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Application News

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Spectrophotometric Analysis

Analysis of Stains on Automobile Components Using the AIM-9000 Infrared Microscope

In the manufacturing process of automotive products, the occurrence of stains on metal components due to residual lubrication oils used on machine tools and cleaning fluid is an issue.
In this research, we investigated the cause of a stain by using the AIM-9000 infrared microscope. This article introduces an approach toward dealing with such contaminant issues and the analysis results.

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Analysis of the Stain

A defective product from the manufacturing process of an automobile component was analyzed using the AIM-9000. By first observing the component with the microscope camera of the AIM-9000, we found stains on the metal surface as indicated in Fig. 1. Since the stains were scattered, we used the infrared microscope, which is capable of measuring minute points. Table 1 lists the instrument used for measurement and the measurement conditions. Fig. 2 shows a representative spectrum obtained from the stain. The aperture size was set to 50 µm × 50 µm.

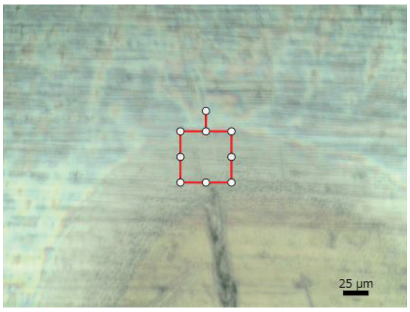

Fig. 1 Picture of Stains on Metal Surface

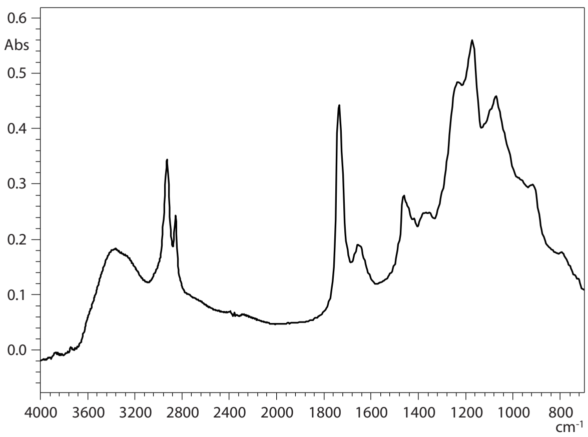

Fig. 2 Infrared Spectrum of the Stain

Table 1 Instruments and Measurement Conditions

Instrument	:	IRTracer-100, AIM-9000
Optical resolution	:	8 cm^{-1}
Accumulation times	:	40
Apodization function	:	Sqr Triangle
Detector	:	MCT

Cause Verification of the Stain

Comparative analysis was performed by measuring cutting fluid and cleaning fluid, both of which can cause stains. We also measured the samples after heat treatment (150 °C, 2 hours) in consideration of heat treatment that is performed within the manufacturing process. Fig. 3 and Fig. 4 show the infrared spectra obtained from the cutting fluid and cleaning fluid, respectively, before and after heat treatment. With both the cutting fluid and the cleaning fluid, the infrared spectra changed after heat treatment. In particular, the spectral shape of the cleaning fluid changed greatly since it is water soluble and the heat caused the fluid to dry.

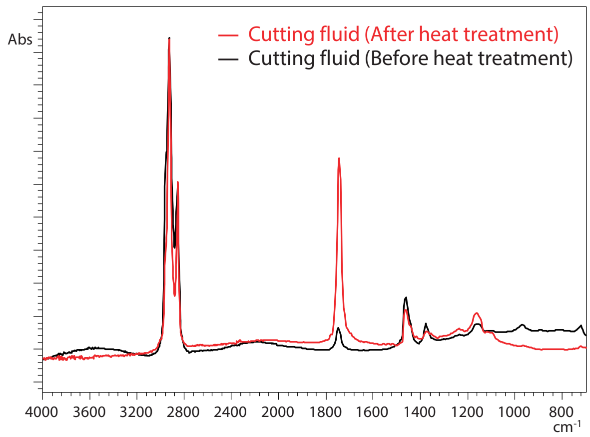

Fig. 3 Infrared Spectra of Cutting Fluid Before and After Heat Treatment

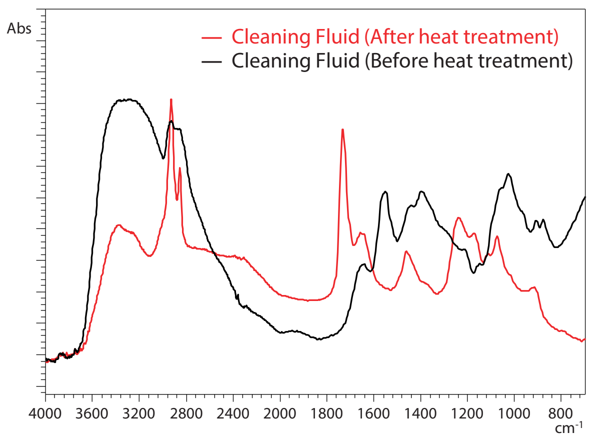

Fig. 4 Infrared Spectra of Cleaning Fluid Before and After Heat Treatment

Fig. 5 shows the infrared spectra of the stain and the cutting and cleaning fluids after heat treatment.

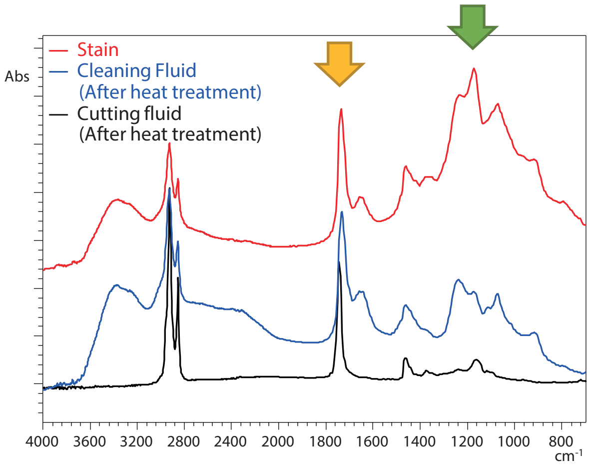

Fig. 5 Infrared Spectra of the Stain and the Cutting and Cleaning Fluids after Heat Treatment

The spectral shape of the stain and the heat-treated cleaning fluid show great similarity. Also, by comparing the spectral shape of the stain with that of the cutting fluid, we can see that the peak wavelengths caused by C=O bonds in the vicinity of 1750 cm^{-1} (indicated by the yellow arrow in Fig. 5) differ slightly. We can therefore assume that if the stain were to contain cutting fluid components, the peak of C=O bonds in the spectrum of the stain should expand toward the higher wavelengths or have a shoulder peak. In addition, by comparing the peaks of C-H bonds in the vicinity of 3000 cm^{-1}, we can see that if the stain were to contain cutting fluid components, the peak of C-H bonds in the spectrum of the stain should have a greater intensity than that was observed. From these points, we can consider that the stain does not contain cutting fluid components.

Next, looking at the peak in the vicinity of 1200 cm^{-1} indicated by the green arrow in Fig. 5, this peak is thought to originate from C-O bonds and the intensity of this peak is strong in the spectrum of the stain. This can be considered to be caused by the adherence of a substance other than that of cleaning fluid or by variations in the effects of heat treatment.

From these results, we can conclude that the primary cause of the stain is cleaning fluid that is used in the manufacturing process. In addition, by comparing components before and after heat treatment as in this research, it is possible to narrow down or identify in which process the stain was adhered within the manufacturing process.

Contaminants that occur within the manufacturing process are often caused by substances that are used within individual processes. Accurate and rapid determination of the cause can be made possible by measuring materials that are used in relation to each process and registering the data to a user library in advance.

Conclusion

In this research we analyzed a stain that was found in the manufacturing process of an automobile component using the system shown in Fig. 6. Infrared spectroscopy enables easy and rapid measurement and is therefore highly effective in solving issues regarding contaminants.

When measuring stains, use of a grazing angle objective (GAO), which is capable of high-sensitivity measurement of organic thin films in the order of nm on the surface of metal plates, may also be effective.

Fig. 6 IRTracer-100 Infrared Spectrophotometer (Left) and AIM-9000 Infrared Microscope (Right)

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