



# Raman Spectroscopy for Rapid Analysis of White Household Paints

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**P**aint samples can provide valuable evidence in many forensic cases, such as trespass or a hit and run incidents. Analysis typically involves optical microscopy, FT-IR and PyGC-MS. Raman spectroscopy is not routinely used for paint examination but its speed and non-invasive nature are significant advantages over these aforementioned techniques.

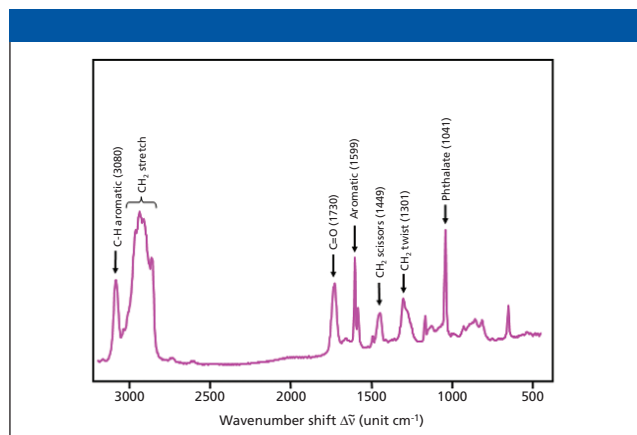
This study investigated white interior and/or exterior household paint, these paints varied in manufacturer and texture. The sample set represented >90% of all the white paints within the geographical area of this study.

## Experiment and Results

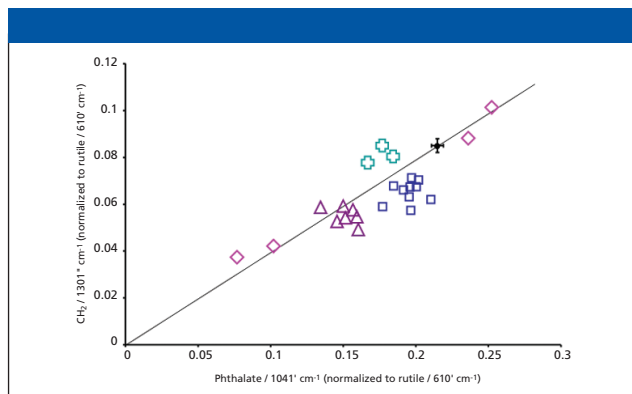
Studies were carried out using an Avalon RamanStation operating in high-throughput mode. Multiple spectra were automatically acquired for each dried paint sample and co-added. Sample auto-focus was used to assure optimum sample positioning, total analysis time per sample was 1 min.

Preliminary experiments using 532-nm excitation showed unacceptable levels of fluorescence; 785-nm excitation provided considerably less fluorescence. FT-IR spectra were also recorded for all the samples, due to the sharpness of Raman bands the organic and inorganic components paint constituents were much easier to identify using Raman (1,2). To remove baseline features spectra were differentiated, the spectra were also normalised with respect to the aliphatic band at 1301  $\text{cm}^{-1}$  (present in all samples).

Spectra indicate the paint samples consist of a simple drying oil/phthalate base and rutile pigment/extender, some samples also contain  $\text{CaCO}_3$ , dolomite and styrene/vinyl toluene modifier. Due to large spectral variations, identification of approximately half the paint samples was straightforward. Sample discrimination was achieved from analysis of relative peak intensities of rutile, phthalate and aliphatic  $\text{CH}_2$  components (1). Unlike FT-IR, relative peak intensities are significant in Raman spectra (2) and so on this basis all samples could be divided into seven groups and six unique samples.



**Figure 1:** Raman spectrum of typical paint sample.



**Figure 2:** Scatter plot showing the variation within group 1 samples.

Figure 2 shows a scatter plot of the intensities of the  $\text{C}=\text{O}$  1730  $\text{cm}^{-1}$  and aromatic 1041  $\text{cm}^{-1}$  vibrations for the largest group of paints. The large spread along the diagonal reflects the large changes of both these bands but indicates strongly cross-correlation. This cross-correlation indicates the aromatic vs aliphatic peak ratio accounts for almost all the variance, despite this it was still possible to divide the 25 spectra in this group into three groups and five unique samples.

## Conclusions

Raman spectroscopy is a powerful tool for paint analysis. This rapid technique is attractive as it gives information on both the binder and inorganic constituents, however, the major advantage of Raman is the reproducibility in the spectra, which allows even relatively small difference in relative intensity (rather than simple absence or presence of features) to be used to discriminate between different paints. Portable, low resolution Raman spectrometers can not provide this level of differentiation. The Avalon RamanField is a unique high resolution field-portable instrument. It offers ultra high performance and is ideal for crime scene analysis.

Avalon would like to thank Dr. S.E.J. Bell and L. Fido, from Queen's University, Belfast and FSNI for carrying out this research. A more in-depth application note, and reprints of the references are available upon request (info@avaloninst.com).

## References

- (1) S.E.J. Bell, L.A. Fido, S.J. Speers, and W.J. Armstrong, *Appl. Spectrosc.*, 59(1) 100–108 (2005).
- (2) S.E.J. Bell, L.A. Fido, S.J. Speers, and W.J. Armstrong, and S. Spratt, *Appl. Spectrosc.* 59(11) 1333–1339 & 1340–1346 (2005).

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