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Application News

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Spectrophotometric Analysis

Microplastic Analysis Using the AIM-9000 Infrared Microscope

Microplastics are minute pieces of plastic with diameters ranging from a few micrometers to a couple of millimeters. In recent years, microplastics have become a global marine environmental issue since they may adversely affect coastal and marine ecosystems and potentially harm the health of human beings. In light of this issue, Japan is investigating the distribution of microplastics and the amount of harmful chemical substances such as PCB that are adsorbed to such microplastics in the coastal and offshore areas of Japan and a wide area spanning from Japan to the South Pole. In addition, the government is calling on businesses to stop using microbeads in personal care products such as scrubs.[*1]

Microplastics are classified into primary microplastics and secondary microplastics. Primary microplastics are manufactured as materials for use in scrubs and industrial abrasives and are often made of polyethylene (PE) or polypropylene (PP). Secondary microplastics refer to plastics that have been broken down from larger debris into pieces with a diameter of 5 mm or less due to external factors such as ultraviolet radiation[*2] and the types of such plastics are various.

A Fourier transform infrared spectrophotometer (FTIR) is suited to the analysis of microplastics since FTIRs are optimal for the qualitative analysis of organic compounds. In cases where the sample is minute and no larger than 100 µm, the use of an infrared microscope is effective.

This article introduces example analyses of primary and secondary microplastics utilizing an infrared microscope.

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AIM-9000 Infrared Microscope

An infrared microscope system is capable of acquiring information of minute areas with high sensitivity by adjusting the infrared beam diameter using an aperture. Fig. 1 shows the system appearance.

Fig. 1 IRTracer™-100 Fourier Transform Infrared Spectrophotometer (Left) and AIM-9000 Infrared Microscope (Right)

Qualitative Analysis of a Primary Microplastic

Primary microplastic contained in a scrub was prepared as a sample and measured.

Microplastic was extracted from the scrub by dissolving the scrub in water and filtering it several times. Fig. 2 shows an optical microscopic image of the microplastic on the filter.

One piece of microplastic was taken from the filter and then compressed in a diamond cell for measurement by infrared transmission microspectroscopy. Fig. 3 shows the measurement sample and Table 1 lists the measurement conditions. Fig. 4 shows the measurement result which indicates that the microplastic is polystyrene (PS).

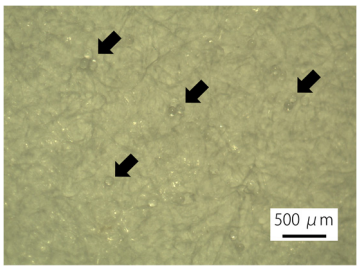

Fig. 2 Microplastic on the Filter (Indicated by black arrows)

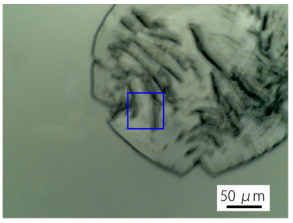

Fig. 3 Measurement Sample

Table 1 Measurement Conditions

Instrument	: IRTracer-100, AIM-9000
Resolution	: 8 cm^{-1}
Accumulation Times	: 40
Apodization Function	: Sqr-Triangle
Aperture Size	: 50 µm × 50 µm
Detector	: MCT

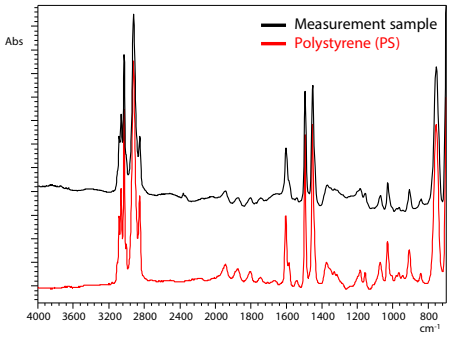

Fig. 4 Measurement Results

Mapping Analysis of Secondary Microplastics

Secondary microplastics such as that found in oceans and rivers were prepared as a sample and measured.
Microplastics dispersed in water were filtered and collected using a polytetrafluoroethylene (PTFE) filter. Since PTFE only has an infrared absorption band near 1200 cm^{-1}, it is convenient in measuring transmission spectra with the sample left on the filter.
In order to identify the many microplastics collected on the filter, mapping analysis was performed using infrared transmission microspectroscopy. Fig. 5 shows an optical microscopic image of the microplastics on the filter and Table 2 lists the measurement conditions. Figs. 6-(a) to (c) show the measurement results. The area of the PTFE filter where no sample was adhered was set as the background.
The measurements revealed that the microplastics in the sample were polyethylene (PE), polypropylene (PP), and polyethylene terephthalate (PET). Figs. 6-(a) to (c) are colored based on corrected peak height values (the peak height from the baseline) of the characteristic peak of each plastic (PE: 718 cm^{-1} caused by CH_2 rocking vibrations, PP: 2839 cm^{-1} caused by CH_2 stretching vibrations, PET: 1724 cm^{-1} caused by C=O stretching vibrations). Red areas indicate points where the plastic component is present in high amounts and blue areas indicate points with low amounts. Fig. 7 shows typical infrared spectra from the areas in Figs. 6-(a) to (c).

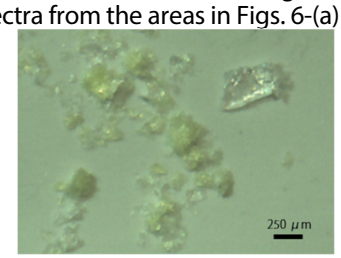

Fig. 5 Microplastics on the Filter

Table 2 Measurement Conditions

Instrument	:	IRTracer-100, AIM-9000
Resolution	:	8 cm^{-1}
Accumulation Times	:	1
Apodization Function	:	Sqr-Triangle
Aperture Size	:	50 µm × 50 µm
Measurement Interval	:	50 µm
Mapping Area	:	1800 µm × 2600 µm
Detector	:	MCT

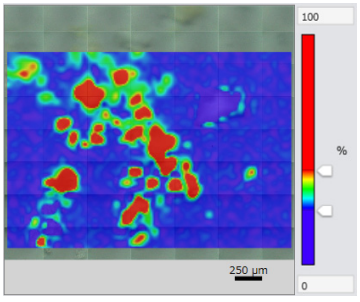

Fig. 6-(a) PE Distribution
(Based on the corrected peak height value of 718 cm^{-1})

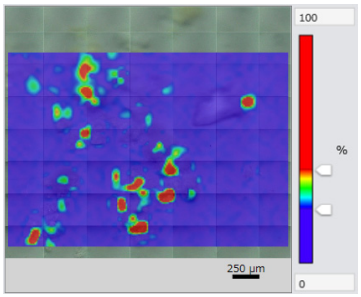

Fig. 6-(b) PP Distribution
(Based on the corrected peak height value of 2839 cm^{-1})

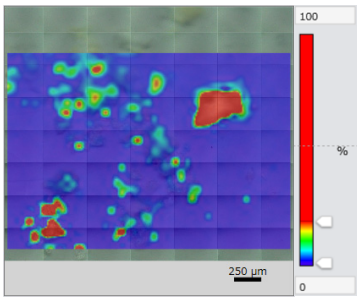

Fig. 6-(c) PET Distribution
(Based on the corrected peak height value of 1724 cm^{-1})

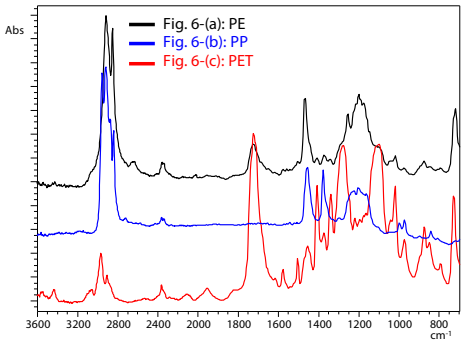

Fig. 7 Typical Infrared Spectra from Areas in Figs. 6-(a) to (c)

Conclusion

Qualitative and mapping analyses of microplastics extracted from scrubs or collected on a filter can be performed by utilizing the AIM-9000 infrared microscope. Minute samples can be measured with high sensitivity and by using the comprehensive library provided by standard, rapid testing is possible.

References
*1 Website of the Ministry of the Environment (Japan)
Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2017, Part II, Chapter 4, Section 7 "Preservation of the Marine Environment" (in Japanese)
*2 Website of the Ministry of the Environment (Japan)
Water / Soil / Ground Environment, Marine Litter, "2016 New Year Symposium on Marine Litter" documentation

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