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Application News

Microplastic Automatic Preparation Device MAP-100
IRSpirit™/IRXross™ Fourier Transform Infrared Spectrophotometers

Analysis of Microplastics in Environmental Water Using Microplastic Automatic Preparation Device MAP-100 and FTIR

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User Benefits

- Automation of the sample preparation process reduces manual work by the analyst and enables sample preparation with high repeatability and reduction of working time.
- Contaminants can be removed safely because handling of reagents is simplified.
- Accurate qualitive analysis of microplastics in environmental water is possible by utilizing the Shimadzu UV-Damaged Plastics Library.

■ Introduction

Microplastic pollution of rivers and oceans is spreading globally, and the impact on ecosystems is a serious concern. Therefore, active monitoring surveys and research have been carried out in recent years to obtain scientific knowledge concerning the distribution of microplastics in many of the world's countries. The microplastic investigation process includes sampling and preparation of samples, measurement of the size and particle count of the pretreated samples, and material analysis to determine the type of plastic. However, appropriate preparation to remove environmental contaminants contained in the sampled specimens is important for accurate measurement and analysis.

This article introduces an example in which sample preparation of microplastics in environmental surface water was carried out using a microplastic automatic preparation device MAP-100, and a material analysis was conducted with a Fourier transform infrared spectrophotometer (FTIR).

■ MAP-100

This section presents a simple introduction of the MAP-100. Fig. 1 shows photographs of the external appearance and interior of the device.

Fig. 1 (Left) External Appearance and (Right) Interior of MAP-100

The sample is introduced into the reaction vessel (Fig. 1) in the MAP-100, and the conditions of the sample preparation process are set by the control software. After this point, the series of sample preparation processes can be carried out automatically by pushing the start button on the front of the device to start preparation. It is also possible to confirm the progress of each process and the estimated preparation finish time in real time by the control software. When preparation is completed, the microplastics, with environmental contaminants removed, are trapped on the sample collection filter. The size of microplastics that can be extracted by preparation by the MAP-100 is from 0.3 mm to 5 mm (long diameter). However, due to the possibility of clogging the piping, samples taken from sites that contain a large amount of sand or mud, such as riverbeds, the sea bottom, and beaches, are not covered by preparation with this device.

■ Sample Preparation Process

The sample preparation process for specimens that contain microplastics consists of the following four processes: ① Screening (sieving) of the sampled specimen material, ② Digestion of contaminants (organic matter) by 30 % hydrogen peroxide water, ③ Removal of inorganic contaminants with large specific gravities, such as stones, by separation using a 5.3 mol/L aqueous solution of sodium iodide, and ④ Filtration of the microplastics. In particular, processes ② to ④ place a heavy load on the analyst, as this work is complex and time-consuming. Moreover, if this work is done manually, this may cause differences in the results obtained by different analysts or analysis organizations, and handling of hydrogen peroxide water can harm analysts because this chemical is a corrosive reagent. By automating the processes shown in Fig. 2, the MAP-100 achieves labor-saving, enhanced repeatability, and improved safety in the analysis work.

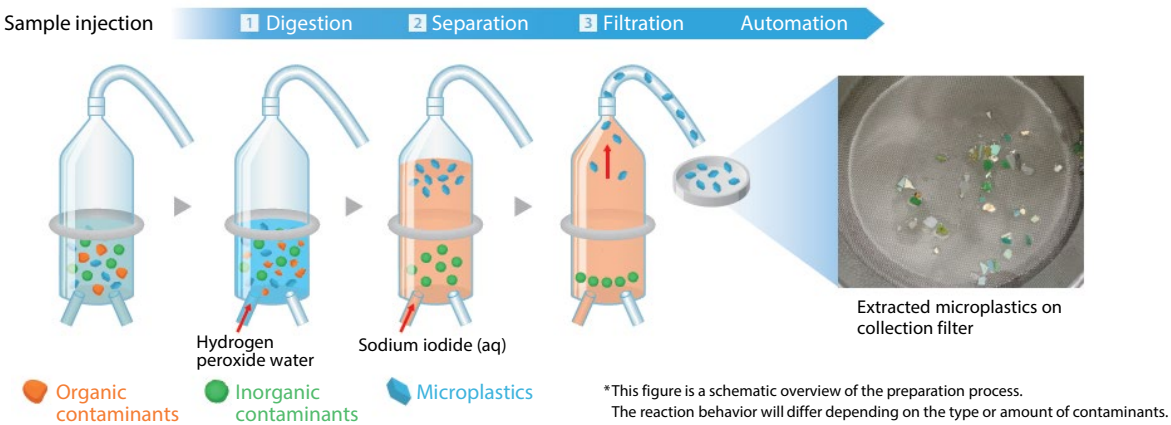

Fig. 2 Automated Sample Preparation Process

■ Preparation of Microplastics Collected from Environmental Surface Water

Samples collected from a river in Okinawa Prefecture were pretreated using the MAP-100. Based on Ministry of the Environment guidelines, in this experiment, digestion was conducted for 3 days, followed by separation for 3 hours. Fig. 3a-3c show the condition of the sample before preparation, during digestion (1 day after the start of treatment), and after preparation. From Fig. 3c, it can be understood that environmental contaminants could be removed cleanly by preparation with the MAP-100.

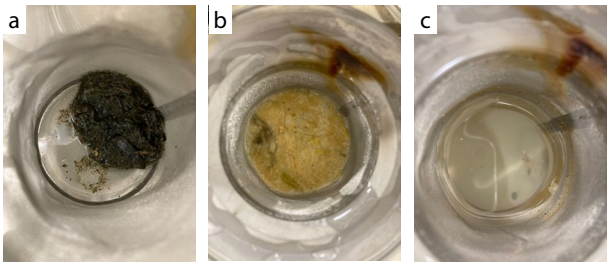

Fig. 3 Condition of Sample Before/After Preparation and during Digestion
a: Before Treatment,
b: During Digestion (1 Day After Start of Treatment),
c: After Treatment

■ Qualitative Analysis by FTIR

A material analysis of the microplastics obtained by preparation using the MAP-100 was carried out using the Fourier transform infrared spectrophotometer (FTIR). In this experiment, we used a plastic analysis system, Plastic Analyzer, which is effective in analyses of degraded microplastics. This system comprises the FTIR itself, a single-reflection ATR (attenuated total reflectance) accessory, and Shimadzu Corporation proprietary method package, which includes UV-Damaged and Thermal-Damaged Plastics Library. For details, please refer to Application News No. A647. Table 1 shows the measurement conditions, Fig. 4 shows the appearance of two measured microplastics, and Fig. 5 and Fig. 6 show the measurement results of the obtained infrared spectra and the search results using the UV-Damaged Plastic Library, which is an original Shimadzu database.

Table 1 Measurement Conditions

Instruments	: IRSpirit™-T, QATR™-S (Diamond)
Resolution	: 4 cm^{-1}
Accumulation time	: 20
Apodization function	: SqrTriangle
Detector	: TGS

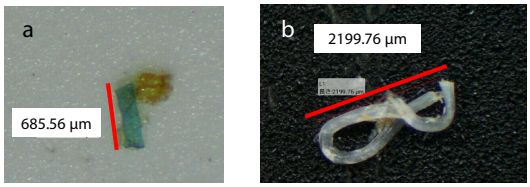

Fig. 4 Appearance of Microplastics (a) and (b)

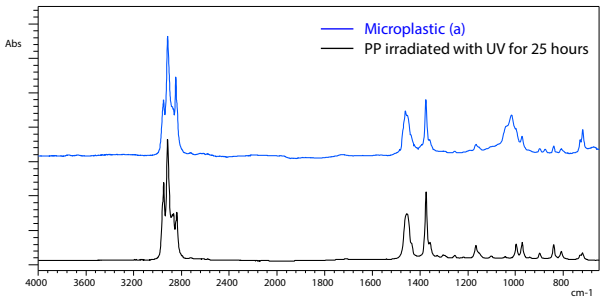

Fig. 5 Infrared Spectrum and Search Results for Microplastic (a)

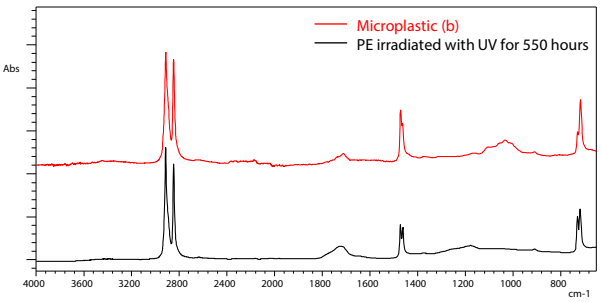

Fig. 6 Infrared Spectrum and Search Results for Microplastic (b)

From Fig. 5, a hit for polypropylene (PP) irradiated with UV for 25 hours was obtained for microplastic (a), and from Fig. 6, a hit for polyethylene (PE) irradiated with UV for 550 hours was obtained for microplastic (b). The respective hit rates showed extremely high scores of 876 points for (a) and 904 points for (b). It is thought that these excellent scores were obtained because the infrared spectra of the simple plastic could be acquired by removing environmental contaminants with the Microplastic Automatic Preparation Device MAP-100.

■ Conclusion

Using microplastics collected from a river in Okinawa Prefecture, sample preparation was conducted with Microplastic Automatic Preparation Device MAP-100, and a material analysis was carried out with an FTIR. Since environmental contaminants were removed and a highly-accurate material analysis could be carried out, the MAP-100 is considered to be an effective tool for preparation of microplastics in environmental surface water.

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