

Micro-Fourier Transform Infrared (μ -FTIR) spectroscopy of Sidney Nolan's early paintings on paper

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ABSTRACT

Sidney Nolan's early works provide rich examples of manipulation of paint media with diluents and the use of non-traditional materials. While visual examination can reveal useful information about materials and techniques, it is not always possible to identify painting mediums accurately without technical analysis. An analytical study of a collection of early paintings on paper by the artist Sidney Nolan with μ -FTIR has revealed the use of several types of oil-based media including an early use of alkyd, the first type of synthetic paint. Combined with information gained from primary research and comparison with investigations into other works by Nolan, this analysis demonstrates the value of undertaking instrumental analysis prior to assigning media descriptions, particularly in the case of works by Sidney Nolan.

Keywords Sidney Nolan, alkyd paint, μ -FTIR

INTRODUCTION

Micro-Fourier Transform Infrared Spectroscopy (μ -FTIR) can be a powerful analytical tool in the examination of Nolan's paint media. Commercial synthetic paint binders such as alkyds (oil-modified polyester resins) and nitrocellulose, which have been identified on a number of early paintings by Nolan, have distinctive FTIR spectral absorptions that are readily detected with microscopic samples taken from paint layers. This identification is assisted by the high proportion of binder used in fluid, high-gloss commercial paints. Many pigments also exhibit strong spectral patterns in FTIR particularly organic coal-tar derived colours that became increasingly popular paint colourants in the twentieth century. The identification of pigment composition can assist with the characterisation of the paints.

The acquisition by the Art Gallery of New South Wales in 2013 of a number of early paintings and works on paper by Sidney Nolan from the Nolan Estate has been the opportunity to test media used by Sidney Nolan outlined in research as an outcome of the Australian Research Council, Twentieth Century in Paint Industry Linkage Grant (2009-2012) (Dredge 2013). What has emerged from this analysis is confirmation of Nolan's bold and experimental use of materials applied using unorthodox techniques. It also demonstrates the value in undertaking analysis of the media as standard practice during acquisition of works, particularly those by Sidney Nolan, for the purposes of cataloguing and determining potential vulnerability to exhibition conditions. Although paintings on paper are commonly executed in water-based media such as watercolour and gouache, this investigation demonstrates Nolan's technique of using oil-based paint for a number of works on paper.

THE WORKS

This paper examines two groups of works selected for acquisition by the Australian Prints and Drawings department at the Art Gallery of New South Wales. The groups relate to

two distinctive production periods in Nolan's life. The first group consists of five large works on thick paper with abstract images in a limited palette of blue, black and red paints¹. These works date from 1939, the period in which Nolan was living outside Melbourne at Ocean Grove with his first wife, Elizabeth Nolan nee Patterson. Elizabeth had previously trained at the National Gallery School and was also an artist. Elizabeth Nolan was trained in the traditional technique of artists' oil paint and it is likely that the two shared materials during this period. At this time Nolan was working on a commissioned set design for the Original Ballet Russe 1940 performances in Australia, for a new ballet called *Icare*. Nolan made a large number of preparatory drawings and paintings related to the *Icare* design. These were principally abstract forms centred around tent shapes, eyes and the sun. This first group of recent acquisitions appear by subject, to relate to studies for the ballet set.

The second group of five works on paper² date from Nolan's conscription into the Australian Army from 1942 to 1944 and include a work titled *On the beach* (Figure 1).



Figure 1. Sidney Nolan *On the beach* 1942, 24.7 x 26.9 cm, alkyd and oil on ivory wove paper. Art Gallery of New South Wales. Purchased 2013. © Sidney Nolan Estate/Bridgeman Art Library

During this period Nolan was sent to Western Victoria, to the area known as the Wimmera, for various domestic Army duties. While in the Army Nolan continued to paint, initially in water-based media on paper, and from mid 1942 in oil media. Several concurrent records exist from this period to assist with the documentation of Nolan's wartime artistic production. The first are Nolan's letters to his then romantic and artistic partner Sunday Reed, in which he describes the materials he was finding locally for painting and also the materials he would like Reed to source from suppliers in Melbourne (Nolan 1942-1944). The second is, several diaries kept by Sunday Reed in 1942 and 1943 in which she records the works by Nolan and their dimensions and media as sent to her for safe keeping (Reed 1942, 1943). These records suggest that Nolan's principal interest was in commercial ready-made paints intended for use for house painting and decorating. The paint mentioned in the correspondence with Reed include the brand names Duco™ (nitrocellulose lacquer manufactured by British Australian Lead Manufacturers [B.A.L.M.]), Dulux® (alkyd manufactured by B.A.L.M.), Dynamel™ (alkyd by Taubmans) and Ripolin®, an imported oil enamel manufactured by the Ripolin company in Britain

VISUAL OBSERVATION

The works dating from 1939 were described at the time of acquisition as mixed media on paper. These five works are all almost identical in size and executed on blotting paper. Four of these works are painted on both sides of the paper and there is some evidence that the image on one side may have been partially traced from the image on the other side. These works fall into two groups. One group of three works is executed on thin blotter (approximately 0.4mm thickness). One of these works has a watermark, "BLOTTIN~" evident in the paper sheet. For these works the paint is diluted and thinly applied with only some areas of more thickly applied undiluted paint. For each work the diluted paint has bled through the paper sheet and is clearly visible as wash-like lines of colour on the reverse. Two of these works have been painted on the reverse with this colour also penetrating the paper sheet and forming a part of the image on the front. In effect this means that Nolan created these two works using at least two paint layers, one applied to the front and one applied to the back of the paper.

Oil stains commonly found on oil paintings on paper, are only evident on one of these works associated with thickly applied spots of red paint. This work also has unusual tide staining at the margins that could indicate that the paper sheet was wet out with diluent to manipulate the absorption and movement of the paint on the paper sheet. If Nolan did wet out the paper with diluent it is likely that the paint application occurred over a number of sittings with the paper allowed to dry in between as only some of the applied paint looks like it may have been applied to a wet sheet of paper.

The other two works in this group are executed on a thicker blotting paper (approximately 0.5mm thickness). These works have also been painted on both sides but the reverse image does not appear to contribute to the front image. Instead, these works have been created using a different, but also unusual, technique. After the application of paint to both sides

of the paper, one side has been painted over with a white gesso layer to cover the painted surface. The gesso has a coarse texture with air bubbles in the paint surface and clearly defined brush marks. The underlying paint layer on this side of the work can be seen faintly through the gesso but the image on the reverse is not evident. On top of the gesso a final paint layer has then been added. This layer is thinly applied with some areas of thicker paint application. There is no evidence of the bleeding effect noted on the other works which may have been prevented, or obscured, by the ground layer. The edges of these two works have been masked with black paint forming a framing device around the image. These methods of building up the image, using the front and back of the paper sheet and allowing underlying paint layers to contribute to the image were unusual and experimental techniques that are nevertheless consistent with Nolan's well-documented unorthodox approach to painting.

The second group of five works, all annotated with the date of their execution, were made in a two month period from late August to early November 1942. All these works are executed on paper sheets (approximately 0.3mm thickness) that have been removed from spiral bound sketchbooks. The absence of paint at the binding edge suggests that the works were probably painted while the paper sheets were still in the sketchbook though now the sheets are all loose and torn along the binding edge. The spiral bound sheets are all essentially the same size. The quality and appearance of the machine made paper is also the same suggesting that the sheets either all came from the same sketchbook or from sketchbooks of the same type.

Described at acquisition as variously gouache on paper, oil and gouache on paper and oil on paper, these descriptions are indicative of a visual assessment of the thickness of paint application and associated surface sheen:

- Two works with matte thinly applied paint were described as gouache on paper.
- Two paintings with areas of thin matte paint and thick gloss paint were described as oil and gouache on paper.
- One painting with thickly applied paint and a mostly gloss surface sheen was described as oil on paper.



Figure 2. Sidney Nolan *Farmer, Dimboola* 1942, 24.7 x 27.3 cm, alkyd on ivory wove paper. Art Gallery of New South Wales. Purchased 2013. © Sidney Nolan Estate/Bridgeman Art Library

This last work, *Dimboola, Farmer* (Figure 2) with its thick, flat, gloss paint surface suggestive of commercial rather than artists' paints, does not visually resemble water-based media. However, the matte thinly applied paint on the other four works is more difficult to assess and a designation of gouache seems possible, though unsubstantiated.

On these five works there is only limited oil staining on the reverse of the paper sheets. It occurs most readily where the paint layer is thinly applied but does not always occur. Across the group of works there are small spots where the paint colour has bled through to the reverse but in most cases this is associated with spots of oil staining that has made the paper translucent. There is only one work, *Untitled* (landscape)³, on which there is a large area of blue paint colour that has bled through the paper appearing as a thin wash on both the front and back of the sheet. On this work there is no oil staining associated with the blue paint.

ABSORPTION OF OIL PAINT INTO PAPER

Preliminary testing of the absorption of oil paint by paper was undertaken to see how easily the paint colour bled through the paper and to see how easily the paper might stain from the absorbed oil. New blotting paper from the conservation department, a tube of artists' oil paint and white spirit were used to do one set of tests. It was found that the diluted paint colour bled through blotter wet with white spirit to some extent but this effect was minimal for dry blotter and for undiluted paint. There was a significant oil stain halo around undiluted artists' paint applied to both dry blotter and applied to blotter that had been wet out with white spirit. Diluted artists' oil paint caused some oil staining on dry blotter but on the blotter wet out with white spirit the staining effect was less and much more diffuse. In a second set of tests undertaken on a piece of sized paper it was found that the paint colour did not bleed through the sheet at all whether the paper was dry or wet with white spirit. Oil staining occurred on dry sized paper and was present but diffuse on the sized paper wet with white spirit.

ANALYSIS

The works dating from 1939 consist of brilliant primary coloured paint, applied mostly by brush. The paint itself has dried matte, but appears to have been fluid when applied. The difficulty with analysis of the binders in matte paint is the smaller proportion of binder compared to pigments and fillers that is present. In this instance Fourier Transform Infrared Spectroscopy (FTIR) of micro-samples taken from the different colours on several works, did not give results for the binders and are dominated by absorbance peaks related to the pigments and fillers in the paint. Without undertaking other types of analytical investigation such as Gas-chromatography/Mass spectroscopy (GC/MS) it would not usually be possible to assert the medium composition of the paint in this instance.

There exists however another work in the collection of the Art Gallery of New South Wales which provided a critical clue to the paints used on the group of new acquisitions from 1939. *Untitled abstract* (c. 1939), oil on silver gelatin photograph, was gifted to the gallery in 2006 (Figure 3). Although thought

to have been a work by Sidney Nolan, this work had previously been catalogued as unattributed. Comparison with the images of the *Icare* series of works demonstrates a close connection with compositions from this group incorporating eyes, sun shapes and tent-like forms. Painted over an older silver gelatin photograph studio portrait of a Victorian-era woman in a dark dress with a book on her lap, the paint film shares the limited, but brilliant paint palette of the new acquisition works. Unlike those works however, the paint over the photograph is thickly applied and pasty in texture holding the impressions of the stiff bristled brush used to apply the paint. This is the texture and appearance of paint usually assigned to the media of artists' oil paints supplied in tubes.



Figure 3. Sidney Nolan *Untitled* (abstract) c1939, 28.0 x 34.4 cm, oil on silver gelatine photograph. Art Gallery of New South Wales. Gift of Gwen Frolich 2006. © Sidney Nolan Estate/Bridgeman Art Library

In the period of the 1930s and 1940s, paint used for domestic and commercial types of painting were supplied in cans, with liquid consistency that dried fast and level without revealing the texture of the brush. The presence of high gloss, level paint films with liquid application cannot be used to definitively describe non-artist paints, as it has been demonstrated that these types of paint film appearances can be replicated by the addition of resins and solvents to conventional artist's paints (Carlyle 2011). However, thick, pasty and highly-textured paint films are unlikely to be modified commercial paints and can be more firmly associated with standard artists' paint.

The presence of the unattributed but suspected work by Nolan with paint texture typical of artists' oil paint, offered an unusual opportunity of FTIR analytical comparison of pigments and fillers of similar colours on well attributed works recently acquired. This comparison provided potential for examining the question of authentication of an unattributed work by comparison with materials from well attributed examples. In addition, the comparison offered the potential for informing understanding of the media on the attributed works by comparison with the visual appearance of the paint on the unattributed work. The analytical comparison of the pigments between the two works is shown in Table 1.

These results demonstrate the similarity in the pigment composition of the two works. Although a small carbonyl peak at 1740cm⁻¹ is conventionally assigned to the binder,

Colour	Untitled (abstract) 172.2013 oil on blotting paper	Untitled (abstract) 132.2006 oil on silver gelatine photograph
Black	Bone black, calcium carbonate	Bone black, calcium carbonate
Red	Calcium carbonate, dinitroaniline red (PO5)	Calcium carbonate, dinitroaniline red (PO5)
Blue	Ultramarine, calcium sulphate	Ultramarine, calcium sulphate

Table 1. Comparison of μ -FTIR results of pigments and fillers in two paintings.

no additional distinctive absorption peaks were identified that could be associated with the binder. This suggests the binder, as suspected, was in small proportion to the pigments. The pigments identified are all of the type used in both commercial and artists' paints, although a rich ultramarine blue-coloured paint is more likely to be an artist's paint than commercial paint as Prussian blue was more typical in blue coloured pre-war commercial paints. Prussian blue was such a strong tinter it could be used in small proportion and mixed with white pigment providing graduated shades of blue from dark to light (Dredge 2012). The presence of the coal tar colour dinitroaniline red (pigment orange 5)⁴ was identified by the FTIR spectral pattern of multiple absorbance peaks that correlate to a library spectrum of this pigment (Figure 4). Commonly known as azo or aniline red/orange, this colour gives an intense bright red and is an ideal substitute for the more traditional bright opaque orange-red pigment vermilion.

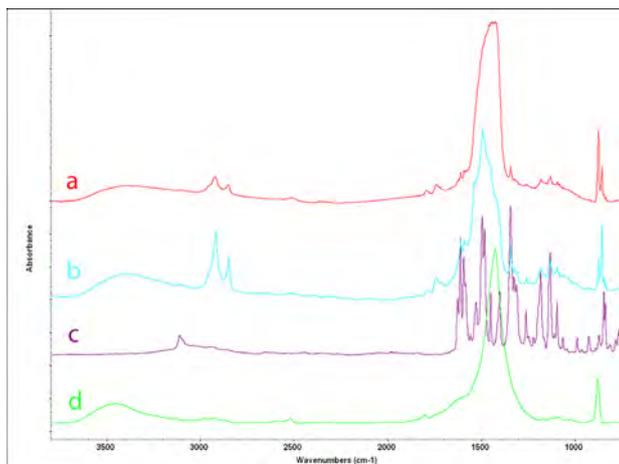


Figure 4. FTIR spectra of sample of red paint from *Landscape* 172.2013 (a), sample of red paint from *Untitled (abstract)* 132.2006 (b), against reference spectra for dinitroaniline red (PO5) (c) and calcium carbonate (d)

A sample of the white ground layer on one of the other works⁵ from the 1939 group, with a white ground layer applied over painted layers, was also examined with μ -FTIR. It gave a clear absorbance pattern matching the characteristic absorbance peaks for calcium carbonate. No clear indication of the binder was detected.

This FTIR examination of a number of paint colours is not a full pigment survey, as some pigments do not have a presence in the FTIR 4000-550 cm^{-1} spectral region. Ideally an additional analytical methodology would be used such as

X-Ray Fluorescence (XRF) to identify the metallic ions present. In this instance FTIR does however make a useful comparative technique when examined against another work. The result of this analytical comparison gives further evidence for the attribution of *Untitled (abstract)*, oil on silver gelatin photograph, to Sidney Nolan. If the same paint was used on the new acquisition works, then it appears likely that it was the same artists' oil paint but thinned with solvent to make more liquid and less textured paint effects.

Micro-FTIR analysis (Appendix) of samples from four of the five works on paper dated by the artist from October to December 1942 gave very different analytical results (Table 2) The paints were dominated by the presence of typical absorbance peaks associated with the presence of alkyd resin (oil-modified polyester resin). A typical result from an area of the sky on *Landscape*, 1942 is shown in Figure 5 compared to an alkyd spectrum obtained from a can of Dulux® from Sidney Nolan's Wahroonga studio (in use 1951-1953). The pigments identified in all the paint colours sampled were also of the type used for commercial paint types, less expensive and strong tinters. One paint colour did not give results for the presence of alkyd and that was the glossy black. The presence of alkyd binders on these works matches well with Nolan and Sunday Reeds papers that describe the use of Dulux® and Dynamel™ as his medium, prior to the purchasing of a stock of oil-based Ripolin paint in early 1943 (Nolan c. October 1942). In the 1930s to early 1950s, Dulux® was a commercial gloss alkyd paint manufactured in Australia from 1931 by the British Australian Lead Manufacturers (B.A.L.M.) under licence to DuPont (U.S.A.) who had developed the first alkyd paint binders in 1928 (Todd 1998).

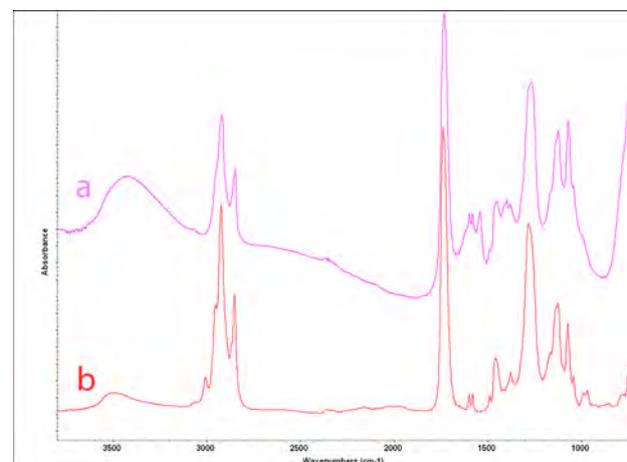


Figure 5. Colour change curves of the 1985 carbonless copy in Figure 4, with the result of a test at 10% illumination intensity over 100 minutes, demonstrating reasonable reciprocity between 5Mlx and 0.5Mlx

Colour area sampled	Landscape (29 Oct 1942) 180.2013	On the beach (28 Oct 1942) 182.2013	Nostalgia for the sky (1 Nov 1942) 183.2013	Farmer, Dimboola (2 Nov 1942) 184.2013
Black	-	Oil & resin?	Oil & resin?	-
Red	-	Alkyd, Chlorinated para-red (PR4), barium sulphate	-	Alkyd, Chlorinated para-red (PR4)
Yellow	-	Alkyd	-	Alkyd, lead chromate/ lead sulphate
Dark blue	Alkyd, Prussian blue, calcium sulphate	Alkyd, Prussian blue	-	-
Pale blue	Alkyd, titanium dioxide, zinc stearate	Alkyd, titanium dioxide, Prussian blue	Alkyd, titanium dioxide, Prussian blue	Alkyd, titanium dioxide, Prussian blue
Green	-	Alkyd, lead chromate, Prussian blue	Alkyd, lead chromate, Prussian blue	-
White	-	Alkyd, titanium dioxide	Alkyd, titanium dioxide	Alkyd, titanium dioxide

Table 2. Comparison of μ -FTIR results of four paintings

CONCLUSION

This paper has described the analytical work undertaken with μ -FTIR to identify the paint types used on several early works on paper by Sidney Nolan. One group of works dating from 1939 has been assigned the medium description of oil on paper, or oil and gesso on paper, based on the similarity of the paint pigment composition to another work with physical features typical of artists' oil paint. The other group from 1942 has been described as alkyd and oil on paper. This is an example of Nolan's use of non-artist paints, as alkyds were not developed as artists' paints until 1973 (Winsor and Newton, 2003-2011). Nolan's alkyd paintings dated 1942 are the earliest use of synthetic paint by an artist yet described. Previously the earliest identification has been on works by Willem de Kooning from 1948 (Lake 2010) and Jackson Pollock in 1949 (Schilling et. al. 2007).

μ -FTIR is a destructive analytical technique as it requires the removal of a sample of the paint from the artwork. Although the size of this sample is microscopic this may not always be justifiable for the purposes of cataloguing medium description alone. In the case of Nolan's early works, this analysis is however providing important new insights about the extent of the artist's experiments with his materials by altering the qualities of his artists' paints by solvent manipulation and the use of commercial non-artist materials. A full testing regime of every colour on every work has not been justified, and therefore inferences have been drawn regarding the use of similar paints on each group of works in order to minimise sampling. It is clear however from this small analytical study, that it is difficult to catalogue Nolan's paint media with any certainty based only upon observation of the physical appearance of the dry media.

Equally, however, the nature of the absorption of paint colour and of oil medium into the paper for both sets of works and the preliminary test undertaken to examine these characteristics, raises some questions about the finality of the medium descriptions so far ascertained. Further analysis and comparison with other works may help to answer such questions and contribute further to our understanding of the work of Sidney Nolan.

ENDNOTES

1. AGNSW accession numbers 170.2013 – 174.2013
2. AGNSW accession number 180.2013 – 184.2013
3. AGNSW accession number 180.2013
4. Due to the large number of different coal-tar colours and the tendency for different manufacturers to give different proprietary names to the same compound, the Colour Index name and number system is used in association with each pigment type. A useful guide to Colour Index names and numbers is given at: http://www.artiscreation.com/Color_index_names.html [Accessed 10 February 2014]
5. AGNSW accession number 170.2013

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APPENDIX

Fourier Transform Infrared Spectroscopy (FTIR) was performed using a Thermo Nicolet Nexus Spectrometer. Samples were studied using the Continuum IR Microscope attachment and MCT-A Detector with KBr window (11,700-400cm⁻¹). A micro compression cell with diamond window was used as a sample platform. Samples were taken by scraping the surface of the material with a sharp clean scalpel blade and pressing this material directly onto the clean diamond surface. The sample was then rolled with an FTIR roller to give thin and even sample distribution. Samples are between 100 and 200 microns (0.1-0.2mm) in diameter and approximately 1 micron (0.001 mm) thick using this technique. Spectra were gathered in the range from 4000-550cm⁻¹ and are the sum of a 100 scans with a resolution of 4cm⁻¹.

AUTHOR BIOGRAPHIES

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