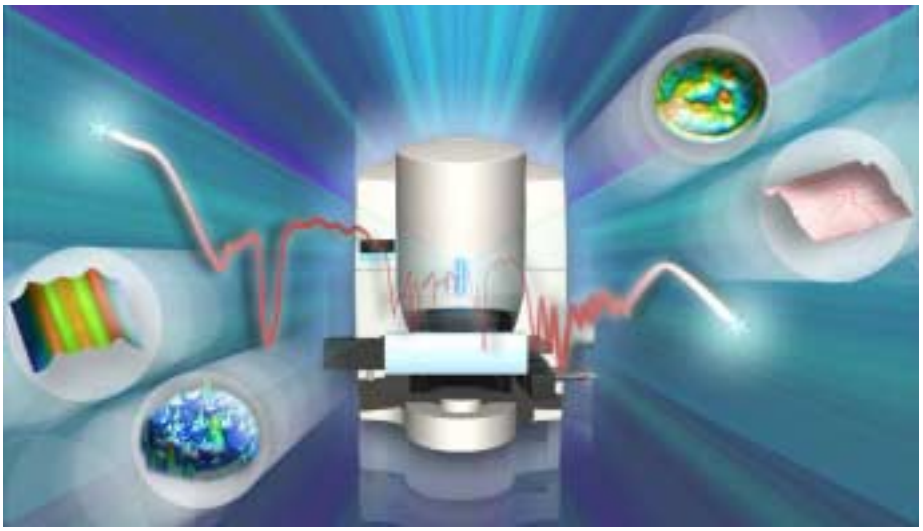
Analysis of a Laminated Film

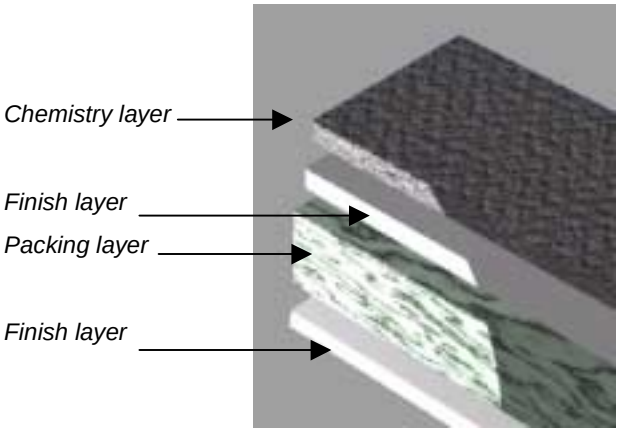
Using the Spectrum Spotlight 300



Introduction

Photographic films have a complex structure, and are constructed from multiple thin layers of polymer. These layers have very different functions, and are used to provide structural strength, gloss finish, photographic process chemistry and protection from scratches (Figure 1). Each of these layers must be intact, particular the chemistry layer. Contamination is also unacceptable as it could lead to inhibition of the photographic chemistry or visual defects, rendering the end product useless. This particular sample is a 4-layer laminate used in a monochrome photographic product.

Figure 1 Cross-section of a film laminate



Results

The visual image of a 50 µm section of the film (Figure 2) shows some identifiable features, although it is not possible to identify the four layers by eye.The infrared image was acquired using spectral range 4000-720 cm^{-1} at 8 cm-1 spectral resolution, 2 scans per pixel, 6.25 µm pixel resolution. Data Acquisition time was less than 2 minutes.

The total absorbance map (Figure 3) showed some detail, particularly in the filler layer. Further spectral analysis across the entire area of the sample (Figure 4) revealed two distinct components which could be clearly separated by single wavenumber analysis, at 1467cm-1 and 1026cm-1 respectively (Figures 5a and 5b).

The two outermost layers had no unique spectral bands by which they could be identified.

The Band Ratio feature of the Spotlight software was used to resolve these layers, using the ratio of the bands at 2905 cm^{-1} and 1853cm^{-1}. This identified the chemistry layer clearly (Figure 5c).

The final layer was resolved using a Band Ratio function of 1727cm^{-1}/1895 cm^{-1} (Figure 5d and 5e).

Figure 2 visual image of a 50 µm film section

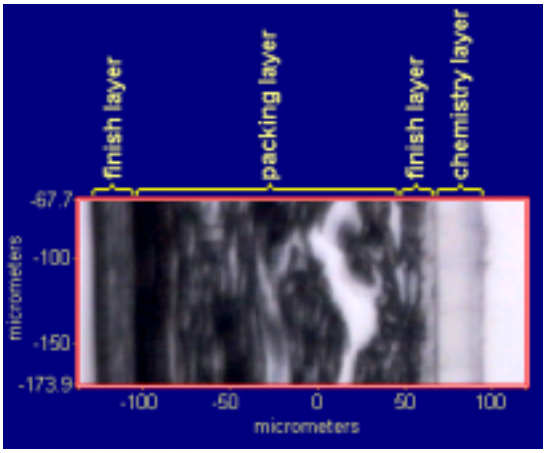


Figure 3 Total absorbance map

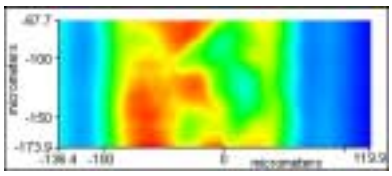
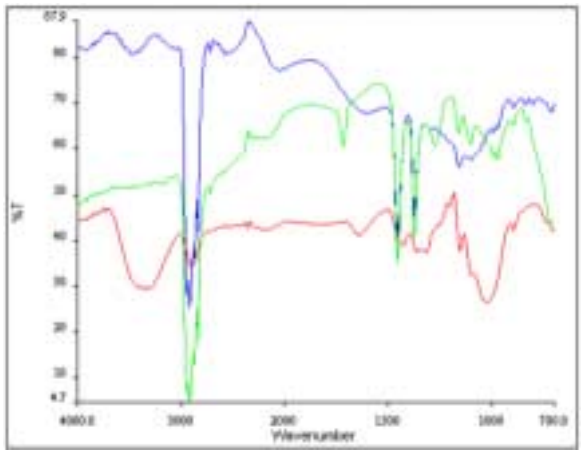


Figure 4 Spectra from the 3 regions in the sample



Visualisation of all of the chemically resolved regions was carried out using Spotlight's Layer Manager software feature. This allows the user to assign a single false colour to each image. The threshold of the colour intensity can be adjusted to optimise contrast between the component images.The image produced by treatment with the Layer Manager is shown in Figure 6.

An interesting structure emerged from the composition, and can be seen as the large dark area within the blue region. This corresponds to packing material visible in Figure 2.The packing material is clearly contained within the packing layer, and does not impinge on the finish or chemical substrate layer, so does not constitute a problem.Total analysis time from inserting the sample into Spotlight to the final superimposed image was less than 30 minutes, of which data acquisition time was less than 2 minutes.

Figure 5a Single wavenumber map at 1467cm^{-1}

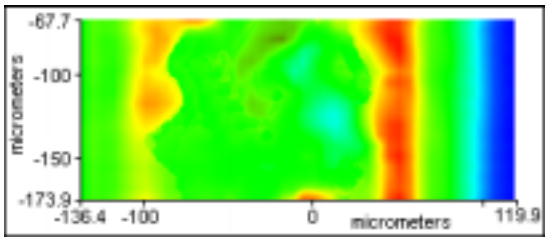


Figure 5b Single wavenumber map at 1026 cm^{-1}

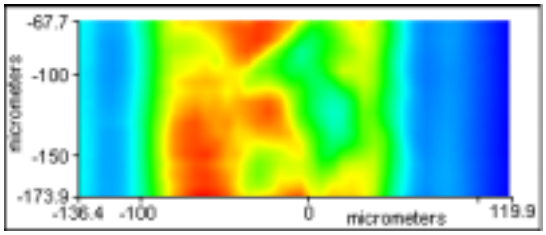


Figure 5c Band Ratio 2905/1853cm^{-1}

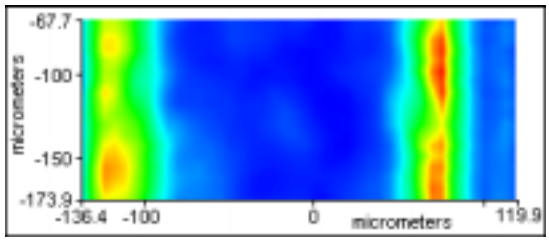


Figure 5d Defining Band Ratio 1727/1895cm^{-1}

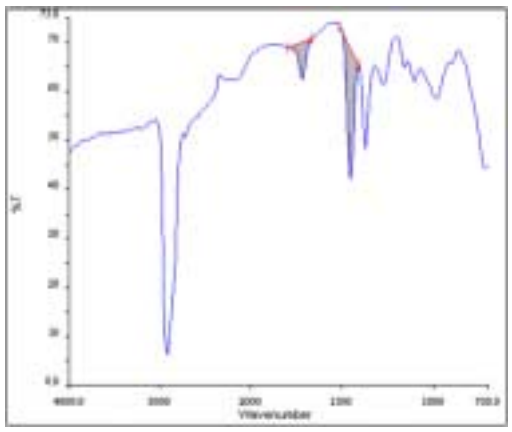
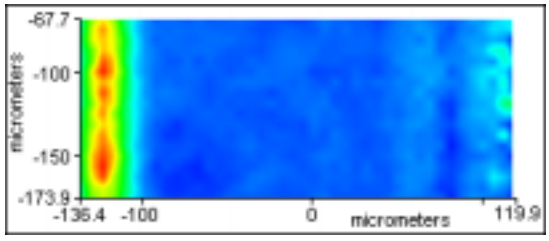
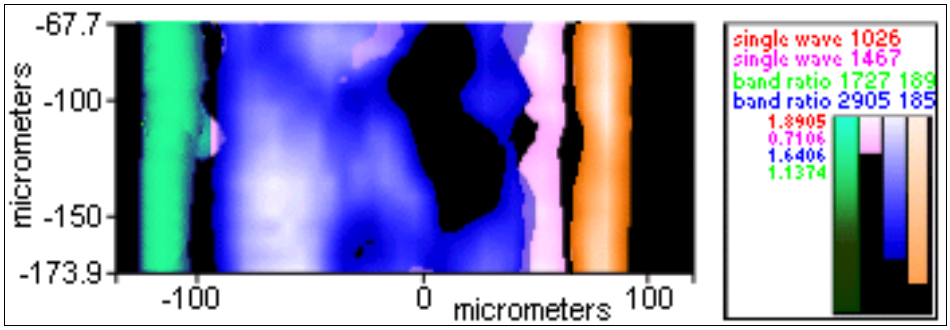


Figure 5e Band Ratio 1727/1895 cm^{-1}



Conclusion

Figure 6 All 4 sets of data superimposed using Layer Manager



Spotlight's superb sensitivity allowed rapid resolution of the 4 regions of the sample, turning the analysis of a complex sample into a trivial process. Spotlight is ideally suited to detailed analysis of laminated and chemically complex samples.

Spectrum Spotlight 300