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Application News

AIMsight™ Infrared Microscope

Analysis of Microplastics Using AIMsight Infrared Microscope

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User Benefits

- Accurate determination of the material of microplastics in the environment is possible.
- Enables direct mapping analysis of microplastics collected on filter paper.
- The length of target objects in samples can be measured from images acquired by the wide-field camera or 15x reflective objective lens.

■ Introduction

Microplastic pollution of rivers and oceans is spreading globally, and the impact on living organisms has also become a serious concern. Active monitoring surveys and research have been carried out in recent years to acquire scientific knowledge regarding the distribution of microplastics in many countries worldwide.

When exposed to ultraviolet (UV) light, wind, and rain and subjected to physical friction, plastics released into the environment become embrittled and break down into tiny particles called microplastics. (This type of microplastic is termed "secondary microplastic.")

Microplastics are generally evaluated by observing their external appearance, measuring their number and size, and determining their material composition, but among these items, qualitative measurement of the type of plastic material is one of the most important items for identifying the origin of a microplastic. However, because the size of the microplastics being evaluated is becoming smaller by the year, it is necessary to select an appropriate analytical instrument.

Because the AIMsight infrared microscope (Fig. 1) realizes an S/N ratio of 30000 : 1, which is the highest in its class, good spectra can be acquired in a short time even with minute specimens with a size of several 10 µm. The AMsolution software used to control AIMsight includes a length measurement function as a standard feature, which makes it possible to measure the length of objects of interest in a sample. Thus, the functions of this system are not limited to qualification of the sample material, but also include acquisition of size information. For analysis of even smaller specimens with sizes on the order of several µm, the AIRsight™ infrared/Raman microscope is an effective tool. For an example of an analysis of microplastics using the AIRsight infrared/Raman microscope, please refer to Application News No. 01-00396.

This article introduces an example in which microplastics in the environment were analyzed using the AIMsight infrared microscope.

Fig. 1 Appearance of IRTracer™-100 (Left) and AIMsight™ (Right)

■ Microplastics Used for Measurement

Microplastics in water were collected using filter paper made of PTFE (polytetrafluoroethylene). The microplastics collected on the filter paper were placed on the stage of the AIMsight, and a mapping analysis was conducted. Fig. 2 shows an image of the microplastics on the filter paper taken with the 15x reflective objective lens of the AIMsight. Since the PTFE of the filter paper has no infrared absorption band except at around 1200 cm^{-1}, the microplastics collected on the filter paper can be measured by the transmission method.

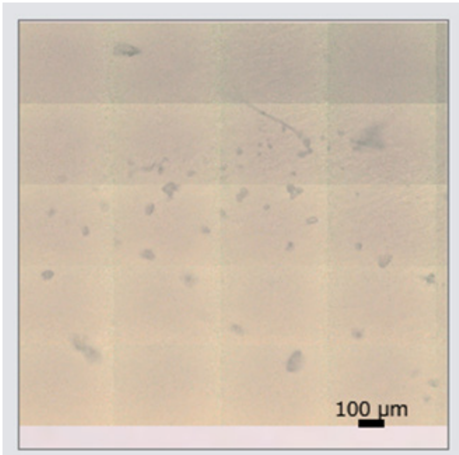

Fig. 2 Image of Microplastics on Filter Paper Acquired with 15x Reflective Objective Lens

■ Mapping Analysis of Microplastics

A mapping analysis of the microplastics collected on the filter paper was conducted by the IR transmission method with the AIMsight infrared microscope. Table 1 shows the measurement conditions.

Table 1 Measurement Conditions

Instruments	: IRTracer-100, AIMsight
Resolution	: 8 cm^{-1}
Accumulation	: 10
Apodization function	: SqrTriangle
Aperture size	: 30 µm × 30 µm
Measurement interval	: 30 µm
Mapping range	: 1560 µm × 1110 µm
Detector	: T2SL

Fig. 3 and Fig. 4 show the two types of infrared spectra acquired from the mapping analysis and the results of a search using Shimadzu original database, the UV-Damaged Plastic Library. The absorption at around 1200 cm^{-1} is due to the PTFE material of the filter paper.

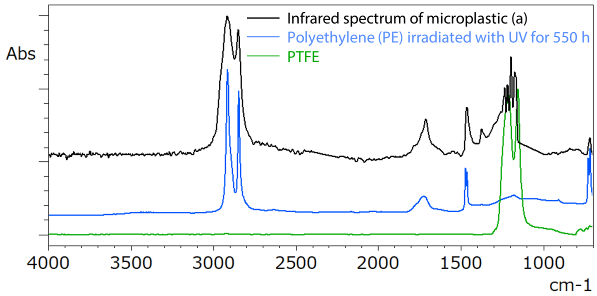

Fig. 3 Infrared Spectrum of Microplastic (a) Acquired by Mapping Analysis and Search Results

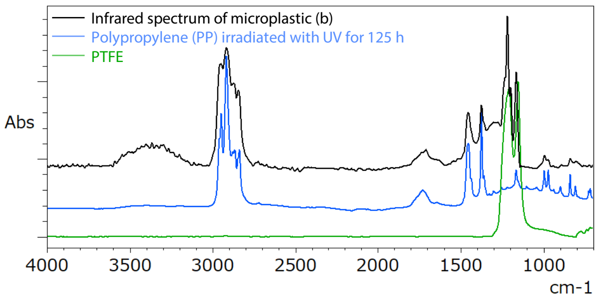

Fig. 4 Infrared Spectrum of Microplastic (b) Acquired by Mapping Analysis and Search Results

From Fig. 3, Microplastic (a) was found to have a spectrum similar to that of polyethylene (PE) exposed to ultraviolet rays for 550 hours. From Fig. 4, Microplastic (b) was found to have a spectrum similar to that of polypropylene (PP) irradiated with ultraviolet light for 125 hours.

Next, Fig. 5 (a) and (b) show the chemical images of distributions of PE and PP respectively, prepared using the corrected peak height values (peak height from the baseline) of 718 cm^{-1} caused by rocking vibration of CH_2, which is the characteristic peak of PE, and 1373 cm^{-1} caused by symmetric bending vibration of CH_3, the characteristic peak of PP. Areas where large numerical values were obtained for the plastic component are shown in red, while areas with small values are shown in blue.

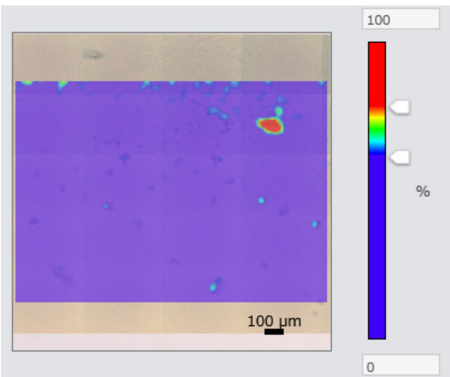

Fig. 5(a) Distribution of PE
(Using corrected peak height of 718 cm^{-1} caused by rocking vibration of CH_2)

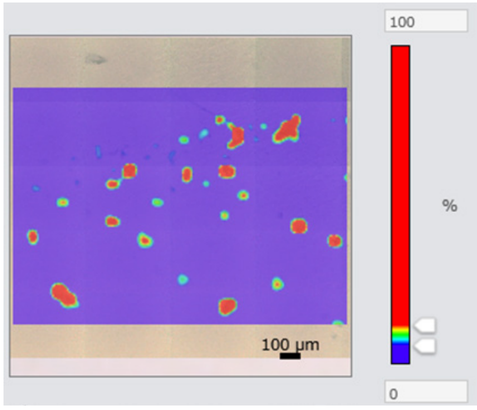

Fig. 5(b) Distribution of PP
(Using corrected peak height of 1373 cm^{-1} caused by symmetric bending vibration of CH_3)

These mapping analysis results, show visually that the larger part of the microplastics collected on the PTFE filter paper is PP, while some PE also exists in the sample.

■ Length Measurement Function

Here, the length measurement function, which is a new function of the AMsolution software used to control AIMsight, will be introduced using the microplastic images measured in this experiment. The length of the target objects in an image acquired by the wide-field camera or 15x reflective objective lens of AIMsight can be measured by setting the starting point and end point. Fig. 6 shows the operation screen of the length measurement function. Size information for microplastics can also be acquired by using this function. Results of length measurement of multiple microplastics collected on the PTFE filter paper were shown in Fig. 6.

Fig. 6 Operation Screen of Length Measurement Function and Results of Length Measurement

■ Conclusion

The material of microplastics collected on filter paper was analyzed qualitatively and a mapping analysis of the sample was carried out using the AIMsight infrared microscope. By using the UV-Damaged Plastics Library for determination of the material of microplastics, which is an original Shimadzu database, it was found that the microplastics collected on the filter paper in this experiment were deteriorated PE and PP. The distribution of the deteriorated PE and PP could be understood visually from the mapping analysis results. In addition, it is also possible to acquire size information on the microplastics by using the length measurement function of the AMsolution software.

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