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AIC CCM PAINTINGS SYMPOSIUM

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14th AICCM Paintings Special Interest Group Symposium

National Portrait Gallery, Canberra

26 - 28 October 2016

A preliminary investigation into the use of Diffuse Reflectance Infrared Fourier Transform spectroscopy (DRIFTS) in the characterisation of early synthetic emulsion paints

Full presentation

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Diffuse Reflectance Fourier Transform spectroscopy (DRIFTS) offers a unique set of advantages for non-invasive molecular analysis in the field of painting conservation. Recent instrumental developments show greater possibilities for fast in-situ analysis with handheld portal devices requiring no sample removal or preparation. However, transmission and attenuated total reflectance (ATR) modes remain the primary applications of infrared spectroscopy for bulk and surface analysis of synthetic paints. One reason for this could be the challenges associated with the interpretation of diffuse reflectance spectra, due to the presence of some specular reflection that cannot be optically separated from diffuse reflectance.

This distortion can take the form of inverted infrared bands that have a high absorption index (referred to as the Reststrahlen effect) and the intensification of secondary bands (overtones and combination bands). A Kubelka-Munk conversion is commonly applied to diffuse reflection spectra to address this absorption/reflection phenomena for qualitative analysis. Interestingly, recent studies suggest that diffuse reflectance offer more spectral information than other modes of FTIR because of the greater number of bands it obtains (Madariaga 2015, p. 4852; Mainali & Tang), and secondary and inverted bands have also been shown to be useful for identification purposes (Arrizabalaga et al. 2015).

This study aims to determine the extent to which DRIFTS can characterise the binder medium and pigments of early artists' synthetic paints, with a focus on acrylic emulsion dispersions. Synthetic paints from the mid-twentieth century pose their own set of challenges with analytical identification because of their complex chemical composition that comprise of a range of proprietary products including resins, pigments and various additives. The spectral data of over thirty paint samples produced with an Agilent Technologies 4300 Handheld FTIR spectrometer, coupled with a diffuse reflectance interface, are compared with ATR spectra from a Bruker ALPHA FTIR benchtop spectrometer with a Diamond Anvil Cell. Preliminary results show the importance of reference spectra of known samples and the application of multivariate analysis to effectively interpret the data. This study also assesses the reproducibility of diffuse reflectance spectra, as well as the impact of glass slides and canvas substrates in the results.

Agilent Technologies 4300 Handheld FTIR spectrometer with a diffuse reflectance interface used to analyse paint samples. Photo: Raymonda Rajkowski, September 2016.

DRIFTS has received minimal use as a technique within the field of cultural material conservation, with only a handful of studies undertaken in relation to the characterisation of the components of paintings and other forms of art (Manfredi et al. 2015; Košařová et al. 2014; Navas et al. 2008; Silva et al. 2006). This study contributes to this body of research through the building and verification of spectral data of a selection of synthetic emulsion paints and pigments. As a portable, non-destructive technique, exploring the potential of DRIFTS will directly benefit the analytical investigation of cultural objects, particularly when transportation or sampling is not an option.

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