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Issues in the Analysis of Microplastics

In recent years, demands for microplastics analysis have increased due to the possibility of microscopic marine plastics impacting the ecosystem. Generally, when discriminating between plastics, a spectrum is obtained using a Fourier transform infrared (FTIR) spectrophotometer or Raman spectrophotometer, and is then compared with a library containing the spectra for standard plastic items. However, the shape of the spectrum for a degraded plastic differs from the spectra of a standard. Accordingly, the spectrum will not match anything in commercially available plastic libraries, which makes identification and qualitative analysis difficult.

At Shimadzu, we are taking measures to develop a methods for analyzing microplastics, utilizing our wide range of products applicable to plastics and our know-how related to analytical and measurement technology. Plastic Analyzer, which is introduced here, contains an Infrared spectral library of plastics degraded by UV rays and heat, enabling dramatic improvements to quantitative accuracy in microplastics analyses. Additionally, very small microplastics on the order of a few µm in size can be qualified using an Infrared/Raman microscope. Note that AMsolution, the software that controls our Infrared microscope and Infrared/Raman microscope, is equipped as standard with a length measuring function capable of measuring microplastics particle size.

Analysis Example 1

White plastic shards of microplastic collected from a seashore were measured using the Plastic Analyzer (Fig. 1). Typical plastic libraries find both polypropylene (PP) and other plastics, such as polybutene (PB), at the top, making qualitative analysis difficult. The Shimadzu UV-Damaged Plastics Library finds UV-degraded PP at the top.

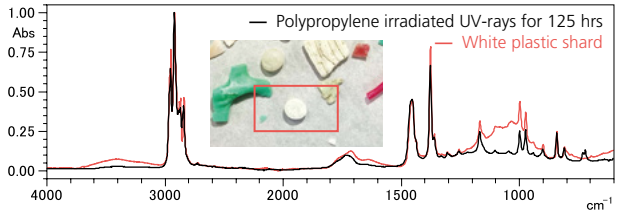


Fig. 1 White plastic shards of microplastic

Analysis Example 2

Microplastics suspended in water were collected using polytetrafluoroethylene (PTFE) filter paper and analyzed using infrared microscopic transmittance mapping. The results confirmed that most of the microplastics collected by the filter paper were PP, and a portion consists of polyethylene (PE) (Fig. 2).

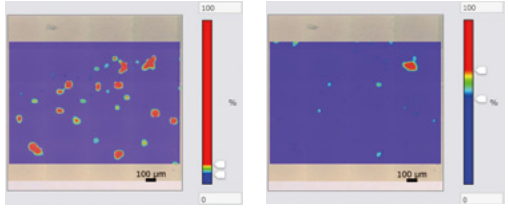


Fig. 2 Distribution of the microplastics collected with the filter paper
Left: PP; Right: PE

Analysis Example 3

In order to measure microplastics of smaller sizes, which are difficult to measure by infrared microspectroscopy, microplastics in water collected using polytetrafluoroethylene (PTFE) filter paper were analyzed by Raman microspectroscopy.

The images of the microplastic acquired by the objective lens are shown in Fig. 3.

The obtained Raman spectra (Fig. 4) shows that microplastic (a) is polyethylene (PE) and microplastic (b) is polystyrene (PS).

For microplastic (b), we measured the particle size using the length measuring function and found it to be 5 µm (Fig. 5).

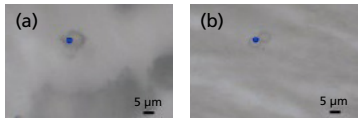


Fig. 3 The images of the microplastics

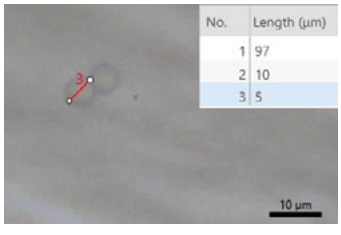


Fig. 5 The measurement of particle size using the length measuring function

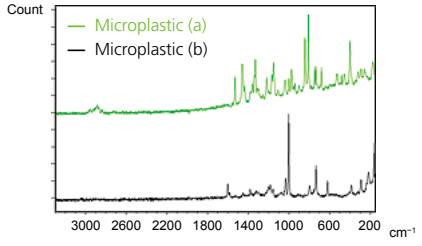


Fig. 4 The Raman spectra of the microplastics on the PTFE filter

Fourier Transform Infrared Spectrophotometer Plastics Analysis System

Plastic Analyzer

Plastic Analyzer consists of the following.

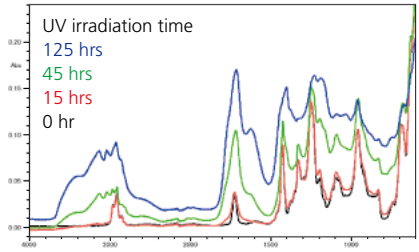
- Fourier transform infrared spectrophotometer
- Single-reflection ATR attachment
- Plastic Analyzer method package
  1. UV-Damaged Plastics Library **2**. Thermal-Damaged Plastics Library
  3. Macro Program for IR Pilot™/Parameter File

The Plastic Analyzer method package includes infrared spectral libraries for plastics degraded by UV rays and heat. Utilizing searches of these libraries demonstrates its effectiveness in the analysis of unknown samples that are difficult to identify with standard libraries. Examples include plastics degraded by exposure to UV rays as well as contaminants and defective items altered by heating.

UV-Damaged Plastics Library

This proprietary library includes more than 300 infrared spectra from the UV degradation of 14 types of plastic. It includes the infrared spectra for plastics degraded by UV rays for the equivalent of approximately 10 years using a super accelerated weathering chamber from Iwasaki Electric Co., Ltd.

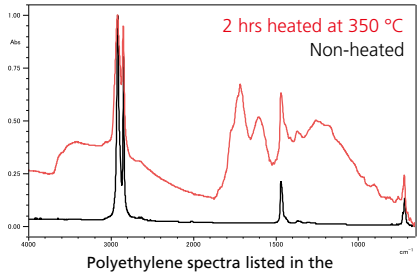
* The UV exposure time is just a reference. It does not indicate that the samples were placed under the same conditions.



Hard PVC spectra listed in the
UV-Damaged Plastics Library

Thermal-Damaged Plastics Library

This proprietary library includes more than 100 infrared spectra from the degradation of 13 types of plastic heated to between 200 and 400 °C. It includes infrared spectra for plastics degraded by heating, acquired through measurements at the Hamamatsu Technical Support Center at the Industrial Research Institute of Shizuoka Prefecture.



Polyethylene spectra listed in the
Thermal-Damaged Plastics Library

Microplastic Analysis for Microscopic Sizes

For microplastics ranging in size from a few µm to several hundred µm, their plastic compounds and additive compounds can be determined using an infrared microscope, which can qualify organic compounds and some inorganic compounds, or using an infrared/Raman microscope, which can qualify both organic and inorganic compounds.

Infrared Microscope AIMsight™

Fourier Transform Infrared Spectrophotometer IRXross™ (Left)
Infrared Microscope AIMsight™ (Right)

Infrared/Raman Microscope AIRsight™

Fourier Transform Infrared Spectrophotometer IRXross™ (Left)
Infrared/Raman Microscope AIRsight™ (Right)

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