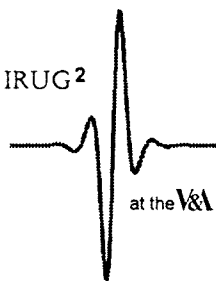


Contents	Page
1. Introduction	1
2. Programme	2
2.1 Tuesday 12 September 1995	2
2.2 Wednesday 13 September 1995	3
3. Abstracts and biographies	4
3.1 The use of a diamond cell for the FTIR characterisation of paints and varnishes available to twentieth century artists	4
3.2 Assessing plastic collections in museums by FTIR spectroscopy	5
3.3 Identification of Calcium carbonate contained as Body in Modern Paints by FTIR Spectroscopy	6
3.4 Infrared spectroscopy - An analytical tool for conservators	7
3.5 Identifying archaeological jet and jet-like artifacts using FTIR	8
3.6 FTIR microscopic studies on organic materials used for cultural properties	9
3.7 IR reflectance spectra of weathered medieval stained glass	10
3.8 The use of a beam-condenser for micro analysis	12
3.9 Improving the resolution of IR spectra.	13
3.10 Infrared microspectroscopy mapping techniques for the analysis of paint cross sections	14
3.11 The characterisation of iron earth pigments using infrared spectroscopy.	15
3.12 Analysis of mineral salts from monuments by infrared spectroscopy	16
3.13 FTIR techniques at the Building Research Establishment (BRE)	17
3.14 An Infrared Spectral Library of Naturally Occurring Minerals	18
3.15 The identification of nitrates on carbonate substrates using diffuse reflectance infrared Fourier Transform DRIFTS in CaF ₂ Matrix.	19
4. Delegates (alphabetical order)	21
5. Presentations (alphabetical by speaker)	25



1. Introduction

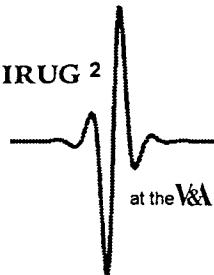
This document contains the timetable and abstracts of the talks presented at the meeting of the Infrared Users Group (IRUG) hosted by the Conservation Department (Science Group) of the Victoria and Albert Museum (V&A) in London. It also includes a list of delegates.

I have compiled the abstracts in the same sequence as the presentations. Apart from minor editing changes, the abstracts are reproduced as submitted.

I hope you have an enjoyable and useful meeting.

Designed, edited and compiled by...

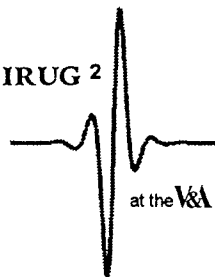
Boris Pretzel
Materials Scientist
© Victoria & Albert Museum
Science Group
South Kensington
GB - London
SW7 2RL
☎ +44 (0)171 /938 8597
Fax: +44 (0)171 /938 8661



2. Programme

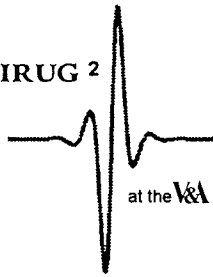
2.1 Tuesday 12 September 1995

Time				
10:00	10:30	Registration and coffee		
10:30	10:40	Welcome	Graham Martin	
10:40	10:45	Introduction	Boris Pretzel	
10:45	12:30	*** Session One ***		
10:45	11:15	The use of a Diamond Cell for the FTIR Characterization of Paints and Varnishes Available to 20thC Artists	Tom Learner	Tate Gallery
11:15	11:45	Assessing Plastics Collections in Museums by FTIR Spectroscopy	Brenda Keneghan	V&A
11:45	12:05	Identification of Calcium Carbonate contained as Body in Modern Paints...	Yasunori MATSUDA Masahiko TSUKADA	Tokyo University of Art & Design
12:05	12:30	Infrared spectroscopy - An analytical tool for conservators	Edward Then	National Museum of Science & Industry
12:30	14:30	Lunch		
14:30	17:30	*** Session Two ***		
14:30	15:00	Identifying Archaeological Jet & Jet-Like Artefacts using FTIR	Siobhan Watts	FakArk, Norway
15:00	15:25	FTIR Microscopic studies on Organic Material used for Cultural Properties	Masanori SATO Masaaki SAWADA	Nara National Cultural Properties Research Center, Japan
15:25	15:45	Tea		
15:45	16:15	IR Reflectance Spectra of Weathered Medieval Stained Glass	Manfred Schreiner	Academy of Fine Arts, Austria
16:15	17:30	Exhibition: The Genius of Wedgwood		



2.2 Wednesday 13 September 1995

Time				
09:30	10:00	Coffee		
10:00	12:00	*** Session Three ***		
10:00	10:25	The use of a Beam-condenser for Micro Analysis	David Thickett	British Museum
10:25	11:05	Improving the Resolution of IR Spectra	Jenny Pilc	National Gallery
11:05	11:35	Infrared Microspectroscopy Mapping Techniques for the Analysis of Paint Cross-sections	Tanya Kieslich Michele Derrick	GCI, USA
11:35	12:00	Discussion and future of spectral library		
12:00	14:00	Lunch		
14:00	17:30	*** Session Four ***		
14:00	14:25	The characterization of iron earth pigments using infrared spectroscopy	Kate Helwig	CCI, Canada
14:25	14:50	Analysis of Mineral Salts from Monuments by IR Spectroscopy	Mads Chr. Christensen	Det Kongelige Danske Kunstakademi, Denmark
14:50	15:20	FTIR Techniques at the Building Research Establishment	Matthew Murray	BRE
15:20	15:50	Tea		
15:50	16:15	An Infrared Spectral Library of Naturally Occurring Minerals	Beth Price Janice Carlson	Philadelphia Museum of Art Winterthur Museum
16:15	17:30	Discussion and close		



3. Abstracts and biographies

The abstracts and short biographies are reproduced as received with minor editing changes only. They are in the order of presentation.

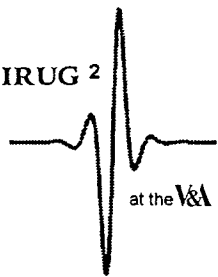
3.1 The use of a diamond cell for the ftir characterisation of paints and varnishes available to twentieth century artists

Tom Learner
Tate Gallery

FTIR has been widely used in binding medium analysis at several art galleries and museums around the world. Most of this work has concerned the natural materials used as traditional binding media and picture varnishes, such as the drying oils, natural resins, proteins, gums and waxes. To complement the choice of materials available to the artist in the twentieth century, a vast range of synthetic resins has been developed, including the acrylics, poly vinyl acetates (PVAs), alkyds, cellulose nitrate, polyurethanes and epoxies. Although only some of these have been used in artists' paints and varnishes, many others are present in the commercial decorative and industrial paints and coatings which have been used by certain artists this century. A means of identifying as many of these synthetic products as possible would be of immense benefit to the conservators who oversee their preservation. This paper will consider the use of FTIR in the characterisation of modern binding media and varnishes. The use of a diamond anvil cell and a beam condenser will be discussed as a cheaper alternative to a microscope for achieving good transmission spectra on small paint samples.

AUTHOR

Tom Learner is a Conservation Scientist at the Tate Gallery, London, and registered for a PhD in Chemistry at Birkbeck College, University of London. Primary research interests are the characterisation of modern paint media and an assessment of their ageing properties. Address: Conservation Dept, Tate Gallery, Millbank, London SW1P 4RG, UK



3.2 FTIR spectroscopy as a tool when assessing plastic collections in museums.

Brenda Keneghan
V&A

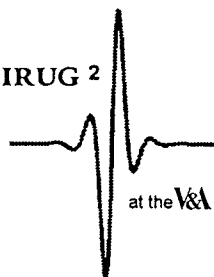
Many people are surprised to learn that there are plastic objects amongst museum collections, as most peoples experience of plastic is limited to cheap, disposable everyday objects. The Victoria & Albert Museum, as the national museum of art and design, contains within its collections very many objects made entirely from plastic, or with plastic components. These objects date from the earliest usage of these materials, for example compressed horn, to the latest carrier bag from Tesco's. Plastics are dispersed throughout the collections. A common misconception is that plastic lasts forever. Environmentalists complain about the non-degradability of these new materials. People can, therefore, be forgiven for assuming that plastic objects in museums are completely stable and no cause for concern. This, unfortunately, is not the case. Plastics do degrade and several costly examples have made most museums and galleries take notice. It was this concern that prompted the V&A to undertake a survey of their plastic objects. The term "plastic" is commonly used to describe an ever-growing range of organic materials. Due to its lack of specificity the term has no meaning to a materials scientist or plastics conservator. As different plastics will degrade in manners characteristic of their chemical composition it is essential that this composition is known. The identification of the plastics involved forms an integral part of our survey. The major technique which we use is Fourier Transform Infrared Spectroscopy. Of particular interest is the sampling technique known as "diffuse reflectance", which requires ~2 mg sample which is acceptable by museum standards. This presentation will illustrate how FTIR has been used in the V&A to:

i) identify particular materials within collections. ii) assist conservators in other areas make informed decisions on particular treatments.

iii) assist conservation students and members of the public with "problem" objects.

Author

Brenda Keneghan received a Masters Degree in organic chemistry from the National University of Ireland in 1986. She then joined the Polymer Physics group at Queen Mary & Westfield College (University of London), where she was part of a research team. She carried out her research work towards a PhD in the Materials Department at Queen Mary & Westfield in the area of polyurethane synthesis and degradation. She is currently completing the writing up of her thesis and hopes to submit before the end of the year. She has been working as Plastics Conservator at the Victoria & Albert Museum since November 1993.



3.3 Identification of Calcium carbonate contained as Body in Modern Paints by FTIR Spectroscopy

Yasunori MATSUDA and Masahiko TSUKADA
Tohoku University of Art & Design

Since the industrial production of the paints for the coatings of architecture and the colours for fine arts had begun, some kinds of colourless or white pigments have been contained in the paint materials as a body pigment. Usually X-ray diffraction or X-ray fluorescence analysis is adopted to the identification of these pigments. However, we found that we can identify them, especially calcium carbonate, by FTIR spectroscopy rapidly, simply and accurately. This method depends on the fact that the calcium carbonate shows strong absorption peaks in IR spectrum at 1430, 875 and 712 cm^{-1} (attributable to the vibration of C=O in the carbonate ion), which characterize the pigment.

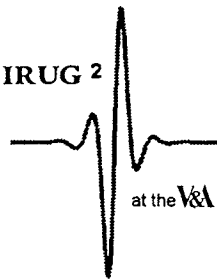
We have examined the samples of the paint layers taken from two different types of artifacts. One is a Chinese architecture in Yokohama, which is called "JIZO-O-BYO" (the tomb of Jizo Emperor). From the documents we found that it was restored and retouched several times. The other is the modern picture painted with oil, acrylic and gouache colours. The measurement of IR spectra was carried out using Perkin Elmer 1600 Series FTIR spectrometer and samples were prepared with the KBr pellet method.

In the former case, the vehicle of most coloured layers was considered to be some kind of alkyd resin. Therefore, in both cases, the binding mediums interfered the clear attribution of the peak at 1430 cm^{-1} of calcium carbonate because they have absorption around 1450 cm^{-1} (attributable to the variation of C-H of methylene or methane group). However, the sharp absorption peaks at 875 and 712 cm^{-1} were detected clearly, which suggests that calcium carbonate is contained as a body pigment. In the paints of former case it would have been used for the purpose of fixing organic dyes on, as we could extract them with acetone.

Authors

Yasunori MATSUDA, born in 1955, is an Associate Professor in the Department of conservation at Tohoku University of Art and Design, established in 1992, Yamagata, Japan. After he obtained his MA degree from TOKYO National University of Fine Arts and Music in 1981, he joined the Pearl Research Laboratory of K. MIKIMOTO Co., Ltd. where he mainly studied on analytical chemistry of natural materials, especially pearls and dye stuffs. He is currently interested in the identification and/or characterization of fresh and deteriorated materials of art objects using FTIR and 3-D fluorescence spectroscopy.

Masahiko TSUKADA, born in 1966, is a Research Assistant in the Department of conservation at the Tohoku University of Art & Design. He obtained a BSc in chemistry from the Jochi University in 1990. In the following two years he studied the restoration of paintings and the analysis of materials applied for the paintings in Florence, obtaining a Diploma from the Università Internazionale dell'Arte. In 1993 he obtained a MA in conservation science from the Tokyo National University of Fine Arts and Music. He is interested in the identification and characterization of organic materials.



3.4 Infrared spectroscopy - An analytical tool for conservators

Edward Then
National Museum of Science and Industry

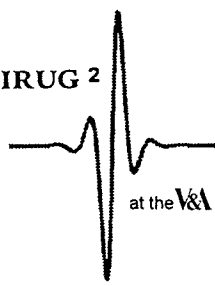
Infrared spectroscopy is no doubt one of the most useful analytical tools available to conservators today. The popularity of the technique is reflected by the presence of the infrared users group (IRUG). One reason why it is becoming popular is because of its (nearly) nondestructive sampling techniques. With the advent of Fourier transform infrared (FTIR) spectrometers and improved sampling techniques, the scan speed and quality of the spectra have been improved tremendously. It is also one of the cheaper and more versatile techniques available for analysis.

Infrared spectroscopy is used by researchers working on conservation projects funded by the museum at Bristol University and London University. Among the materials identified with varying degrees of success using infrared techniques are organic components such as plastics and inorganic fillers.

This paper highlights some of the ways infrared spectroscopy can be used to help in the conservation of artefacts.

Author

Edward Then graduated from the University of London in 1985 with a BSc (Eng) degree in Materials Science and Engineering. He was awarded his DPhil degree at Sussex University (School of Molecular Sciences) in 1989, where he also worked as a research fellow for two years. In 1992 he joined the conservation department at the Victoria and Albert Museum, London, as a Plastics Conservator. He joined the newly formed conservation section at the Science Museum in 1993 as the Senior Conservator for New Materials. Dr Then is also corporate member of the Institute of Materials (MIM).



3.5 Identifying archaeological jet and jet-like artifacts using FTIR

S. Watts* and A. M. Pollard

Department of Archaeological Sciences, University of Bradford

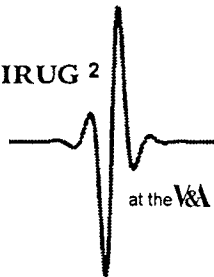
Recent work has illustrated the problems with identifying the various materials that were used to make black lithic ornaments in the past. The different materials that were worked include jet, cannel coal, oil shale, lignite and solidified bitumens - all of these originate from sedimentary deposits rich in organic material. Fourier Transform Infrared Spectroscopy (FTIR) has shown potential as a technique for identifying the materials; the analysis of geological samples from different material types produces distinctive spectra which can be related to their geological depositional environment, based on their chemical composition.

This paper will discuss the problems encountered when the method is applied to archaeological material; the artifacts are often small and intricately carved, so that they are difficult to sample. Where artifacts have been conserved, the resins used for conservation produce an infrared spectrum which can mask the spectrum from the original material. This problem is lessened when the resin is identified and spectral subtraction methods are used to remove its IR spectrum from that of the jet or jet-like material. Oxidation of jet and coals in the archaeological burial environment can also alter their characteristic infrared spectra, and affect the success of FTIR as a discriminating technique. The results of FTIR analyses from two archaeological assemblages - from York and Verulamium - will be discussed to illustrate these points.

*current address: FakArk, Vitenskapsmuseet, Universitetet i Trondheim, Trondheim, N-7004, Norway.

Presenting author

Siobhan Watts obtained her BSc(Hons) in Classics, New Hall, from Cambridge in 1989. She received an MA in the Conservation of Historic Objects (Archaeology) from Durham in 1992 (including a one year placement at the Ancient Monuments Laboratory, English Heritage). She then became a research student at Bradford University, Department of Archaeological Sciences since 1993, researching analytical methods for identifying archaeological jet and jet-like materials. Siobhan is currently working as a Conservator for the University Museum in Trondheim



3.6 FTIR microscopic studies on organic materials used for cultural properties

Masanori SATO & Masaaki SAWADA

Nara National Cultural Properties Research Institute

The identification of several kinds of ancient organic materials is one of the important subjects in the field of conservation study as well as archaeology. Specimens usually decompose under several conditions of preservation. Also, the quantity of samples that can be examined is minimal. As a result of recent improvements in instruments, FTIR microscopy has become a promising method of analysis having a sufficient sensitivity for the investigation of organic materials in the above-mentioned situations.

This paper describes several aspects of investigations of textile materials (wool, silk, hemp, ramie), leather, natural dyestuff and Japanese lacquer ("Urushi").

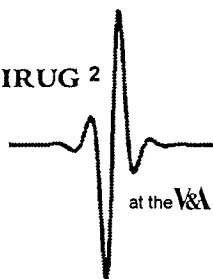
Under good conditions of preservation, silk fibres used for clothes (6th C) showed distinct spectrum corresponding to amide I and II. On the contrary, fibres attached to the surface of iron or copper articles completely lost organic characteristics and were estimated to be substituted with metallic oxide, though they still showed fibre-like appearance. A very small sample collected from a part of iron armour (6th C), showing a completely rusted appearance, had a spectrum corresponding to an animal component (amide I and II).

A large amount of textiles found at the 12th C site were covered with black material. FTIR investigation confirmed that the fibre material was of ramie and the black material at the surface of the fibre was of Japanese lacquer.

The fibre quality of wool carpet ("Kasen") having been stored in Shoso-in (8th C) was compared with that of modern animal hairs of several species. Though the results using an electron scanning microscope showed that the quality of ancient fibre was very good and comparable to that of modern production, FTIR investigation revealed distinct difference between spectra of ancient wool and modern ones.

Presenting author

Masanori SATO graduated from Kyoto University Faculty of Science in 1954. He was awarded his Doctor of Science (Kyoto University) in 1959. In 1978, he became Professor of Kyoto Institute of Technology, Faculty of Textile Science. He is currently a guest researcher at the Conservation Science Laboratory, Nara National Cultural Property Research Institute.



3.7 IR reflectance spectra of weathered medieval stained glass

Manfred Schreiner

Institute of Chemistry, Academy of Fine Arts, Vienna

In medieval glass paintings stained window panes of potash-lime-silica glasses with low silica contents and high amounts of K_2O and CaO were used. During the natural weathering of that type of glass water and/or aqueous solutions of air pollutants are present on the glass surfaces due to condensation or precipitation. An ion exchange mechanism takes place, where the alkaline and earth alkaline glass components are leached and hydrogen bearing species are incorporated into the silicate structure according the chemical reaction

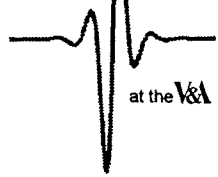


As a consequence, a surface layer is formed: The structural changes in this layer can be analysed by using Infrared Reflectance Spectroscopy (IRRS) in the range $1300 - 700 \text{ cm}^{-1}$. The shift and the variations in intensity of the silicon-nonbridging oxygen vibrations and the silicon-bridging oxygen stretching bands at approximately 950 cm^{-1} and 1050 cm^{-1} , respectively, can be detected.

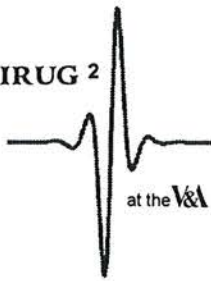
Leaching experiments in various acidic solutions were carried out on several sample glasses with a chemical composition similar to medieval stained glass. The freshly polished and corroded glass specimens were measured in a single-beam FTIR spectrometer of Bruker, type IFS 113v. The measurements were performed at a grazing angle of 20° using a Perkin Elmer IRRS unit. The spectra were obtained using an aluminum mirror as a reference material and calculating the absorbance by Greenler's algorithm.

The IR measurements carried out on untreated glass specimens and samples treated in 10^{-4} and $10^{-2}N$ HNO_3 , HCl , H_2SO_4 and oxalic acid reveal an increase of the peak intensity at 1050 cm^{-1} and a shift of the peak maximum to a higher wavenumbers during the leaching process. On the other hand the silicon-nonbridging oxygen vibrations at approximately 950 cm^{-1} decrease in intensity and wavenumber. These results indicate the formation of a vitreous silicon and a greater amount of Si-bridging oxygens on the glass surfaces than in the bulk due to the condensation reaction.



**Author**

Manfred R. Schreiner studied chemistry at the University of Technology in Vienna. In 1975 he obtained an engineering degree in chemistry. He was awarded a PhD in material science (hard metals, cemented carbides) in 1980 and went on to do a post doc at the University of California San Diego, researching on hydrogen storage in metals and intermetallic compounds. In 1981 he became assistant professor at the Institute of Chemistry at the Academy of Fine Arts in Vienna. In 1985 he went to the Fraunhofer Institute of Silicate Chemistry in Wuerzburg/FRG, researching in to deterioration of glass and other silicate materials. He was awarded a 2nd PhD (Habilitation) in analytical chemistry in art (application of surface analytical techniques for studying the deterioration process of medieval stained glass) in 1989 and is now Professor at the Institute of Chemistry at the Academy of Fine Arts. He is a member of IIC and ICOM



3.8 The use of a beam-condenser for micro analysis

David Thickett
British Museum

Infra-red spectroscopy is a powerful method of analysis and has found widespread use in the field of conservation research. By concentrating the energy of the infra-red beam through a small area, a beam-condenser allows very small samples to be analyzed using infra-red spectroscopy without the expense of an infra-red microscope. When dealing with antiquities and objects of art, it is obviously desirable to remove as small a sample as possible. Also certain degradation processes produce only microscopic amounts of material, for example, efflorescences of soluble salts.

A diamond compression cell provides a convenient way to prepare micro samples for a beam-condenser. Also this is non-destructive to the sample and it can be used for further analysis. The diamond windows of the cell are inert and undergo no reaction with the sample. This can be advantageous with certain hydrated materials such as iron corrosion products which may become dehydrated when pressed into a potassium bromide disc, a common sample preparation method.

Various examples of successful and unsuccessful applications are presented.

Author

David Thickett received an honours degree in Natural Sciences from Cambridge University in 1988. He spent two years researching refractories and special ceramics before joining the British Museum Department of Conservation in 1990 where he is a member of the Conservation Research Group. His research interests include the conservation of stone and deterioration of artefacts due to outgassing of storage and display materials.

research
industry

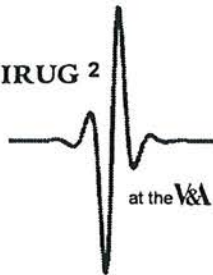
Diamond cell
10 µg

10-10:25

Baltic Amber - scale to 1100
What do you get in this region? 200.

Degradation - oxidation - ~1700 cm⁻¹ appears

Diamond - no possibility of hydrate site a/an exchange
Glass weeping - ion migration
NO₃, K Sulfates



11:05

3.9 Improving the resolution of IR spectra.

Jenny Pilc
National Gallery, London

The problems we have in interpreting binding media from IR spectra are increased by natural products being rarely pure and having similar functional groups. Furthermore, with ageing, they are susceptible to oxidation, polymerisation and reaction with the pigment. Certain types of paint artists used continually give us headaches: mixtures of oils and protein, the possibility of a touch of resin added and lake pigments frequently produce spectra with high baselines and overlapping features. Often, collecting data at a higher resolution cannot yield more accurate information.

Derivatives are used to enhance a spectrum; the second order is the most common but analysis of multiple derivatives can further enhance the spectrum. We now use Nicolet OMNIC software which uses Fourier Self-Deconvolution. The FSD trace is able to resolve the overlapping bands and improve resolution.

Author

Jenny Pilc graduated from Brunel University with a BSc in Applied Chemistry and was subsequently awarded a PhD in *Surfactants & Ethane Oil Recovery* in 1988. She started work as a Conservation Scientist specialising in organic analysis at the Nation Gallery in London in 1987.

Second derivatives - neg bands

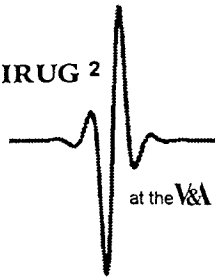
Deconvolution - second derivative \approx 4+5th derivative

1530 - oil rxn w/ carbonate

1620 + 1657 - rxn prod.

H₂O becomes enhanced

onset - N. anhydride test



3.9 Infrared microspectroscopy mapping techniques for the analysis of paint cross sections

Michele Derrick and Tanya Kieslich[†]
Getty Conservation Institute

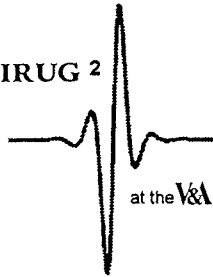
Infrared microspectroscopy is useful for characterizing binding media in very small paint cross section samples using both transmission and reflection modes of analysis. In a direct comparison of the two methods, reflection techniques produce poorer quality spectra than the transmission methods. However, many of the problems of reflection spectra can be mitigated by looking at the variation that occur between spectra taken under similar conditions. An excellent venue for such a study is the use of infrared mapping. Mapping studies compare the intensities of absorption bands versus their location in the sample to generate an image of compositional differences in a region.

The method used for a multilayer paint cross section embedded in plastic, is to microtome or polish the sample to produce a level surface for analysis, then it is placed in the infrared microscope for analysis. An analysis grid is selected with an automated X-Y stage then spectra are collected by reflection of an apertured beam of infrared radiation off the sample surface. From the array of spectra, contour maps may be produced by selecting a wavelength of interest, such as a hydrocarbon stretching band, and plotting its intensity versus its collection position in the grid. Because previous extensive analysis is done on the samples, the selected infrared absorption band and corresponding functional group can be related to components in the sample. Several examples will be shown to discuss the advantages and limitations of the technique.

[†] current address: Courtauld Institute of Art

Presenting Author

Tanya Kieslich worked on the infrared microspectrometer at the Getty Conservation Institute with Michele Derrick while studying Chemistry at Loyola Marymount. She is currently training at the Courtauld Institute of Art in London for a post graduate diploma in the conservation of easel paintings.



3.10 The characterisation of iron earth pigments using infrared spectroscopy.

Kate Helwig
Canadian Conservation Institute

Iron earth pigments, coloured by the oxides, oxyhydroxides and hydrated oxides of iron, have a long history of use by many different societies from the palaeolithic to the post-modern.

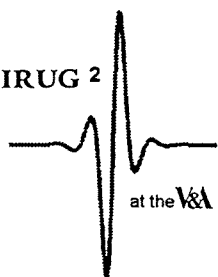
The geological sources of the iron earths are varied and their chemistry is complex. Depending on the environment which led to their formation, many types of accessory minerals (such as clays, carbonates, sulphates and aluminium hydroxides) may be associated with the iron oxide compounds. As well, the genetic environment will affect properties of the iron oxide minerals such as hydration, structural order and crystal size. The chemistry of these pigments may be complicated further by processing such as heat treatment or the addition of pigments and fillers to achieve a desired colour.

Infrared spectroscopy is a powerful technique for the characterization of these complex materials. When only small quantities of accessory minerals are present, the infrared spectrum provides information about the properties of the iron oxide compounds themselves. Often, however, the infrared spectrum is dominated by absorptions due to accessory minerals. This may be used to advantage by allowing pigments to be grouped depending on the presence of certain materials, and in some cases may indicate a specific type of geological formation as the source of the earth. Heat or chemical treatments may be used to aid in spectral interpretation by resolving overlaps between the iron oxides and the accessory minerals.

Examples of the characterization of iron earth pigments by infrared spectroscopy will be presented, using standards of known origin as well as samples from cultural artifacts.

Author

Kate Helwig received her BSc in chemistry from the University of Toronto, MSc in physical chemistry from Stanford University and Master's degree in art conservation (MAC) from Queen's University. Since 1993 she has been working as a conservation scientist in the Analytical Research Services laboratory of the Canadian Conservation Institute, where she carries out analyses of art historical and archeological materials. Current research interests include the development of analytical techniques for the characterization of the iron earth pigments.



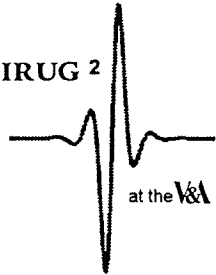
3.12 Analysis of mineral salts from monuments by infrared spectroscopy

Mads Chr. Christensen
Det Kongelige Danske Kunstakademi

Identification of salt efflorescence from monuments such as wall paintings masonry and stone sculpture is important in determining courses of deterioration and in finding the proper preventive and conserving methods. Normally identification has been done by a combination of optical microscopy and microchemical tests or X-ray diffraction. Infrared spectroscopy can be a convenient supplement or an alternative to these often time consuming techniques which require considerable skill and experience. Most salt efflorescence (except alkali metal halides) can easily and quickly be identified by Infrared spectroscopy and mixtures or X-ray amorphous salts are also recognised by the often simple spectra of these inorganic products. Illustrated with case histories, the presentation will discuss strategies for salt analysis by combining FT-IR spectroscopy with microchemical tests and optical microscopy. Different sample preparation techniques such as nujol mull, potassium bromide pellets and disposable IR cards from 3M will be reviewed. Also diffuse reflectance techniques for salt analysis will be discussed. Finally a collection of spectra from salts that are common in monuments will be presented.

Author

Mads Chr. Christensen gained his degree in chemistry and biology from Odense University in 1980. Since 1981 he has been a lecturer at the School of Conservation in Copenhagen. Main interests: Analysis of Painting materials, especially from wall paintings. Authors address: The Royal Danish Academy of fine Arts, School of conservation, Esplanaden 34, DK 1260 Copenhagen, Denmark.



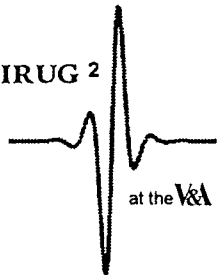
3.12 FTIR techniques at the Building Research Establishment (BRE)

Matthew Murray
BRE

The BRE uses diffuse reflectance and IR microscopy to analyse the surfaces of building materials such as limestone, sandstone, mortars and masonry treatments. Of particular interest is the effect of sulphur dioxide from atmospheric pollution on stone masonry, and the resultant sulphate products. At the BRE we have recorded the location of sulphates and carbonates at 100 micron intervals into the surface of weathered stone masonry using IR microscopy in reflection. Individual mineral crystals can also be identified as either sulphate carbonate or silica under the microscope. Techniques using diffuse reflectance FTIR have also been developed to observe the depth of penetration of stone treatments such as stone consolidants and microcrystalline waxes into masonry surfaces. The BRE will explain the various techniques that it has adapted or developed to analyse masonry surfaces, using results to show their effectiveness.

Author

Matthew J. Murray obtained his BSc in Chemistry from Kings College, University of London. He went on to obtain an MSc (Biosensors) from the University of Newcastle in 1989. He joined the Weathering Science Section, BRE in 1992 and has been involved in the development and use of an ion chromatography for analysing products from the reaction of atmospheric pollution and building materials. He is now responsible for the running of this system which provides a valuable service to the Section. He has also worked on the application of other analytical techniques to determine the composition of the surface of weathered stone and on the protection of natural stone, in particular, the use of FTIR which is being used additionally for research on graffiti removal and consolidants.



3.13 An Infrared Spectral Library of Naturally Occurring Minerals

Beth Price[†], Janice Carlson[‡] and Richard Newman^{*}

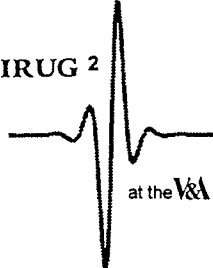
[†] Philadelphia Museum of Art; [‡] Winterthur Museum; ^{*} Museum of Fine Arts, Boston

An infrared spectral library of naturally occurring minerals from the collections of Rutgers University (Chester Collection) and the Mineral Sciences Department of the National Museum of Natural History - Smithsonian Institution has been compiled. This paper will discuss the formation of the spectral collection and present several examples from conservation applications illustrating its use.

Presenting authors

Beth A. Price has been the Conservation Chemist at the Philadelphia Museum of Art since 1990. She came to the Museum after working for six years as a synthetic organic chemist in research and development, at FAC. Corporation in Princeton, New Jersey. She received degrees in art history and chemistry from the State University of New York College at New Paltz.

Janice H. Carlson received her BA in chemistry from the College of Wooster and her MS in Analytical Chemistry from the University of Michigan. After working for several years in industry, she joined the staff of The Henry Francis DuPont Winterthur Museum near Wilmington, Delaware where she is Museum Scientist. She also serves as Adjunct Associate Professor of Conservation Science in the University of Delaware/Art Conservation Program in the Conservation of Artistic Historic Works.



3.14 The identification of nitrates on carbonate substrates using diffuse reflectance infrared Fourier Transform DRIFTs in CaF₂ Matrix.

M. Camaiti*, M. Bacci and M. Picollo**

* Centro Opere d'Arte - C.N.R., Florence.

** Istituto di Ricerca sulle Onde Elettromagnetiche (I.R.O.E.) - C.N.R., Florence.

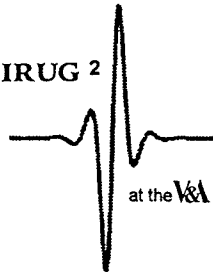
It is well known that both pollution and other alteration factors produce the growth of authigenetic minerals which previously were not present in the original composition¹

For the conversion of works of art it is necessary to be able to recognise these products. The most common substances found on carbonate substrates are: oxalates, nitrates and chlorides.^{2,3} The main focus of the present work is the detection of NO₃ ions and, in particular, their spectroscopic characterization.

Among the various techniques of analysis, FTIR is one of the fastest and most commonly used. However, when the analysis is performed using KBr pellets without any specific sampling procedures, FTIR only provides information about the presence of the NO₃ ion without giving information about the associate cation. In fact, the presence of inorganic nitrates is commonly related to a strong absorption band around 1385 cm⁻¹ without the characterization of the associated cation. This non-characterization could be partially due to the cation exchange between NO₃ and KBr facilitated by the high mechanical pressure used in the pelleting process.⁴

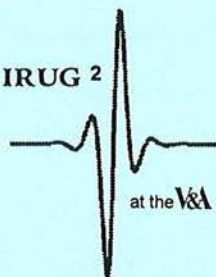
To verify this, spectra of KNO₃ and NaNO₃ in both transmittance (KBr pellets) and diffuse reflectance (KBr and CaF₂ matrix) modes were performed. The diffuse reflectance measurements (DRIFT) were collected after grinding each sample without the matrix and then mixing the sample together with the matrix without any pressure.

Both transmittance and DRIFT in KBr matrix present the same absorbance band around 1385 cm⁻¹ for the two nitrates, even if the DRIFT spectra also show different bands in this part of the spectrum. On the other hand, the DRIFT spectra in CaF₂ matrix show different absorption bands in the same part of the spectrum, so that DRIFT measurements in CaF₂ matrix can be proposed in the characterization of inorganic nitrates.

References

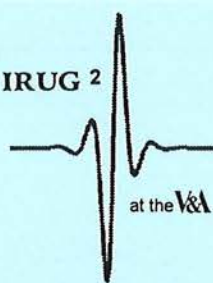
1. G. Amoroso and V. Fassina, *Stone Decay and Conservation*, Elsevier, New York, 1983.
2. T. Malavelaki, G. Biscontin, E. Zenchi, L. Marchensi and G. Repaci, *Evaluation of Deterioration Processes on the Istria Stone of Venetian Monuments*, Proc. of International Congress on Deterioration and Conservation of Stone, Lisbon, 1992, pp 163-173.
3. AA.VV., *The Oxalate Films: Origin and Significance in the Conservation of Works of Art*, Proc. of International Symposium, Milan, 1989.
4. R.A. Nyquist and R.O. Kagel, *Infrared Spectra of Inorganic Compounds*, Academy Press inc., London, 1971.

Marcello Picollo is unable to attend the meeting and has had to withdrawn his presentation. The abstract is reproduced for information.

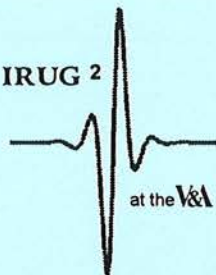


4. Delegates (alphabetical order)

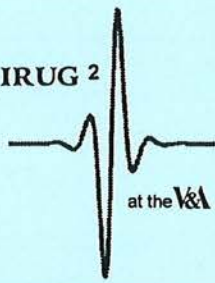
Name	Address	Country
Leon Black	University of Bristol Interface Analysis Centre 121 St Michael's Hill	Bristol BS2 8BS
Nigel Blades	V&A South Kensington	London SW7 2RL
Shona Broughton	287 Main Road Biggin Hill Westerham	Kent TN16 3JJ
Janice Carlson	Winterthur Museum Winterthur DE 19735	USA
Ana Maria Mesquita E Carmo	Instituto de José de Figueiredo Rua das Janelas Verdes 1200 Lisboa	Portugal
Umberto Casellato	Consiglio Nazionale Delle Ricerche Istitu di Chimica e Tecnologie Inorganiche e dei Materiali Avanzati Corso Stati Uniti 4 35020 Padova	Italy
Mads Chr. Christensen	Det Kongelige Danske Kunstakademi Konservatorskolen Esplanaden 34 DK 1263 Copenhagen K	Denmark
Jo Darrah	V&A South Kensington	London SW7 2RL
Michele Derrick	63 Ledgelawn Road Lexington MA 02137	USA
Sheila Fairbrass	27 Dalebury Rd	London SW7 7HQ
David Ford	V&A South Kensington	London SW7 2RL
Georgina Garrett	Saffron Walden Museum Museum Street Saffron Walden	Essex CB10 1JL
Norma Garrington	De Montfort University Dept of Chemistry The Gateway	Leicester LE1 9BH
Sue Hardman	Department of Chemistry University of Wales College of Cardiff POBox 912	Cardiff CF1 3DT
Helen Hatcher	Research Lab for Archaeology and the History of Art 6 Keble Road	Oxford OX1 3QJ



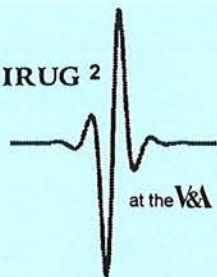
Name	Address	Country
Kate Helwig	Canadian Conservation Institute 1030 Innes Road Ottawa ON K1A 0M5	Canada
Simon Hogg	Department of Materials Royal School of Mines Imperial College of Science, Technology and Medicine Prince Consort Road	London SW7 2BP
Helen Howard	Conservation of Wall Painting Department Courtauld Institute of Art Somerset House The Strand	London WC2R 0RN
René Huigen	Central Laboratory for Research of Objects of Art and Science G Metsustraat 8 1071 EA Amsterdam	The Netherlands
Brenda Keneghan	V&A South Kensington	London SW7 2RL
Tanya Kieslich	Conservation & Technology Department Courtauld Institute of Art Somerset House The Strand	London WC2R 0RN
Tom Learner	Tate Gallery Millbank	London SW1P 4RG
Graham Martin	V&A South Kensington	London SW7 2RL
Yasunori MATSUDA	Tokyo University of Art & Design 200 Kamisakurada Yamagata-shi Yamagata	990 Japan
Chris Moynehan	University of Bristol Interface Analysis Centre 121 St Michael's Hill	Bristol BS2 8BS
Matthew Murray	Building Research Establishment Garston	Watford WD2 7JR
Marcello Picollo	Consiglio Nazionale Delle Ricerche Istituto di Ricerca sulle Onde Elettromagnetiche (IROE) 64 via Panciatichi 50127 Firenze	Italy
Jenny Pilc	The National Gallery Trafalgar Square	London WC2N 5DN
Boris Pretzel	V&A South Kensington	London SW7 2RL



Name	Address	Country
Beth Price	Philadelphia Museum of Art Benjamin Franklin Parkway Box 7646 Philadelphia Pennsylvania 19101 - 7646	USA
Patrick Ravines	Bahá'í World Centre Conservation Office POBox 155 31001 Haifa	Israel
Masanori SATO	Nara National Cultural Properties Research Center 2-9-1, Nijyo-cho Nara 630	Japan
Manfred Schreiner	Institute of Chemistry Academy of Fine Arts Schillerplatz 3 A 1010 Vienna	Austria
Nobuko Shibayama	Textile Conservation Centre Hampton Court Palace	London
Amy Snodgrass	Struas Center for Conservation Harvard University Art Museums 32 Quincy Street Cambridge, MA 02138	USA
Robbie Stewart	National Museums of Scotland Royal Museum of Scotland Chambers Street	Edinburgh EH1 1JF
Dusan Stulik	Getty Conservation Institute 4503 Glencoe Avenue Marina Del Rey California 90292-7913	USA
Edward Then	The Science Museum Exhibition Road South Kensington	London SW7 2DD
David Thickett	The British Museum Department of Conservation	London WC1B 3DG
Masahiko TSUKADA	Tokyo University of Art & Design 200 Kamisakurada Yamagata-shi Yamagata	990 Japan
Thomas Wall	Långa Raden 9 18252 Täby	Sweden
Siobhan Watts	FakArk Vitenskapsmuseet Universitet i Trondheim Trondheim	N-7004 Norway



Name	Address	Country
Sarah Webb	Research Lab for Archaeology and the History of Art 6 Keble Road	Oxford OX1 3QJ



5. Presentations (alphabetical by speaker)

NAME	ADDRESS	TITLE
Mads Chr. Christensen	Det Kongelige Danske Kunstakademi, Denmark	Analysis of Mineral Salts from Monuments by IR Spectroscopy
Kate Helwig	CCI, Canada	The characterization of iron earth pigments using infrared spectroscopy
Brenda Keneghan	V&A	FTIR Spectroscopy as a Tool when Assessing Plastics Collections in Museums
Michele Derrick Tanya Kieslich	Getty Conservation Institute USA	Infrared Microspectroscopy Mapping Techniques for the Analysis of Paint Cross-sections
Tom Learner	Tate Gallery	The use of a Diamond Cell for the FTIR Characterization of Paints and Varnishes Available to 20thC Artists
Yasunori MATSUDA Masahiko TSUKADA	Tohoku University of Art & Design	Identification of Calcium Carbonate contained as Body in Modern Paints...
Matthew Murray	Building Research Establishment	FTIR Techniques at the Building Research Establishment
Marcello Picollo	Consiglio Nazionale Delle Ricerche...	The identification of nitrates on carbonate substrates using DRIFTS in CaF ₂ Matrix
Jenny Pilc	National Gallery	Improving the Resolution of IR Spectra
Beth Price Janice Carlson	Philadelphia Museum of Art Winterthur Museum	An Infrared Spectral Library of Naturally Occurring Minerals
Masanori SATO Masaaki SAWADA	Nara National Cultural Properties Research Center, Nara, Japan	FTIR Microscopic studies on Organic Material used for Cultural Properties
Manfred Schreiner	Institute of Chemistry Academy of Fine Arts Schillerplatz 3 A 1010 Vienna, Austria	IR Reflectance Spectra of Weathered Medieval Stained Glass
Edward Then	Science Museum	Infrared spectroscopy - An analytical tool for conservators
David Thickett	British Museum	The use of a Beam-condenser for Micro Analysis
Siobhan Watts	FakArk Vitenskapsmuseet Universitet I Trondheim Trondheim; N-7004 Norway	Identifying Archaeological Jet & Jet-Like Artefacts using FTIR