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Application News

No. A559

Spectrophotometric Analysis

Imaging with the AIM-9000 Infrared Microscope
- Defect Analysis in the Electrical and Electronic Fields -

Imaging is the visualization of spatial differences in the distribution or chemical structure of substances within an object for measurement. Since the technique can obtain a lot of information within a short time period, it is widely utilized for various purposes such as contaminant analysis and the analysis of industrial materials and biological samples. The AIM-9000 infrared microscope features a mapping speed approximately four times faster*1 than the preceding AIM-8800, therefore enabling unprecedentedly speedy and streamlined imaging analysis. In addition, the AIM-9000 also features outstandingly high sensitivity with an S/N ratio of 30,000:1, which is the highest in the industry. As such, the AIM-9000 achieves both high speed and high sensitivity. The mapping program is capable of both area mapping measurement for analyzing the in-plane distribution of substances within a sample, and line mapping measurement which is effective for analysis in the depth direction.

This article introduces example analyses regarding a mixed contaminant and a defect on an electronic substrate.

*1: The speed differs depending on measurement conditions (aperture size, step type, accumulation times, etc.).

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Example Analysis of a Mixed Contaminant

The instruments used for analysis are shown in Fig. 1. The sample was first sampled on to a diamond cell and then compressed to a thickness appropriate for transmittance measurement (10 to 20 µm). The diamond cell after sample compression was then placed on the stage. Through visible observation of the contaminant, we confirmed that the contaminant is a mixture of a number of substances. Fig. 2 shows the overall appearance of the contaminant obtained by connecting multiple images using the tiling function. Fig. 3 shows the microscope camera observation image of the area squared in white on Fig. 2. The approximate size of the contaminant is 600 µm × 900 µm (H × W). Points with characteristic features in Fig. 3 were marked A, B, and C respectively, and the infrared spectrum obtained at each point is shown in Fig. 4. Polyethylene was detected from points A and C, and the components of aramid fiber were detected from point B.

Fig. 1 IRTracer™-100 Fourier Transform Infrared Spectrophotometer and AIM-9000 Infrared Microscope

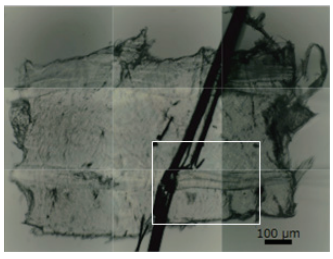

Fig. 2 Overall Appearance of Contaminant

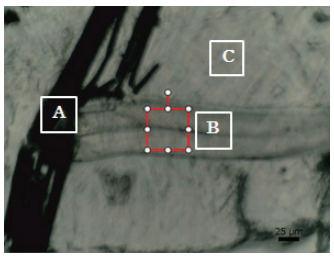

Fig. 3 Microscope Camera Observation Image

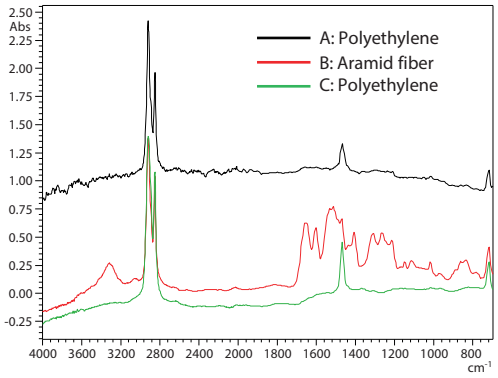

Fig. 4 Infrared Spectra of Mixed Contaminant (Points A, B, and C)

Next, imaging analysis was performed to measure the distribution of each substance by transmittance microspectroscopy. An area of 175 µm × 250 µm (H × W) on the sample was measured. Table 1 lists the measurement conditions and Fig. 5 shows the image after setting the measurement range. An aperture size of 25 µm × 25 µm was set at each measurement position. Since the blue frames indicate the aperture at each measurement position, the entire selected area will be measured without any gaps.

Table 1 Measurement Conditions

Instrument	: IRTracer-100, AIM-9000
Resolution	: 8 cm^{-1}
Accumulation times	: 20
Apodization function	: Sqr-Triangle
Aperture size	: 25 µm × 25 µm
Measurement interval	: 25 µm
Detector	: MCT

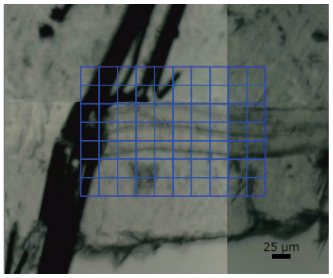

Fig. 5 Image after Setting the Measurement Range

Fig. 6 (a) shows the result of imaging at the peak height of 1651 cm^{-1} based on the C=O stretching vibrations in the amide bonds (-CONH-) of aramid fiber, and Fig. 6 (b) shows the result of imaging at the peak height of 1470 cm^{-1} based on the CH_2 bending vibrations of polyethylene. The images of aramid fiber and polyethylene are inverted and clearly indicate the distribution of each substance.

As described above, we were able to determine the substances contained in a mixed contaminant and also visualize the distribution of each substance through imaging analysis.

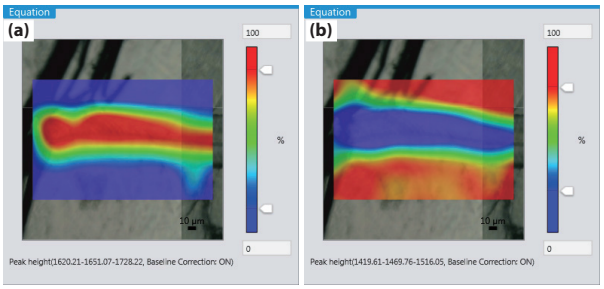

Fig. 6 (a) Distribution of Aramid Fiber (Peak height: 1651 cm^{-1}) (b) Distribution of Polyethylene (Peak height: 1470 cm^{-1})

Example Analysis of an Electronic Substrate Defect

The tiled image of the electronic substrate is shown in Fig. 7. Since the location of the defect could not be determined in visual observation, imaging analysis was performed over a relatively wide area by reflectance microspectroscopy.

An area of 200 µm × 325 µm (H × W) was measured. Other measurement conditions are the same as those listed in Table 1.

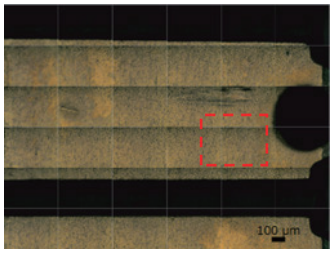

Fig. 7 Tiled Image of Electronic Substrate

Fig. 8 shows the infrared spectra obtained from the electronic substrate at the area squared in red. The spectra indicate the detection of substances presumed to be paraffin oil and silicate. Since the point where silicate exists also shows a peak indicating paraffin oil, we can expect that both of the substances are present at this specific point.

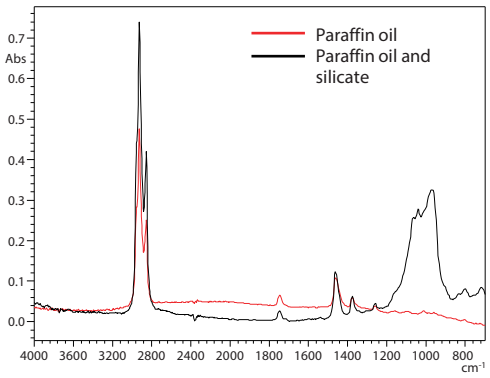

Fig. 8 Infrared Spectra Obtained from Electronic Substrate

Fig. 9 (a) shows the result of imaging at the peak height of 1377 cm^{-1} based on the CH_3 bending vibrations of paraffin oil, and Fig. 9 (b) shows the result of imaging at the peak height of 972 cm^{-1} based on silicate. We can see from Fig. 9 (a) that paraffin oil exists across the left side of the measurement range and from Fig. 9 (b) that silicate exists locally at the points indicated in red. In addition, these images show that there are also areas where neither of these substances are present (blue areas).

Imaging analysis enabled the clear visualization of the distribution of substances on this sample, which could not be recognized by visual observation.

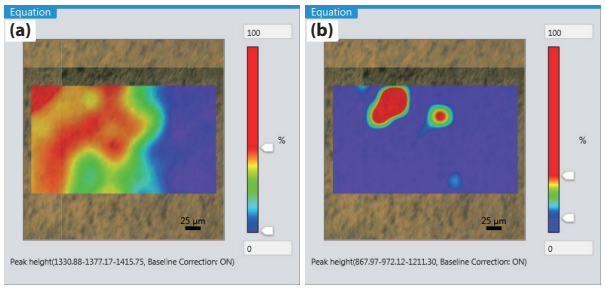

Fig. 9 (a) Distribution of Paraffin Oil (Peak height: 1377 cm^{-1}) (b) Distribution of Silicate (Peak height: 972 cm^{-1})

Conclusion

This article demonstrates the effectiveness of imaging analysis using the IRTracer-100 Fourier transform infrared spectrophotometer and AIM-9000 infrared microscope for the analysis of mixed contaminants and electronic substrate defects.

Although point measurement is often employed for contaminant analysis, imaging analysis using an infrared microscope is necessary to accurately perform qualitative analysis of each minute point on a mixed contaminant and determine the distribution of substances.

We hope the AIM-9000, which achieves both high speed and high sensitivity, will be effective in your imaging analysis needs.

IRTracer is a trademark of Shimadzu Corporation.

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