange background	1	SEM-EDX	Cadmium sulpho-selenide
		FTIR, SEM-EDX	Barium sulphate
Priming	2	PyGCMS	Alkyd (Az/P = 1.70, P/S = 2.01)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Kaolin
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Chalk

Conclusions

The orange layer appears very dry and underbound, with little medium detected in FTIR. Cadmium orange is the principal material. The entire canvas is covered with orange and it is uncertain why this would be done, as it would be more usual for the background colour to be applied around any compositional elements. In particular the powdery surface would not be easy to work on top of. The outlines of several shapes seem to show that the orange was originally applied around an area which might have formed part of a painted composition, which was then covered with orange as well.

The commercial priming is alkyd based, with lead white as a principal component in both layers, with chalk in lower layer and kaolin in upper layer.

Untitled (Portrait in blue shirt)



Identification details	
Title: F245:8 Portrait	*Date:* c. 1973
Dimensions (hxwxd): 35.5 x 30.8 x 1.7 cm (14 x 12 x ¾ “)	*Location/owner:* Hugh Lane Gallery, slashed canvas (RM98F245:8)
Marks/Inscriptions:	

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
4-member softwood stretcher, mitred mortice and tenon joints. Bar width 2.9 cm, depth 1.5 cm (with bevel at front). 6 keys present (2 missing).

Plain weave linen canvas, 17 x 21 threads/cm^2. Appears fairly springy, good condition. Attachment through pale grey metal tacks, diameter 6-7 mm, spacing 7.5-10 cm. 4 tacks on each side. Canvas is stapled to back of stretcher.

Paint and ground

Priming:
Off-white, on back.

Paint description:

Very thinly painted portrait, with main part of face cut out. Thin black stain to canvas, used for background, painted around head, with thin turquoise blue below for shirt. Traces of pink remain from forehead and ear. Bare canvas is visible in area of forehead, with thin strokes of black/blue paint forming the hair. Bare canvas also exposed in shirt. Thicker paint near cut edge, fragile and flaking where canvas has become folded back on itself. Thicker pink paint also at collar (neck), which appears to be on top of thin black layer.

Bright orange splashes of pigment on back, and a few smaller spots on front also.

Surface coatings/gloss

Very dusty and matt

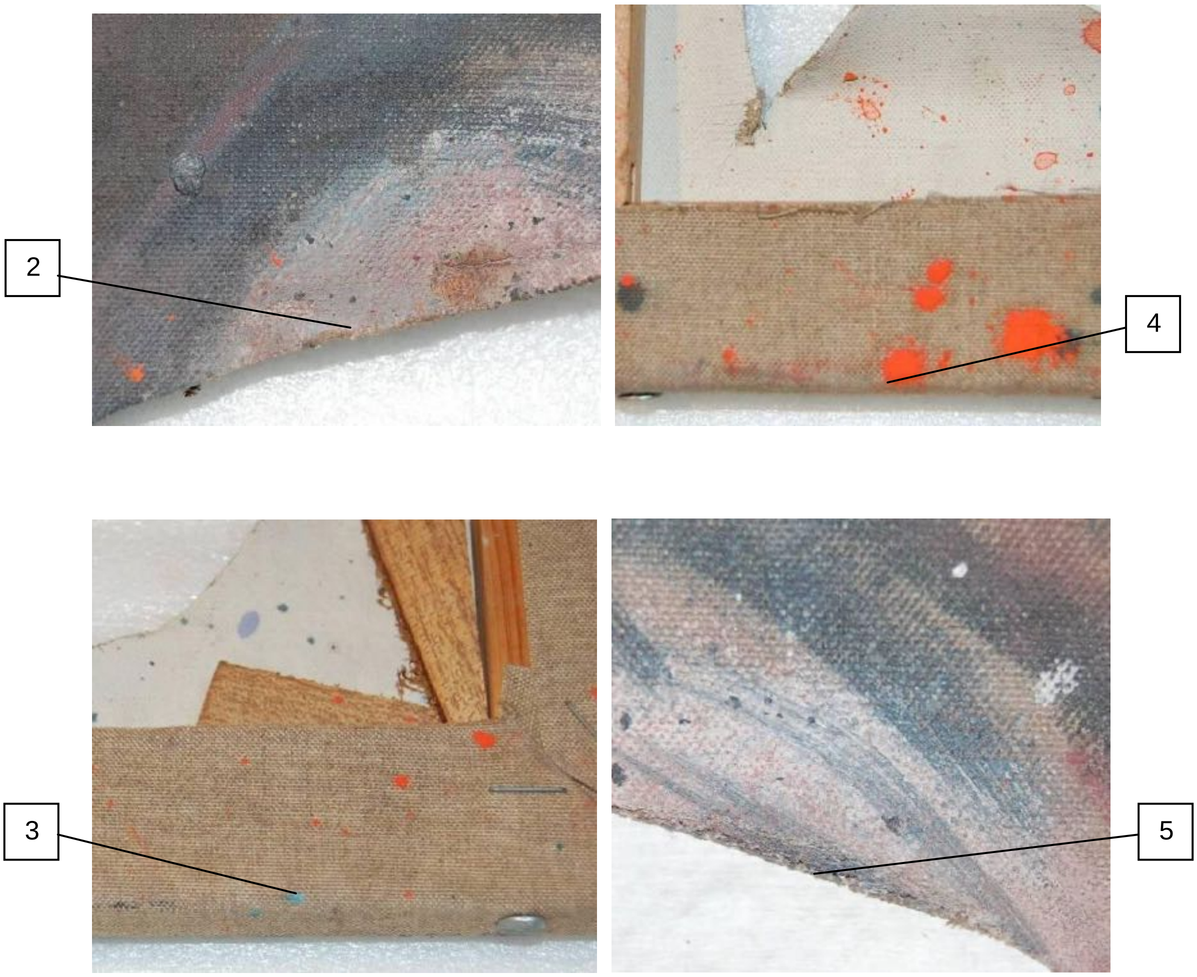
Samples taken

No.	*Colour*	*Location*
1	Priming	Flake from cut edge.
2	Grey-blue over pink	Loose fragments from forehead, 9.2 cm from left ,4.4 cm from top.
3	Pale blue splash	Back bottom turnover edge, 6.5 cm from left.
4	Bright orange powder	Back, bottom turnover edge, 7.5 cm from right.
5	Blue over white, forehead	Loose fragments near cut edge, 11.2 cm from right, 4.3 cm from top.
6	Black stained fibre + scraping from tack head	Right cut edge 15.5 cm from top, 4.5 cm from right Left edge, 13 cm from bottom.

Notes

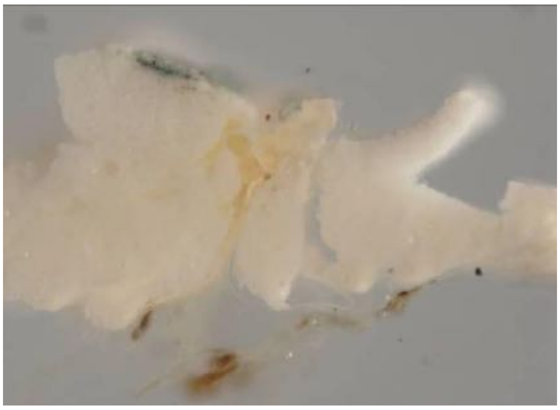
Notes from Hugh Lane database suggest this work may be a self-portrait from the early 1970s, noting the similarity of the shirt to that in *Three Studies for Self-Portrait*, 1972.
Several other self-portraits using similar blue striped shirts can be found, in Self-Portrait 1972 (Portraits & Self-portraits p27), Three Studies for Self-Portrait 1973 (p172-5) and Self-Portrait 1972 (p89). Less similar but related blue-red shirt in Triptych 1977 (p96-7) & Two Studies for Self-Portrait 1972 (p109-11).

Sample sites

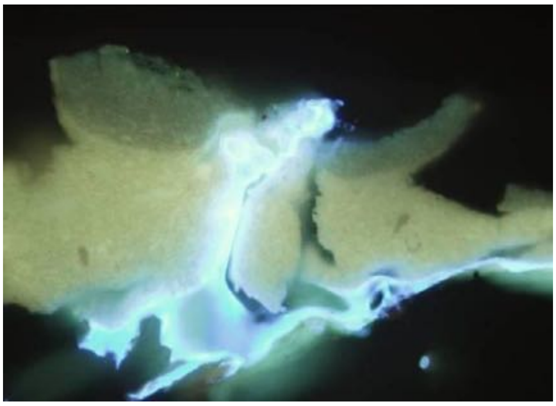


Cross sections

F245:8-1 Priming from reverse

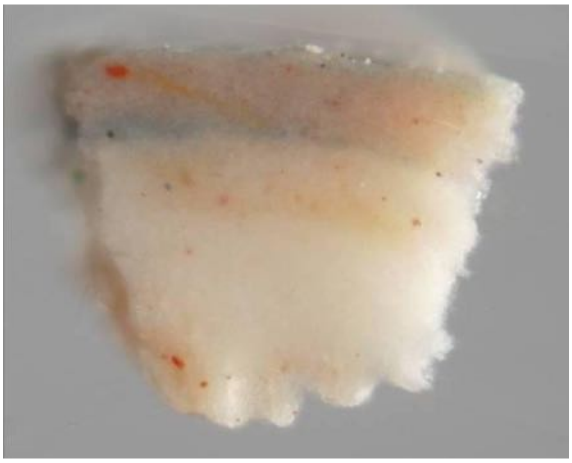


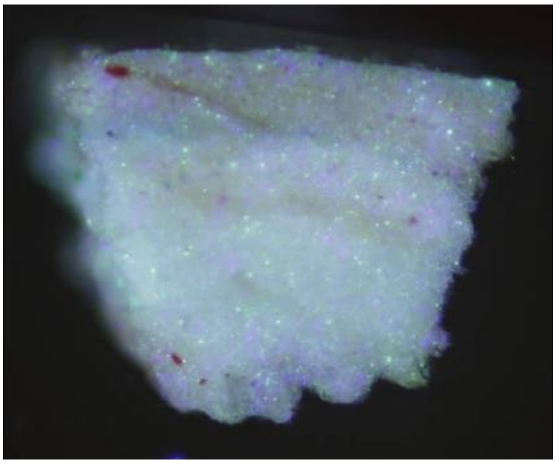
Normal light (taken at x200 magnification)



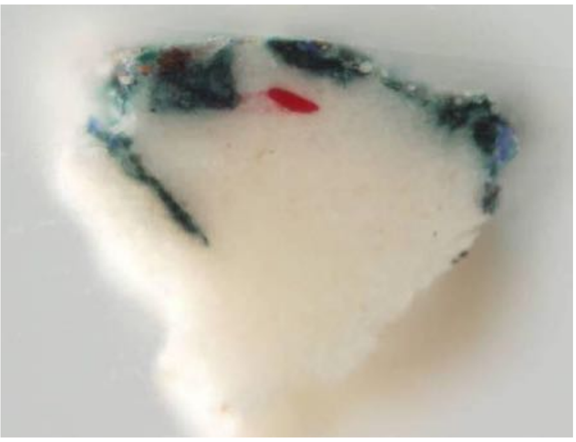
Ultraviolet (x200 magnification)

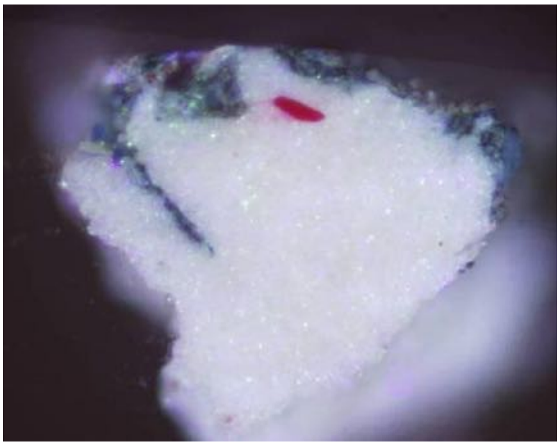
F245:8-2 Grey-blue over pink from forehead


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

F245:8-5 Blue over white, forehead


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of Analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Pink	2	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Vermilion
Pale blue	3	FTIR, GCMS	Oil (Az/P = 0.99, P/S = 2.12)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Prussian blue
		SEM-EDX	Zinc white
Orange	4	SEM-EDX	Cadmium orange
		FTIR, SEM-EDX	Barium sulphate
White	5	FTIR, GCMS	Oil (Az/P = 1.53, P/S = 2.28)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
Blue	5	SEM-EDX	Cobalt blue
		SEM-EDX	Phthalocyanine green
		FTIR, SEM-EDX	Prussian blue
Black	6	GCMS	Oil (Az/P = 2.66, P/S = 2.07)
		EDX	Carbon black?
Priming	1	FTIR, GCMS	Ortho-phthalate Alkyd (Az/P= 0.46, P/S= 1.60)
		FTIR	Protein size
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Titanium white
		SEM-EDX	Kaolin
		SEM-EDX	Barium sulphate

Conclusions

All paints tested had an oil medium. Lead white with vermilion appears to be used for the flesh paint, and lead white with Prussian blue for the shirt. Blue strokes over the forehead contain a mixture of pigments, including Prussian blue, cobalt blue and probably phthalocyanine green. The bright orange splashes on the canvas appear to be cadmium orange pigment.

The alkyd priming consists of two layers of lead white, kaolin and titanium white over a protein size layer.

Appendix F. Reports on Case Studies

Head, c.1949

Identification details		
Title: Head		*Date:* 1949
Dimensions (hxwxd) : 81 x 65 x 2.4 cm	*Location/owner:* Private Collection	

Marks/Inscriptions:
Black marker pen, written on both top stretcher bar and horizontal cross bar: ‘23/0299’

Black pen, horizontal cross bar of stretcher: ’MT 547’
Black pen (biro) on back of canvas: [difficult to decipher]
Black biro, canvas of bottom tacking margin: ‘PROPRIETA [difficult to decipher] Clement [?]

Green ribbon tied in a bow around vertical cross-bar

Support
Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
6-member wooden strainer, with vertical and horizontal cross bars. Horizontal cross bar quite knotty. Corners appear to be square mortise and tenon and are apparently fixed, no channels for keys. Slots exist at the centre of the four outer stretcher bars for the cross bars – to allow some adjustment of the cross bars, or for keys? Width of members 3.7 cm.

Plain weave linen canvas. Thread count 24 (weft) x 16 (warp) /cm^2. Selvedge at bottom edge, other sides cut slightly roughly. Canvas tacked to back of stretcher at corners and along edges. Canvas is fairly stiff with the thickness of paint.

Attachment through tacks, 5-6 mm diameter, at 9.5-10 cm spacing. Turnover edges and tack heads are painted a dark brown, making it difficult to see tack material.

Paint and ground
Priming: On reverse, off-white. Blotchy grey appearance may indicate damp. Dark patches near bottom may be from past mould attack.
Paint description: Grey outline of head and shoulders of a man, against grey vertical striped background (curtain?). Dimensions of head 24 x 29 cm. Very thickly painted in upper part of background and figure. Small areas of bare canvas in bottom two corners. Canvas has quite dark appearance. The background has vertical strokes of black and dark olive green painted over thick earlier paint layers which have a rough, craggy, rippled texture. There are drips of thick paint over the top tacking edge and a few losses along this edge. In areas of loss/abrasion, traces of lighter grey, chalky-looking blue and yellow paint are visible underneath the surface layer. Generally the grey background gives the impression of being painted over an earlier lighter layer, with whitish spots revealed at the tops of the texture where the paint is abraded. The area of the figure is also very thickly painted, but has a smoother texture. The face and the area just to the right of it are particularly thick, suggesting extensive reworking. Horizontal strokes are used across the face in the same grey/black as used in the background. Strokes across the top of the head with grey plus white suggest slicked back hair. Thin lines of black paint are used to outline head and features (nose, chin) as final layer. The paint is much thinner in the bottom ~quarter of the painting, until at the very bottom there is exposed canvas. Some thin strokes of paint skim over the tops of the canvas only. A curved line made with dark greenish paint runs through the sitter's right shoulder, reminiscent of framing for an oval portrait. Blue-grey paint is used in the jacket, with white strokes suggesting collar/shirtfront. One area of very thick impasto in white paint. Orange traces on right shoulder. There are several horizontal cracks through the thick areas of paint. The edges are slightly raised, but paint appears secure. There is a brown putty-like material in a loss at centre of top edge.

Surface coatings/gloss
Slightly glossy surface, fairly uniform, although head appears glossier due to smooth texture. Slightly sparkly and darkened appearance of canvas indicates a thin varnish layer may be present.

Samples taken

No.	*Colour*	*Location*
1	Grey scraping	Drip at top edge, 16.8 cm from left
2	Grey over blue (more thick layers beneath not collected)	Edge of loss at top edge, 21.5 cm from right
3	White grey speck	Left edge 10.5 cm from bottom
4	Light green & grey	Left edge, 26.8 cm from bottom
5	Grey	Edge of crack at top edge, 27 cm from left
6	Grey over yellow/white (down to canvas)	Edge of loss at right edge, 6 cm from top
7	Black/brown	Loose flake from back of tacking margin, paint used on canvas edges.

Notes

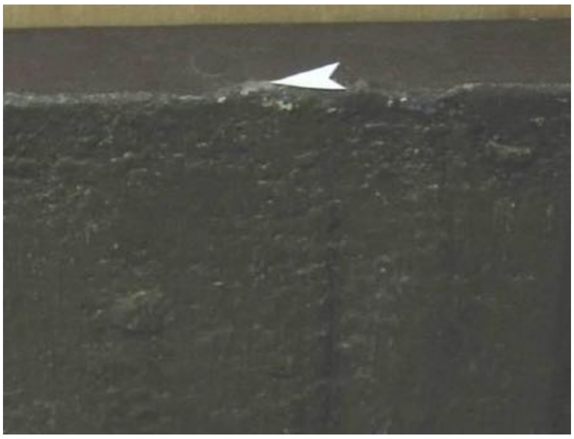
Very thick paint has built up rough texture, with surface of canvas not discernable except at lower edge of picture. May be one Bacon would describe as ‘clogged’.

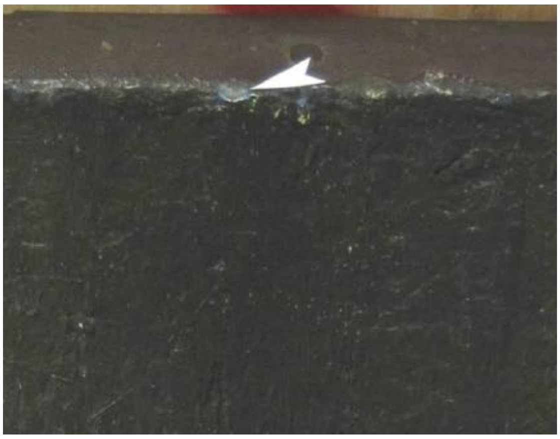
Painting also x-rayed while at Martinspeed.

X-ray:
Shows significant differences compared to the final painting – in the x-ray the figure is facing to the front with the mouth open in a grin, similar to the figure beneath the umbrella in *Painting* 1946. The shape of an ear at the left of the head can also be clearly seen, and the impression of an eye socket or eye-glass. In the finished painting the features are less distinct, the head appears to be turned to the right, with faint strokes of darker grey marking the mouth, one eye socket and the shadow below the nose. No ear is visible. The head has the appearance of having been wrapped in a grey cloth or veil. Strokes over the back of the head could possibly indicate folds of this suffocating cloth or represent slicked-back hair.

The line of the collar and jacket also appear to have been changed, again with the shape of the collar appearing more definite in the x-ray.

1



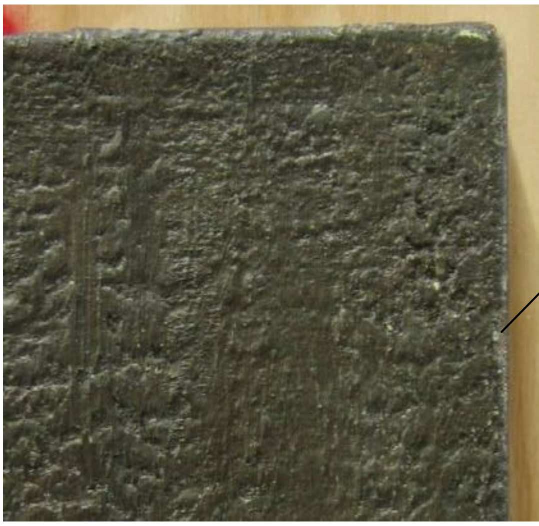


2

3

4

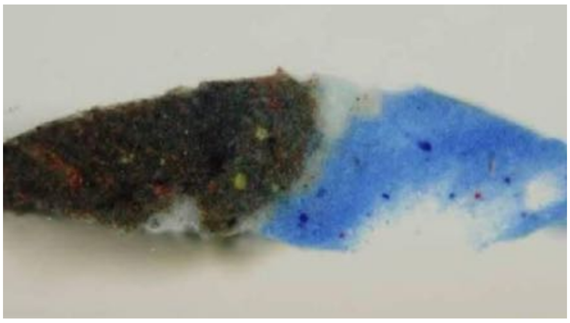
5



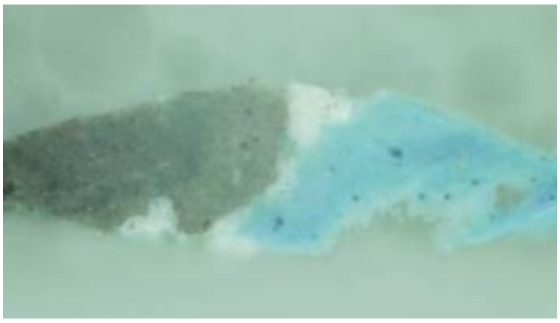
6

Cross sections

FBA4-2 Grey over blue, edge of loss at top edge.

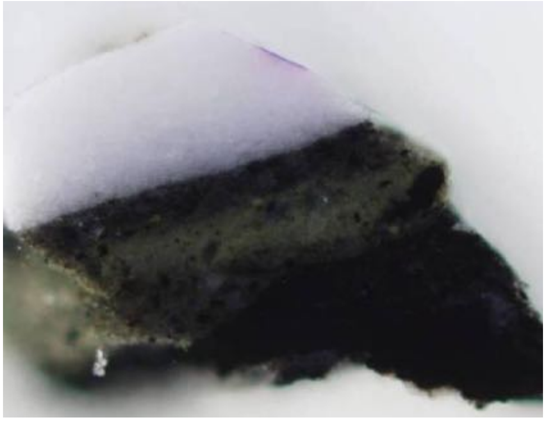


Normal light (taken at x200 magnification)

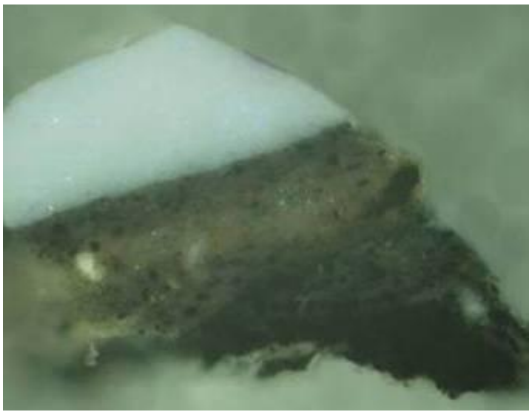


Ultraviolet (x200 magnification)

FBA4-3 White speck over grey, lower left edge

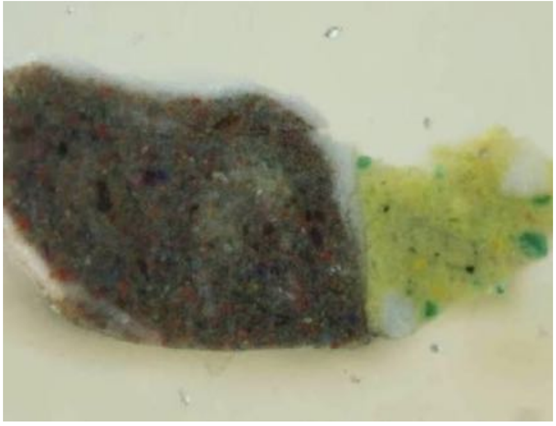


Normal light (taken at x200 magnification)

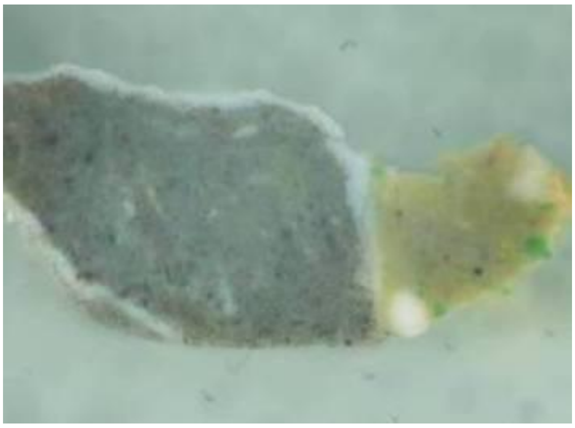


Ultraviolet (x200 magnification)

FBA4-4 Grey over light green, left edge

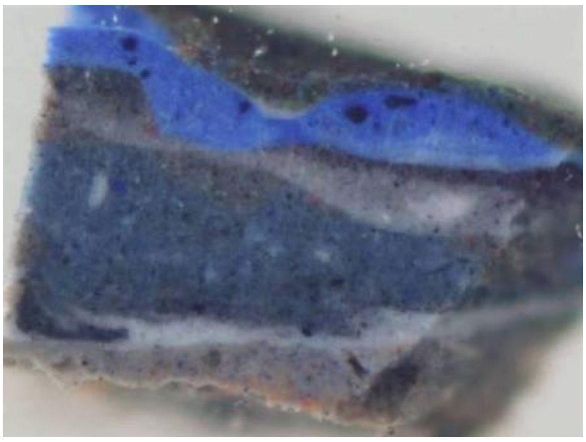


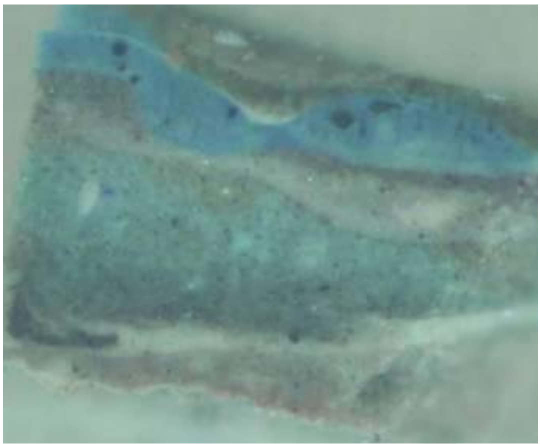
Normal light (taken at x200 magnification)



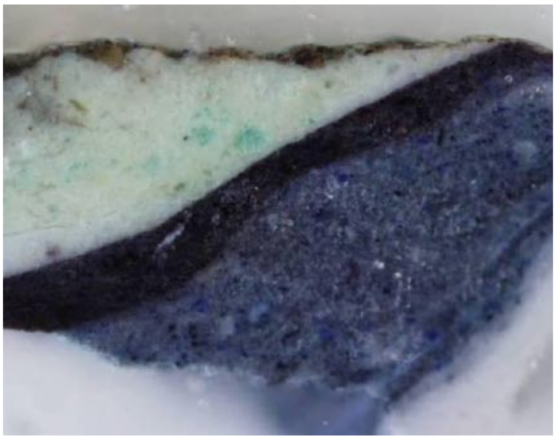
Ultraviolet (x200 magnification)

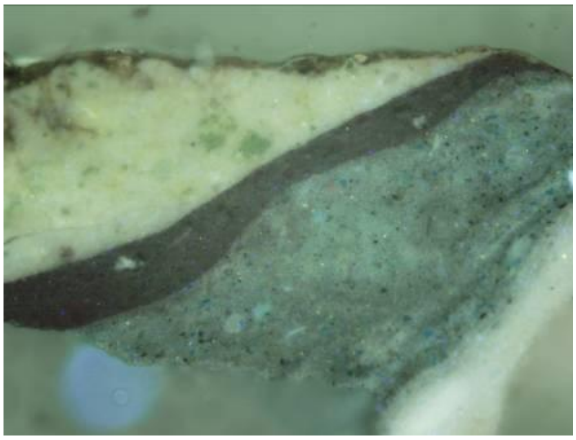
FBA4-5 Grey, edge of crack at top edge.


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FBA4-6 Grey over yellow/white, edge of loss at upper right edge.


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Grey	1	FTIR, GCMS	Oil (Az/P = 0.61, P/S = 2.95)
		FTIR	Lead white
Blue	2, 5	SEM-EDX	Barium sulphate & zinc white/ lithopone
		SEM-EDX	Phthalocyanine blue?
Grey	2, 4, 5	SEM-EDX	Lead white
		SEM-EDX	Vermilion
		SEM-EDX	Cadmium yellow
	2	SEM-EDX	Cobalt violet
	4, 5	SEM-EDX	Cerulean blue
White	3	FTIR, GCMS	Oil (Az/P = 1.17, P/S = 3.06)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white

Grey-black	3	SEM-EDX	Ivory black
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
Green	4	SEM-EDX	Viridian
		SEM-EDX	Cadmium yellow
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
Grey-brown	6	SEM-EDX	Raw umber
		SEM-EDX	Lead white
		SEM-EDX	Zinc white
Brown	7	FTIR, PyGCMS	PVAc
		FTIR	Chalk

Conclusions

Many layers have been used throughout the painting – these can be clearly seen in sample 5 (at least 8 layers). In other samples the full thickness of the paint was not collected. The whole painting has the appearance of being very thickly painted. The grey surface layer appears to have red, yellow and blue particles mixed in, and covers a very thin layer of white paint (lead white & zinc white). This in turn covers a bright blue paint in some areas (top edge) and a bright green in others (lower left edge). The bright colour of these layers is surprising considering the monochrome appearance of the finished painting. The colours observed could be consistent with a landscape composition of blue sky and green grass. However, there appears to be many more paint layers under these bright colours (from sample 5).

Bacon's paintings from this date are all fairly monochrome, and this bright colour does not seem to fit with his work at this time. However a similar use of colour underneath grey surface layers is seen in samples from *Head II,* which is also very thickly painted. It is uncertain whether the earlier paint layers relate to an earlier composition, or whether they were successively applied as modifications to the same composition. There is also the possibility that the layers were applied more deliberately to build up a thickness of paint, with the colours possibly intended to have an optical effect on the final surface (although the grey surface layer appears fairly opaque in this case, unlike in *Head II* where some colours show through).

The surface texture in the background has some similarity to other paintings from a similar date – notably *Head II*, 1949. The curve in the lower left corner of this painting is also echoed.

Study of a Head, c.1959

Identification details		
Title: Study of a Head (St Ives?)		*Date:* c.1959
Dimensions (hxwxd): 37 x 28.5	*Location/owner:* Private Collection	
Marks/Inscriptions: None (back not visible)		

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
Canvas, probably on stretcher, but back is not visible due to Fome-cor backboard. Canvas is linen, plainweave, 15 x 16 threads/cm^2

The central section of the canvas has been cut out. At the two sides, cut edges of the canvas are visible and it appears that the canvas has been strip-lined after trimming of the tacking edges (possibly cut down from a larger canvas). At the top and bottom the canvas appears intact over the front turnover edge, but all the tacking edges are covered with strips of black canvas tape, so we cannot see if these edges are also strip lined. Similarly, no tacks are visible. A loose lining of canvas covered with a glossy black paint has been stretched under the canvas, supporting the cut edges.

Paint and ground

Priming: off-white, on back

Paint description:
Canvas is stained with thin bright green paint throughout the background. This appears to have been applied over the whole background. A darker square of thin black paint is painted on top of the green, with the portrait placed on top of this. Thinly painted lines of red/salmon pink outline the dark square (figure F.A5.2).

Only the upper profile of the face and an area of white shirt from the figure remain, the rest of the portrait having been cut out. The white shirt has been thinly painted over the green stain, resulting in a pale green layer. The face is much more thickly painted, again over the green, pink and white are swirled together on the forehead and nose, with bright green outlining. There are traces of red and dark blue around the profile which appear to be from earlier layers. The paint on the face has horizontal age cracks and appears much thicker and more glossy than that in the rest of the image. It appears that some of the paint has sheared off in one area towards the top of the nose, this may have been a particularly thick blob of white paint (figure F.A5.1). A layer of pink-blue paint is revealed beneath.

Surface coatings/gloss

Very matt throughout, except for the flesh paint which is relatively glossy. Slight sheen on white paint used for shirt.

Samples taken

No.	*Colour*	*Location*
1	Priming	Back of canvas
2	Pale green over dark green stain	Shirt, flaking near cut edge
3	Green over pink	Face, cut edge. 31.2 cm from top, 18 cm from left
4	Dark pink	Face, cut edge. 40 cm from top, 14.8 cm from left
5	Pink	Forehead (green canvas & white paint visible beneath), cut edge. 24.8 cm from top, 23.5 cm from left
6	White/pink	Edge of chipped paint at top of nose. 33.5 cm from top, 16cm from left
7	Red line	Left edge, 26.5 cm from bottom
8	Green-stained canvas fibres	Canvas fibres from background, cut edge. 23 cm from top, 10cm from right
9	Dark blue	Chin, cut edge. 42.2 cm from top, 14.5 cm from left

Notes

Painting sold recently at auction as part of ‘The Ron Thomas Collection of items from the Studio of Francis Bacon’ (Live Auctioneers, Jun 21st, 2007). Ron Thomas worked for Marlborough Fine Art.

This work was thought to be from St Ives period (end of 1959-1960). It can be compared to Muriel Belcher portrait and several other works with the same type of green stained background. Several works brought back from St Ives are recorded in photos by Douglas Glass, some of which were later cut down or destroyed by Bacon. This work may well have been cut down at left and/or right sides, but if this was done by Bacon it is uncertain if it was displayed as a trimmed work before destruction, as the remaining original canvas has no means of being attached to a stretcher at left and right as it now stands. The strip lining would presumably have been done much later, as a way of presenting this already destroyed work.

Figure F.A5.1 Detail showing loss in white paint on nose and cracking in thick pink paint

Figure F.A5.2 Green staining over canvas, with pink line edging square of black around

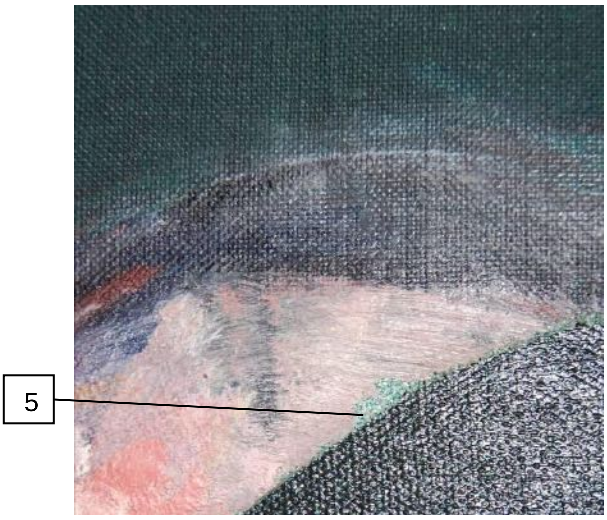
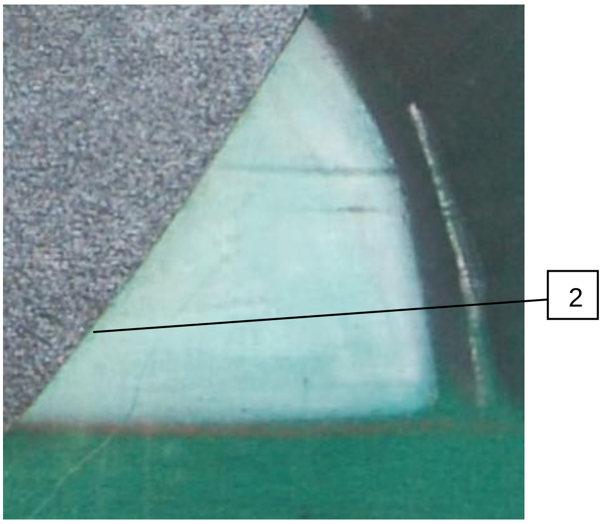
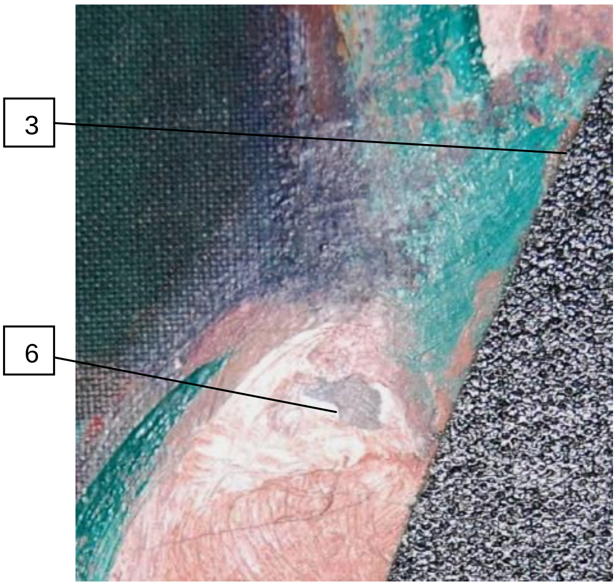
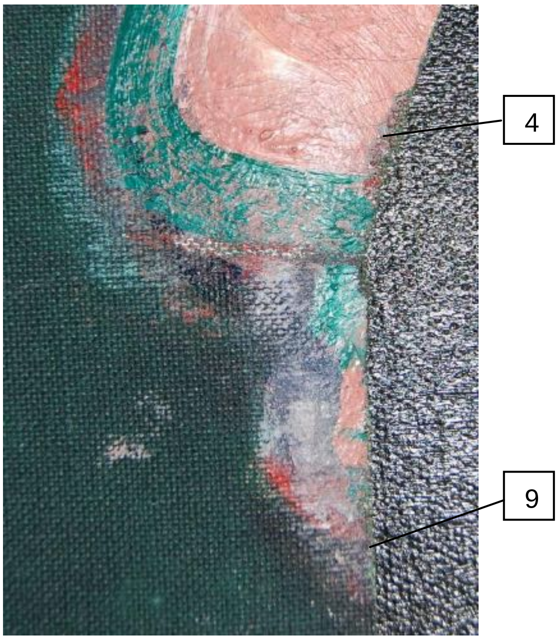
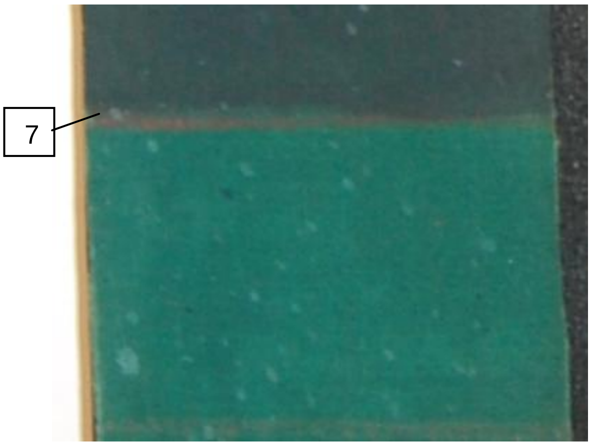


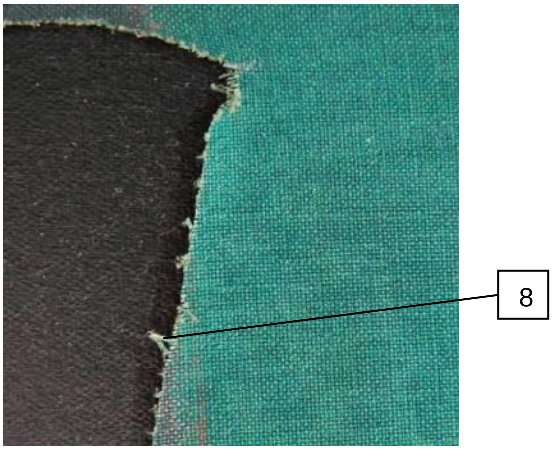
Figure F.A5.3 Detail from forehead showing green stained canvas beneath loss





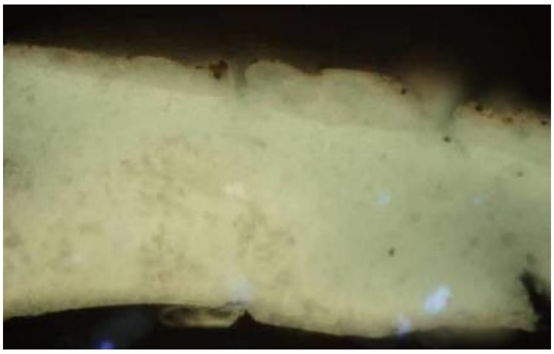




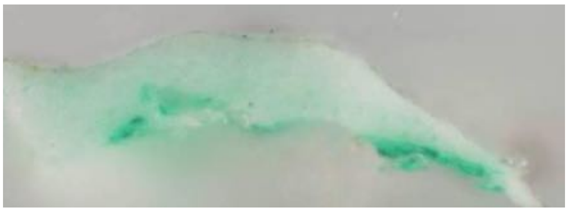


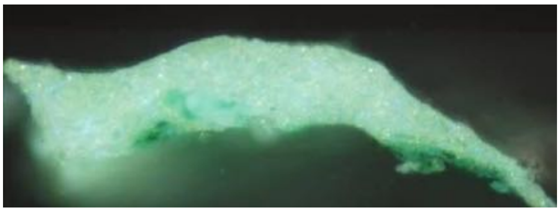
FBA5-1 Priming


Normal light (taken at x200 magnification)

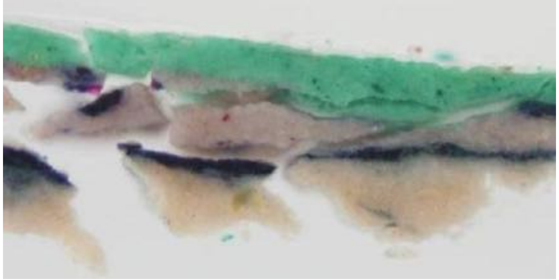

Ultraviolet (x200 magnification)

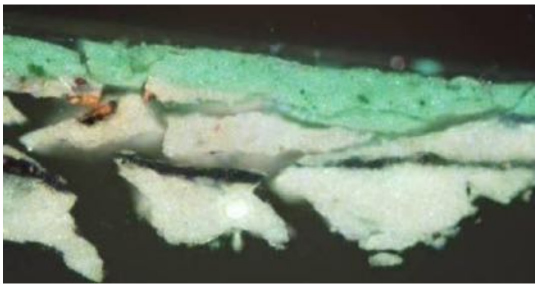
FBA5-2 White over green


Normal light (taken at x200 magnification)

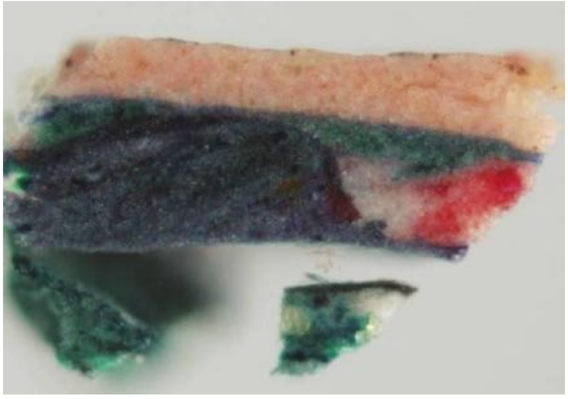

Ultraviolet (x200 magnification)

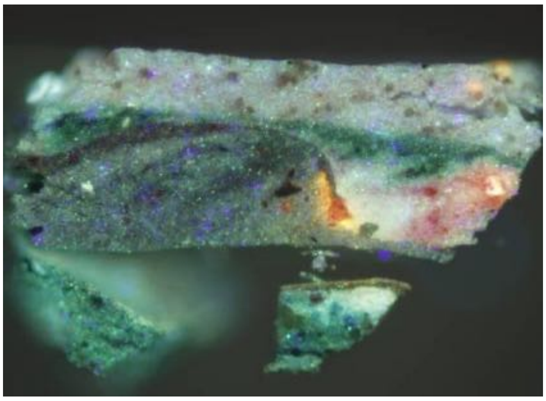
FBA5-3 Green over flesh paint


Normal light (taken at x200 magnification)

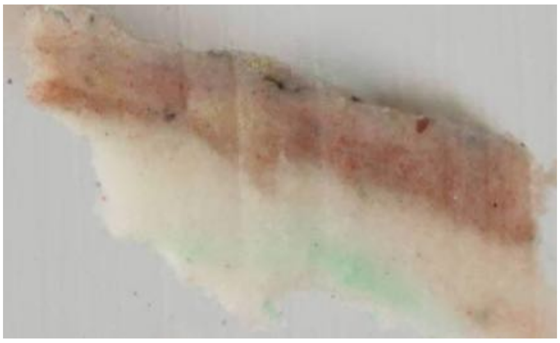

Ultraviolet (x200 magnification)

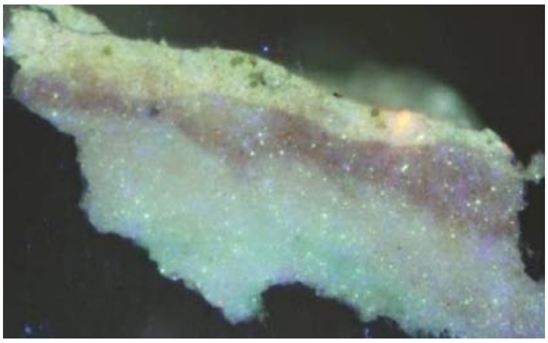
FBA5-4 Pink from nose


Normal light (taken at x200 magnification)

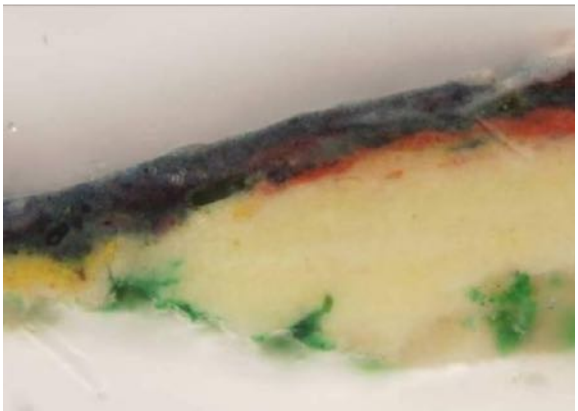

Ultraviolet (x200 magnification)

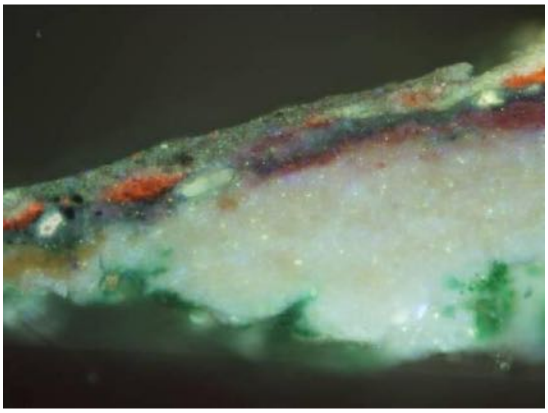
FBA5-5 Pink on forehead


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FBA5-9 Blue


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
White	2	FTIR, GCMS	Oil (Az/P = 0.97, P/S = 3.42)
		FTIR, SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Phthalocyanine green
Priming	1	FTIR, GCMS	Oil (Az/P = 1.66, P/S = 2.42)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Barium sulphate
Pale green	3	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Phthalocyanine green
Pink	4, 5	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Barium chromate
		UV, SEM-EDX	Rose madder?
Blue	4, 9	FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Prussian blue
White-pink	6	FTIR, GCMS	Oil (Az/P = 1.26, P/S = 6.42)
		FTIR	Lead white
Red stripe	7	SEM-EDX	Cadmium red
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Barium sulphate
Green stain	8	SEM-EDX	Phthalocyanine green
		SEM-EDX	Zinc white
		SEM-EDX	Barium sulphate

Conclusions

An oil medium was found in paint used for flesh and for the white shirt. Phthalocyanine green was used for the green stain, which has also been found, used similarly in *Figures in a Room*, 1959 and *Head of a Woman*, 1960. The same pigment was also used for the lighter green strokes over the face. Prussian blue, barium chromate and cadmium red were also found. Rose madder genuine was believed to be present, from the fluorescence of some particles.

Untitled (Sketch for a Portrait), c.1967

Identification details	
Title: Untitled (Sketch for a Portrait)	*Date:* c.1967
Dimensions (hxwxd): 14 x 12 in	*Location/owner:* Private Collection
Marks/Inscriptions: None (back not visible)	

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:

Plainweave linen canvas, 16 x 22 threads/cm^2. Central part of canvas has been cut out. Attached by slightly blackened metal (steel?) tacks, 8-9 cm spacing, 5 mm diameter.

Hardboard backing screwed into back of stretcher, back not visible. The backboard is painted black where visible at the front through the hole in the canvas.

Paint and ground

Priming: On back, off-white

Paint description:

A dark green stain is used over the canvas, which continues over the tacking margin at the lower edge and partly over other edges. A thin black paint is used on top to form the background. Grey and chalky pink paint is used on top of the green at the neck (figure F.A7.1). Thin brown, grey and pink traces at top of cut-out area form forehead and hair. Spots of yellow powdery material over green in top right corner.

Surface coatings/gloss

Slight gloss on grey paint, otherwise very matt.

Samples taken

No.	*Colour*	*Location*
1	Dark green	Bottom edge from around tack head, 10.2 cm from left
2	Yellow powdery material	Right edge, 18.8 cm from bottom
3	Priming	From loose threads bottom right of cut area
4	Pink & grey flake	Neck, from cut edge. 7.5 cm from bottom, 8.5 cm from left
5	Pink flake	Cut edge. 8 cm from bottom, 8 cm from left
6	Grey with black under	Cut edge. 7 cm from bottom, 12 cm from left
7	Black scraping	Top edge, 1.5 cm from left

Notes

Compared to Lucian Freud, 1967

Sold at auction, part of ‘Items from the Studio of Francis Bacon’ at Ewbank Clarke Gammon Wellers Auctioneers, Apr 24th 2007, along with FBA8.

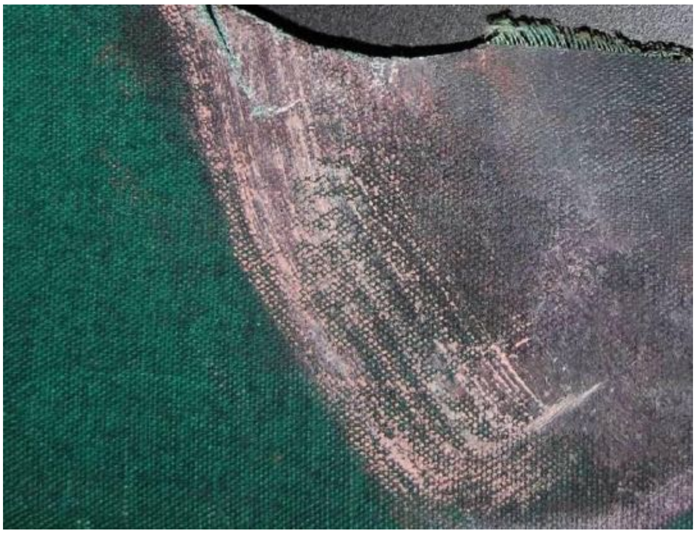
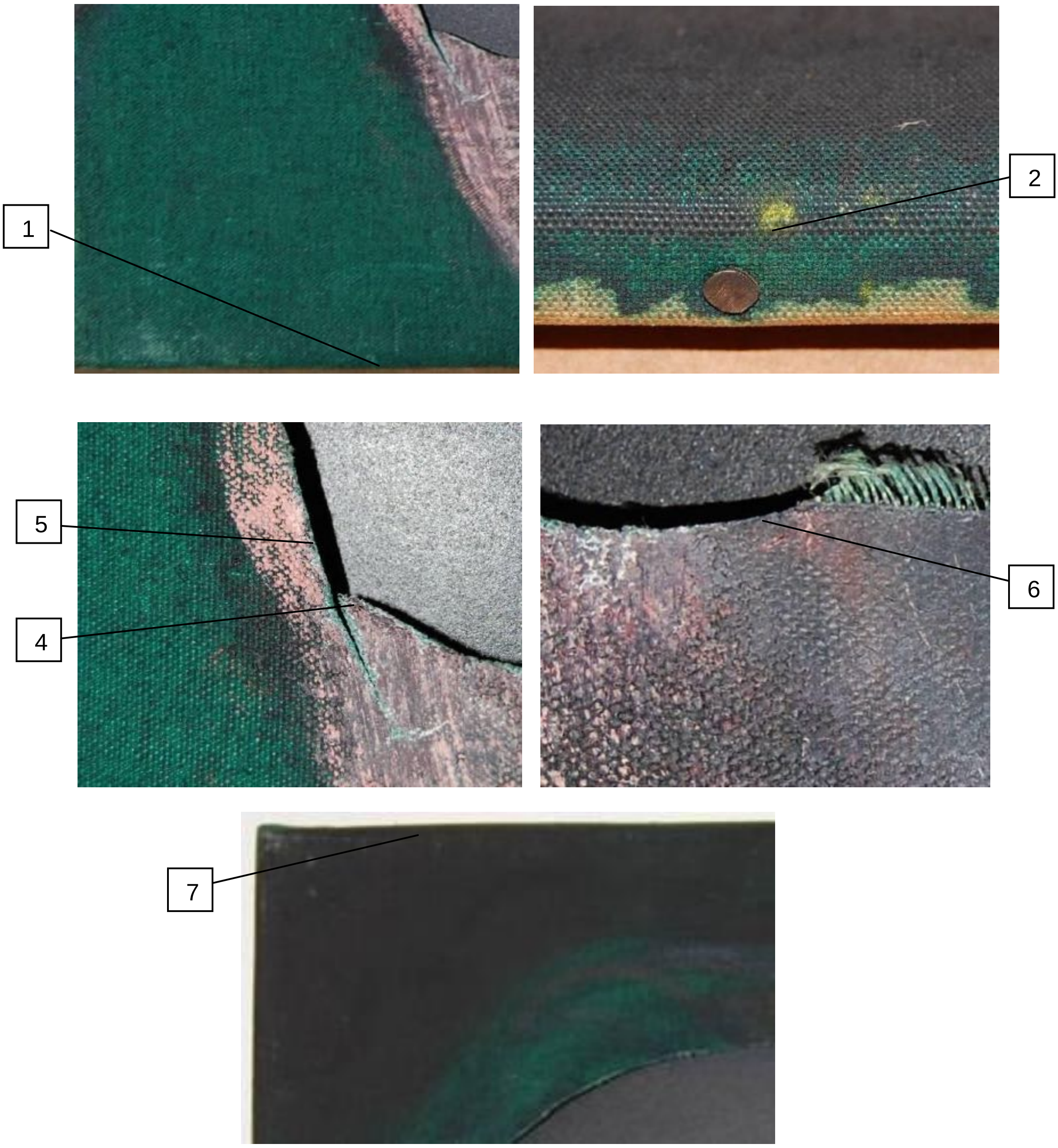
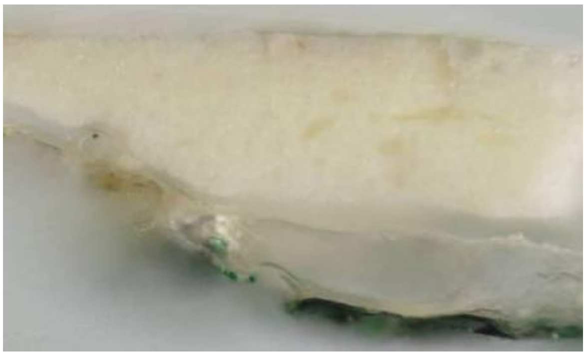
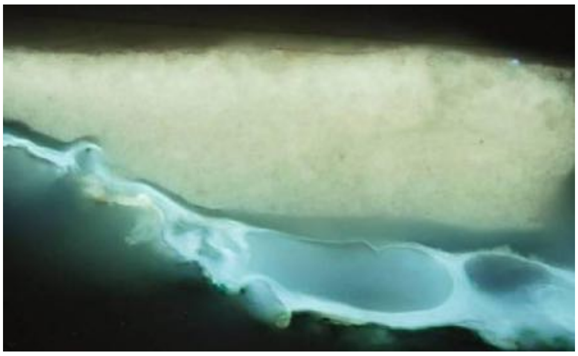


Figure F.A7.1 Detail showing stroke of pale pink paint dragged over green stained canvas



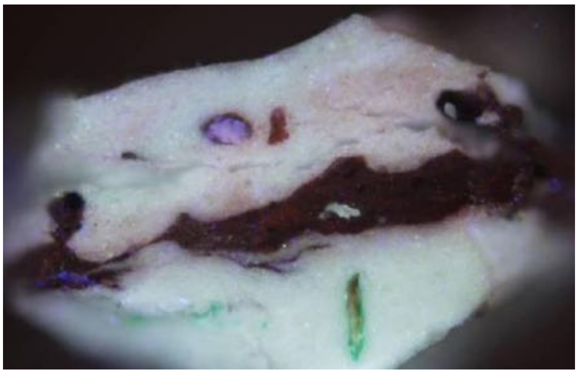
FBA7-3 Priming from reverse


Normal light (taken at x200 magnification)

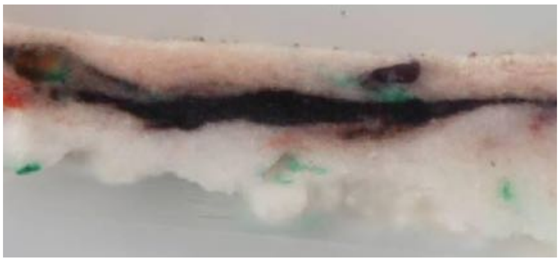

Ultraviolet (x200 magnification)

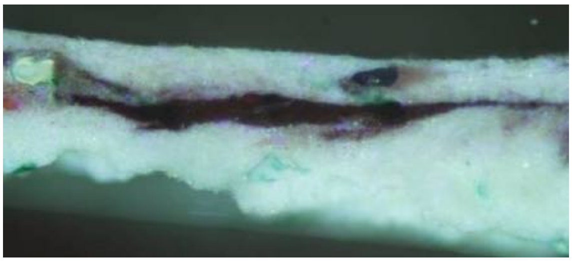
FBA7-4 Grey-pink


Normal light (taken at x200 magnification)

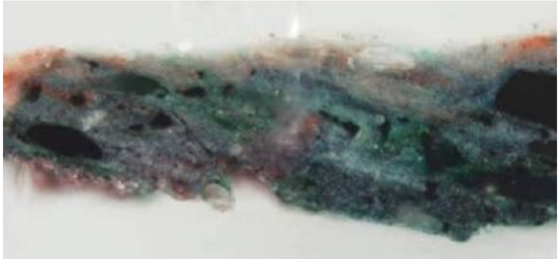

Ultraviolet (x200 magnification)

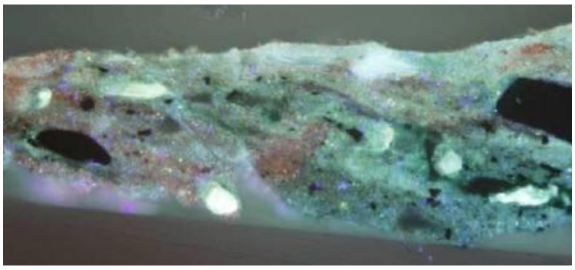
FBA7-5 Pink


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FBA7-6 Grey


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Priming	3	FTIR, GCMS	Drying oil (Az/P = 2.31, P/S = 1.57)
		FTIR	Protein-based size
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Chalk
Dark green	1	FTIR, GCMS	Drying oil (Az/P = 1.01, P/S = 2.21)
		FTIR, SEM-EDX	Phthalocyanine green PG7
		FTIR, SEM-EDX	Barium sulphate
Yellow	2	SEM-EDX	Cadmium yellow
		SEM-EDX	Barium sulphate
Pink	5	FTIR, GCMS	Drying oil (Az/P = 0.92, P/S = 2.63)
	4, 5	SEM-EDX, FTIR	Lead white
	4	SEM-EDX	Zinc white
		SEM-EDX	Cadmium red
White	4	SEM-EDX	Lead white
		SEM-EDX	Zinc white
Red-black	4	SEM-EDX	Lead white
		SEM-EDX	Cadmium red
		SEM-EDX	Carbon black?
Grey	6	FTIR	Drying Oil
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Prussian blue
		SEM-EDX	Cadmium orange/red
		SEM-EDX	Zinc white
Black scraping	7	SEM-EDX	Carbon black?
		SEM-EDX	Ivory black (only 1 particle identified)

Conclusions

Phthalocyanine green was used for the green stain on the canvas, in an oil medium. The black used on top appears to be mainly lamp black, although a particle containing calcium phosphate (indicating ivory black) was also found. Lead white is used as the main pigment in flesh paint, with cadmium red, Prussian blue and probably lamp black. An oil medium was also used for the flesh paint.

The priming is oil based, over a protein size layer. Lead white and chalk were found in the priming, with a higher proportion of lead white in the upper part of the sample.

Study of a Dog

Identification details		
Title: Study of a Dog		*Date:* c.1967?
Dimensions (hxwxd): 30.5 x 35.6 x 1.5 cm (12 x 14 in)	*Location/owner:* Private Collection	
Marks/Inscriptions:		

Support

Type: Canvas / Board / Paper / Stretcher / Strainer

Description:
Four-member softwood stretcher, mitred mortise and tenon joints, no keys. Width of members 2.8 cm.
Plainweave linen canvas, 15/16 x 22 threads/cm^2. Canvas is attached to stretcher with galvanised tacks, 7 mm diameter, 9-10 cm spacing.

Paint and ground

Priming:
On back, white commercial priming

Paint description:
Thin green-blue background with some thicker yellow-green at bottom edge. Whiter green at top edge, hairs stuck in paint in top right corner. Dark blue-black strokes make up form of animal, pale brownish paint on back. Couple of smears of pink below head. Very thin overall.

Purple smears over tacking edge along bottom edge. Many paint spatters on back of canvas, over priming layer, in green, black, pale blue, grey.

Surface coatings/gloss

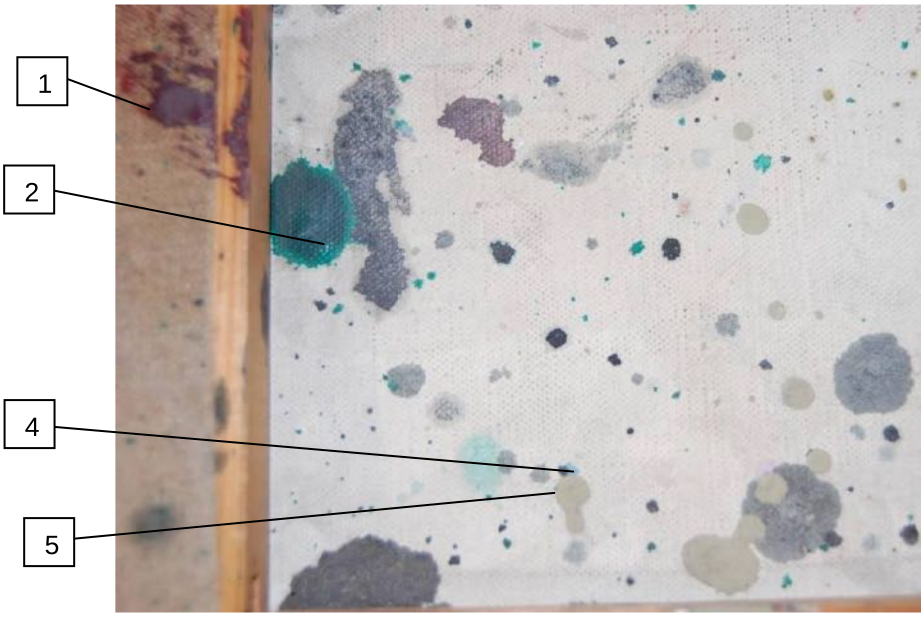
Slight gloss on back of animal and in thicker areas in background, otherwise fairly matt.

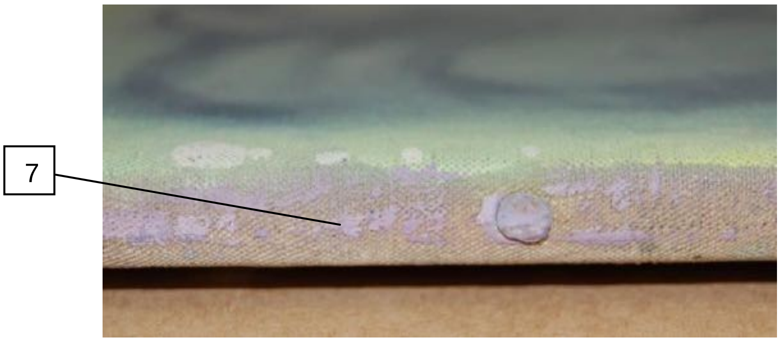
	Samples taken	
No.	*Colour*	*Location*
1	Dark red	Smear over stretcher bar on back
2	Dark green	Spot on back
3	Priming	Back
4	Pale blue	Spot on back
5	Buff/grey	Spot on back
6	Yellow-green from edge	Bottom left corner, 1.5 cm from bottom
7	Purple from tacking edge	Bottom tacking edge, 10.5 cm from left
8	Pale green	Top right corner, 2 cm from right.

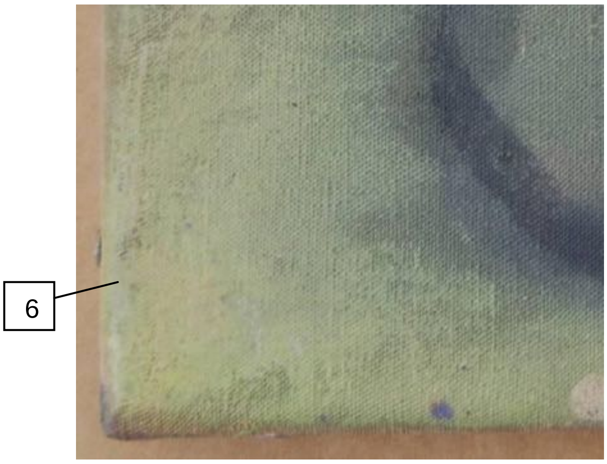
Notes

Sold at auction, part of 'Items from the Studio of Francis Bacon' at Ewbank Clarke Gammon Wellers Auctioneers, Apr 24th 2007, along with FBA7.

Sample sites

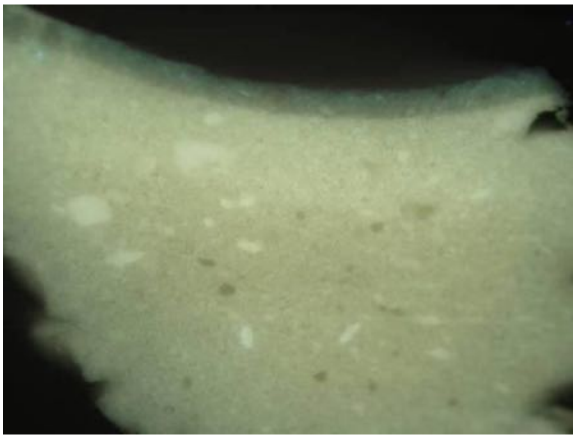




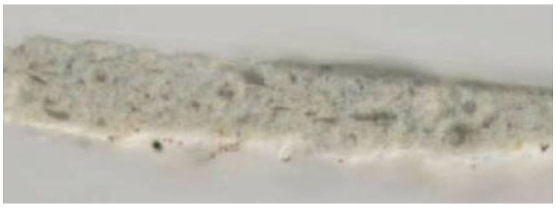


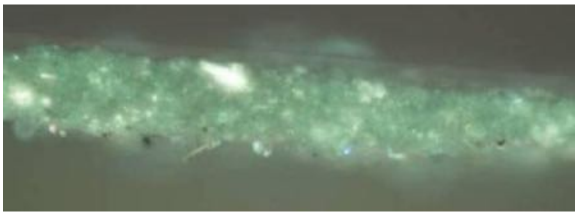
FBA8-3 Priming from reverse


Normal light (taken at x200 magnification)

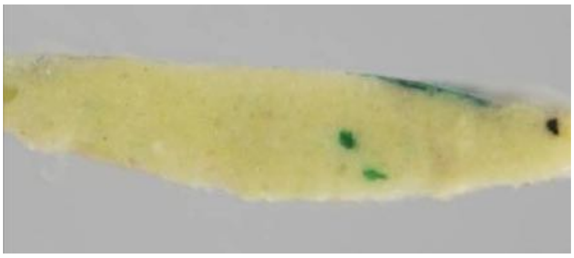

Ultraviolet (x200 magnification)

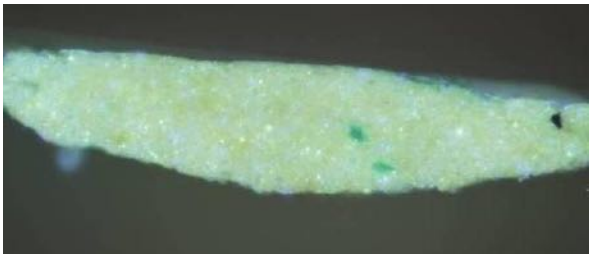
FBA8-5 Grey


Normal light (taken at x200 magnification)


Ultraviolet (x200 magnification)

FBA8-6 Yellow green


Normal light (taken at x50 magnification)


Ultraviolet (x50 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Dark red	1	FTIR, PyGCMS	Drying Oil (Az/P = 1.49, P/S = 1.56)
		FTIR, PyGCMS	Alizarin
Dark green	2	SEM-EDX	Phthalocyanine green (PG36)
		SEM-EDX	Barium sulphate
		SEM-EDX	Zinc white
Priming	3	FTIR, GCMS	Orthophthalate Alkyd (Az/P =1.34, P/S =2.11)
		FTIR, SEM-EDX	Lead white
		FTIR, SEM-EDX	Kaolin
		SEM-EDX	Titanium white
		SEM-EDX	Barium sulphate
Pale blue	4	SEM-EDX	Lead white
		SEM-EDX	Prussian blue
		SEM-EDX	Zinc
Grey	5	FTIR, PyGCMS	PVAc with MMA/2-EHA copolymer
		FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Kaolin
		FTIR, SEM-EDX	Chalk
		PyGCMS	PY1/3?
Yellow-green	6	SEM-EDX	Lead white
		SEM-EDX	Zinc white
		SEM-EDX	Viridian
		SEM-EDX	Cadmium yellow?
Purple	7	PyGCMS	MMA /2-EHA copolymer
		FTIR, SEM-EDX	Titanium white
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Cobalt blue
Pale green	8	GCMS	Drying oil (Az/P = 0.80, P/S = 3.17)
		FTIR	Lead white

Conclusions

The yellow-green paint in the background has an oil medium, with lead white, zinc white, cadmium yellow and viridian. The other samples were taken from the back or sides of the canvas, and might have been accidental splashes from other works done nearby. Alizarin crimson oil paint was found, a material commonly used by Bacon. Two samples appeared to be from household paints. The purple paint appeared to have an acrylic methyl methacrylate – 2-ethylhexyl acrylate (MMA-2EHA) binder, the same type used in Dulux paints found in the studio. The other appeared to contain both PVAc and acrylic (MMA-2EHA) polymers, which may have been a mixture of two household paints or a PVAc-acrylic copolymer.

The priming has an orthophthalate alkyd binder with lead white, kaolin and titanium white in the upper layer, and some barium sulphate also in the lower layer.

Portrait of Mick Tobin

Image omitted for copyright reasons

Identification details

Title: Portrait of Mick Tobin	*Date:* ? 1980s
Dimensions (hxwxd): 35.5 x 30.4 x 1.9 cm (14 x 12 x ¾“)	*Location/owner:* Private Collection

Marks/Inscriptions:
Three paper labels stuck to back of stretcher/canvas turnover:

Bottom stretcher bar, left, printed: 'CONTRACT 4795739 LINE 1 // Possible F Bacon portrait 35 // (Bar code: 10047957360001)'

Bottom stretcher bar, centre, black pen: ‘26230’

Top stretcher bar, left. Print and black biro: ‘<u>TO BE PHOTOGRAPHED</u> // <u>MODERN & CONTEMPORARY ART</u> // RESEARCH (circled) // TRANSPARENCY/PHOTOGRAPH(circled) / DIGITAL // RECEIPT..*4795736..* LINE ..*1..* RACK.....’
In biro on upper right of label: ‘PLEASE photograph back & front’

Support

Type: <u>Canvas</u> / Board / Paper / <u>Stretcher</u> / Strainer

Description:
4-member softwood stretcher, pale wood. Mitred mortise and tenon joints, only 4 keys present (4 are missing). The stretcher bars are bevelled on their inner edges, but the two vertical members appear to have been assembled back to front, so that the bevel is at the back, rather than resting against the canvas. Width of stretcher bars: 4.4 cm / 1 ¾ “, depth 1.3 cm / ½ “.

Plain-weave linen canvas, 13 x 14 threads/cm^2. The threads are variable in width, but many are fairly narrow (particularly those running horizontally), making this a fairly open-weave canvas, and squares of the priming can be seen through the gaps in the weave. The canvas is fairly slack and distorted, and dishes inwards at the corners. The edges of the stretcher bars are becoming visible where the canvas sags over them. The canvas may have been roughened, as fibres stand up from the surface, visible in raking light.

Attachment is through bluish steel tacks, 4mm diameter, spacing 6-8.5 cm. Only 3 tacks are used on the right edge, tacked from the centre outwards. No other tack-holes are apparent, so the canvas does not appear to have been re-stretched, and splashes of paint on the tacks indicate that these are original to the painting. The canvas is anchored to the back of the stretcher with one tack in each corner.

Paint and ground

Priming:
White, on verso. Grubby marks on upper centre area of verso

Paint description:
Fairly thinly painted with some areas of canvas left unpainted. The green used in the upper background appears to have been applied over an underlying thin dark blue layer, traces of which are visible at the edges. The same dark blue also appears to have been used to outline areas of the composition – this can be seen outlining the left ear, collar and neck/shirt. The green background appears to have been applied after the ear was painted (at least at the right side), as this overlaps slightly onto the lilac paint outlining the ear.

Swirls of grey-blue, white, red and pink are used to form the face, with some low impasto. Strokes of pink pastel or other underbound material appear to be used over the eyes, nose and mouth. Slight disturbance/loss to red paint on upper part of nose. There are some white powdery patches on the nose, which have the appearance of abrasion, but under magnification this actually appears to be white material on top of the paint – possibly an underbound paint/pastel applied sparingly.

A thin matt black layer has been applied lapping over a dark blue layer at left and right sides of the face. There is a ridge of blue-black paint at the edge of the paint-stroke to the lower left of the face, with a slightly flattened surface.

A very thin brownish stain is applied over parts of the exposed canvas, with patchy application. This appears to be used to create shaded modelling on the lower part of the cap, and to create a slight shadow below the collar.

Surface coatings/gloss

The paint is generally fairly glossy, except for the areas of black which are very matt. The gloss appears to be associated with the paint, rather than being an applied coating, and reflects UV rather than fluorescing. The green background is less glossy than the face.

Samples taken

No.	*Colour*	*Location*
1	Dark blue scraping	Left edge, layer under green. 20.5 cm from bottom
2	Green scraping	Splash on tack head on right edge. 10.5 cm from top
3	Green over blue	Background, right tacking edge. 11 cm from top
4	Pale pink over grey	Bottom edge, 10.4 cm from right
5	Matt black scraping	Black area to right of face. 10 cm from bottom, 3.5 cm from right
6	Pink scraping (pastel?)	Upper part of nose. 12 cm from right, 12.5 cm from top
7	Red-pink	Edge of loss on nose. 17 cm from right, 13.5 cm from top
8	Glossy lilac	Above ear. 4.5 cm from right, 7.5 cm from top
9	Priming	Back of canvas

Notes

It was suggested at the Authentication Committee Meeting that the brown stain to the canvas might have been applied in an attempt to make it appear more aged. However, the stain is very unevenly applied and appears to be used more as a shading layer on the cap and beneath the collar.

Technical Examination

Microscopic examination of surface
Clumps of pink powder, possibly pastel, can be seen across much of the face, caught on raised threads of the canvas weave. The paint beneath appears very glossy. Many fine hairs are stuck in the paint, which appear to be from the canvas surface. Areas of exposed canvas also have raised fibres. Some spots of glossy material are visible over the green background – possibly a fixative spray (no associated fluorescence visible in UV).

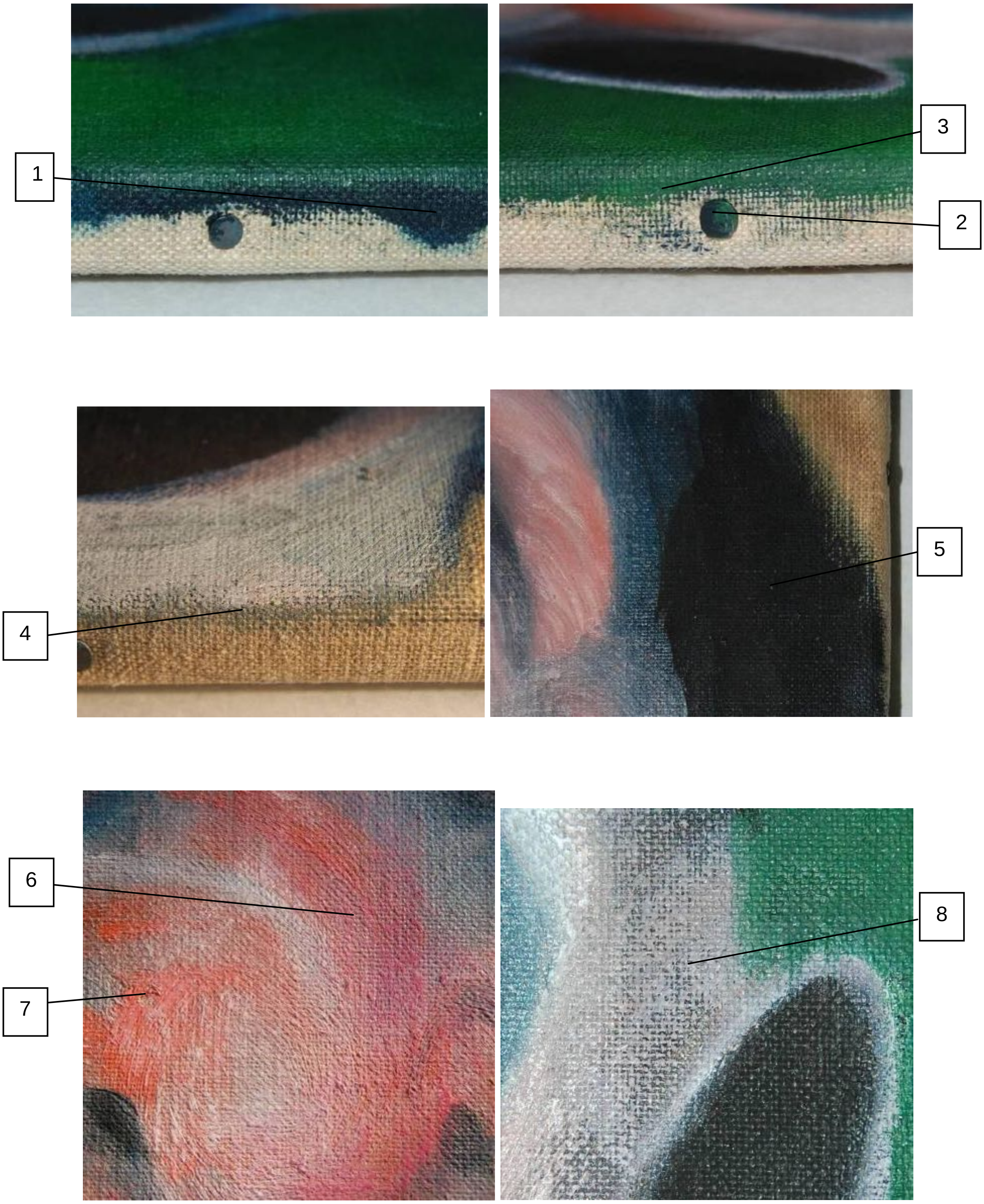
Raking light
The distortion of the canvas is clearly visible, as is the weave texture. The raised fibres from the roughened canvas also stand out.

Ultraviolet (UV)
The areas of exposed canvas appear light in UV, due to the priming showing through the canvas interstices from the back. The pink (pastel?) material used over areas of the face is relatively dark. The stroke of pink over the upper left of the nose (with loss/disturbance) appears brighter orange under UV than other pink areas.

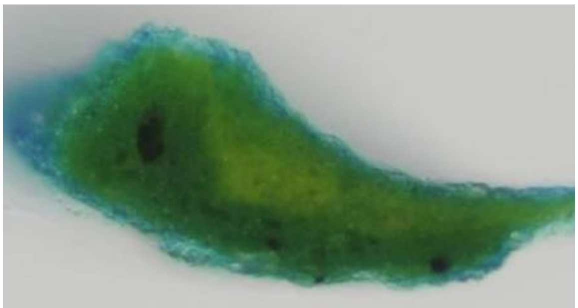
Infrared (IR)
Some brush-strokes can be seen more clearly in the IR image, but overall it does not reveal much new information.

X-ray
The x-ray has low contrast and is fairly dark, confirming the absence of lead-containing pigments or a lead white-based priming layer. Details of much of the composition are therefore difficult to see. The line marking the lower left edge of the jowl/face can be seen more clearly in the x-ray, showing a smooth boundary, which was subsequently partially covered by the matt black paint layer. This seems to show that the matt black was added at a fairly late stage, over a paint layer containing pigments which appear lighter in the x-ray. The black layer itself cannot clearly be seen in the x-ray.

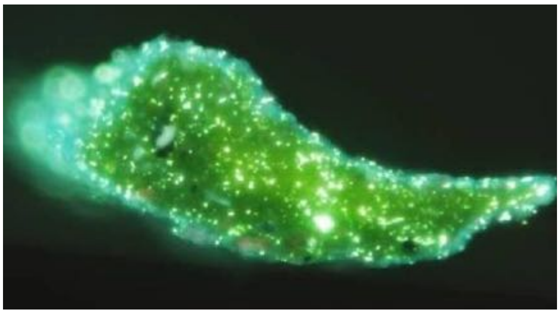
Sample sites



FBA9-3 green over blue, from right edge

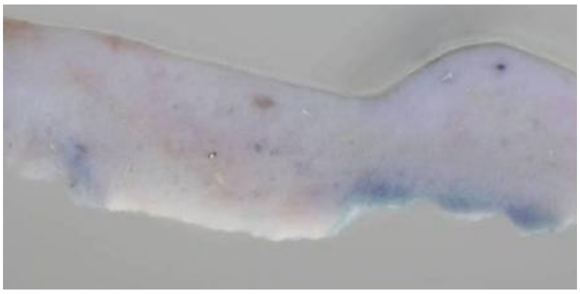


Normal light (taken at x200 magnification)

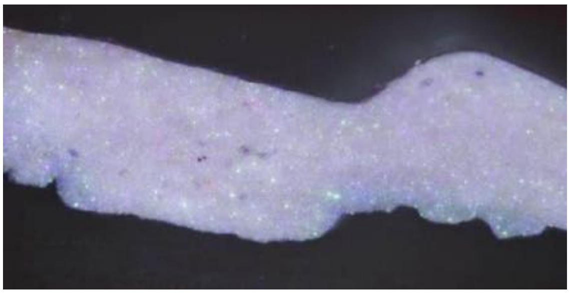


Ultraviolet (x200 magnification)

FBA9-4 Pale pink over grey



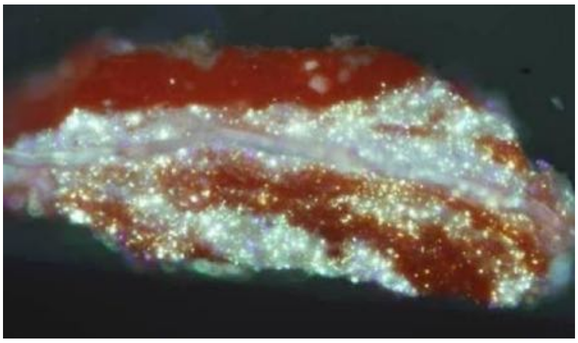
Normal light, (taken at x200 magnification)



Ultraviolet (x200 magnification)

FBA9-7 Red from edge of loss

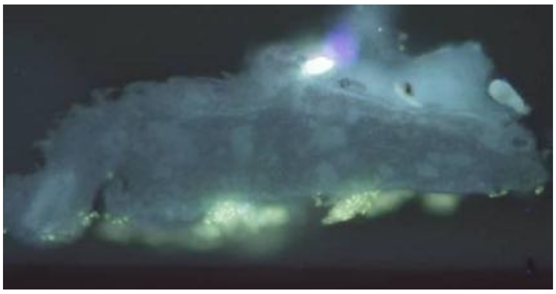
Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

FBA9-9 Priming

Normal light (taken at x200 magnification)



Ultraviolet (x200 magnification)

Summary of analysis			
Paint	*Sample*	*Analysis*	*Materials identified*
Dark blue	1	FTIR, GCMS	Oil (Az/P = 1.21, P/S = 2.12)
		FTIR, SEM-EDX	Prussian blue
Green background	2	FTIR	Oil
		FTIR, PyGCMS	PY1
	2, 3	FTIR, SEM-EDX	Prussian blue
		FTIR, SEM-EDX	Barium sulphate
White-pink	4	FTIR, GCMS	Oil (Az/P = 0.90, P/S = 1.63)
		SEM-EDX	Zinc white
		FTIR, SEM-EDX	Barium sulphate
		FTIR, SEM-EDX	Silica
Black	5	SEM-EDX	Ivory black
Pink	6	SEM-EDX	Titanium white
		SEM-EDX	Silica
		SEM-EDX	Zinc white
Red-orange	7	FTIR	Barium sulphate
		FTIR, PyGCMS	PO34
Lilac	8	SEM-EDX	Titanium white
		SEM-EDX	Zinc white
Priming	9	FTIR, PyGCMS	Styrene-Acrylic (MMA-BA)
		FTIR, SEM-EDX	Chalk
		SEM-EDX	Titanium white
		FTIR, SEM-EDX	Barium sulphate

Conclusions

The blue, green and white paints all appear to have an oil medium. The white used for the shirt had zinc white as the principal white pigment, while titanium white was found in the flesh paint.

The priming layer on the back has a styrene-acrylic copolymer binder. Titanium white and chalk were found as the principal pigment and filler, with barium sulphate at the base of the sample.