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Application News

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

Automatic Preparation and Analysis of Microplastics in Soil

Kazuki Sobue and Yoshio Ikezawa

User Benefits

- When soil is pretreated by sieving, the MAP-100 microplastic automatic preparation device can be used to collect microplastics from the soil.
- The automatic preparation device can pretreat samples containing microplastics while also offering labor savings, improved reproducibility, and greater safety.

■ Introduction

Microplastics (MPs) are widely recognized as a marine environmental problem, but many reports have indicated that they are also commonly found on road shoulder and in soil and other places.[1)] If they become attached to algae, they can also sink to the seafloor.[2)]

The MAP-100 microplastic automatic preparation device (Fig. 1) can automatically pretreat environmental surface waters while complying with the guidelines of the Ministry of the Environment.[3),4)] While the MAP-100 is designed for treating environmental surface water samples (with MP sizes from 300 µm to 1 mm), it can also be used to pretreat soil. Clearly, pretreated soil is not the same as environmental surface water, and there is a risk it may damage the tubing, switching valves, and other items in the device.

This article describes pretreating soil from rice and vegetable fields with the MAP-100 and then analyzing the samples with a Fourier transform infrared spectrophotometer (Fig. 1).

Fig. 1 MAP-100 (Left) and IRSpirit™-TX (Right) Systems

■ Pretreatment of Soil

Four soil samples were acquired from a rice field and two from a vegetable field (Fig. 2). The soil samples were left to dry naturally for 1 day (left photo in Fig. 3) and then filtered through sieves. (The mesh sizes are 1.4 mm, 500 µm, and 150 µm and are shown in the center photo of Fig. 3). Then the soil samples were placed in the strainer inside the MAP-100 reaction vessel (right photo in Fig. 3). The sample quantity was adjusted to a height of roughly 3 cm or less from the bottom of the strainer (about 20 g), and then the MAP-100 injected various liquids from outside the strainer. To avoid clogging the strainer mesh and reduce tubing material degradation, the samples must be passed through a sieve.

Fig. 2 Soil Sample Acquisition Sites (Left: Rice Field; Right: Vegetable Field)

Fig. 3 Pretreating Soil Samples
Left: Natural Drying; Center: After Sieving; Right: Loaded into Strainer

■ Automatic Preparation of Soil

After sieving the soil samples with the 150 and 500 µm sieves, the soil was divided into 12 samples and then pretreated. The pretreatment conditions were the same as those used to pretreat environmental surface water (Table 1). Ten 1 to 1.2 mm diameter spherical polyethylene (PE) beads (with standard MPs) were added to the samples, and the rate of recovery of the beads was checked (Fig. 4).

Table 1 Pretreatment Conditions

Instrument	MAP-100
Digestion Treatment*1	
Digestion Time:	3 days
Stirring Speed:	200 rpm
Temperature:	60 °C*3
Gravity Separation*2	
Standing Time:	3 hours
Stirring Speed:	500 rpm
Overflow	
Number of Overflows:	3

*1 Oxidative decomposition of organic matter by 30 % hydrogen peroxide.
*2 Specific gravity separation using a 5.3 mol/L sodium iodide aqueous solution.
*3 Set the solution temperature to approximately 55 °C. Adjust the set temperature according to the ambient temperature.

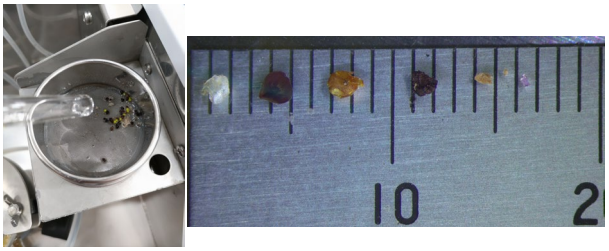

Fig. 4 Example of MP Recovery Process (Left) and Examples of Candidate MP Substances (Right)

Candidate MP substances with diameters ranging from about 300 µm to 1 mm were recovered (Fig. 4). This demonstrates that a similar automatic preparation process can be used for soil as for environmental surface water. The average recovery rate of standard MP substances from soil samples that remained in the 500 µm sieve was 90 %, and it was 70 % from the soil samples that remained in the 150 µm sieve. Fig. 5 shows the inside of the strainer after preparation. The recovery rate from the 150 µm soil samples was presumably lower due to the MPs being covered by soil and mud clusters that remained after oxidation treatment, which may have prevented adequate gravity separation. Therefore, these effects must be carefully considered before automatically pretreating soil samples.

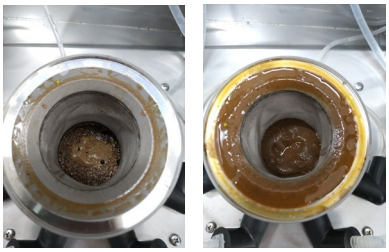

Fig. 5 After Pretreating Soil Samples
Left: Sample in 500 µm Sieve; Right: Sample in 150 µm Sieve

■ FTIR Analysis of Candidate MP Substances

Candidate MP substances recovered with the MAP-100 (right photo in Fig. 4) were measured using a Fourier transform infrared spectrophotometer (FTIR) with a single reflection ATR measurement attachment based on the pretreatment condition settings indicated in Table 2. An example of the measurement results is shown in Fig. 6, and the library search results are shown in Figs. 7 and 8.

Table 2 Measurement Parameters

Instrument:	IRSpirit-TX, QATR™-S (Diamond)
Resolution:	4 cm^{-1}
Number of Scans:	20
Apodization Function:	SqrTriangle
Detector:	TGS

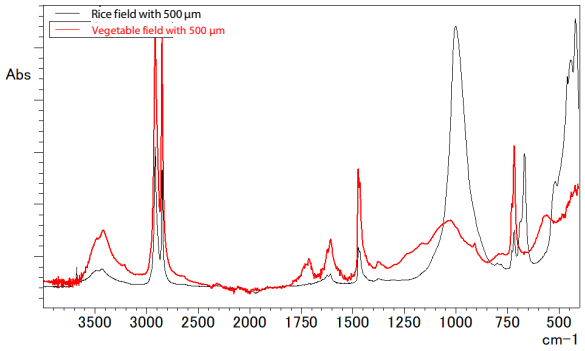

Fig. 6 Example of Infrared Spectra of PE in Candidate MPs

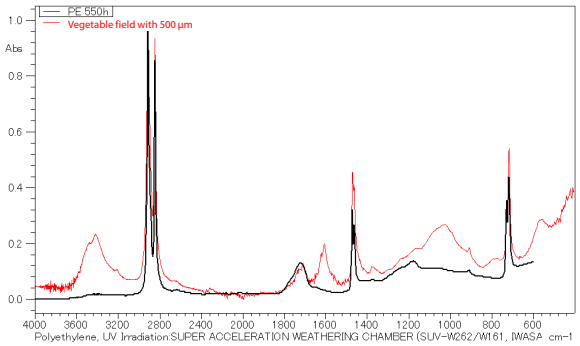

Fig. 7 Example 1 of Infrared Spectral Search Results

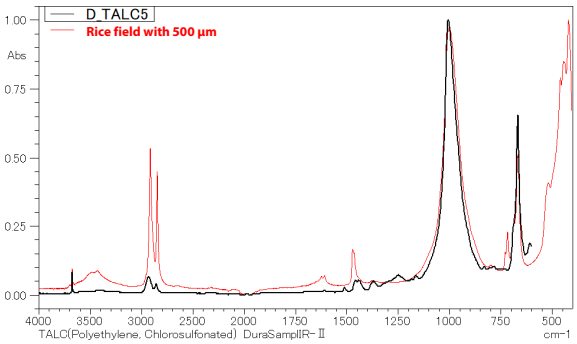

Fig. 8 Example 2 of Infrared Spectral Search Results

The results confirmed that candidate MP substances from both the rice fields and the vegetable fields contained PE. Also, there were signals that talc was detected in some samples. This is probably because equipment and supplies (agricultural plastic films) used in fields, etc. contain talc as an additive in addition to PE (Fig. 9). LabSolutions™ IR software allows measured spectral data to be added to libraries, so the accuracy of qualitative analysis can be improved as data about sample candidate substances is added.

However, PE was the only MP that was confirmed to be present, and fewer than 10 beads were found from the rice and vegetable fields (about 20 g of soil samples).

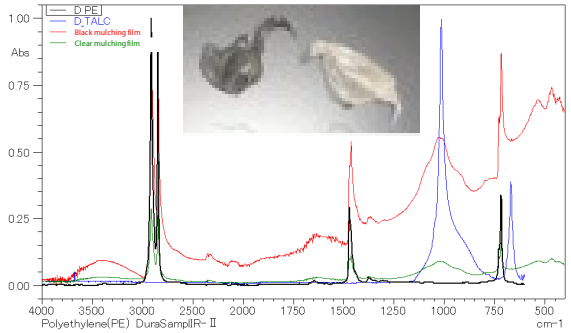

Fig. 9 Infrared Spectra of Materials (Agricultural Films) Used in the Vegetable Field

Substances other than MPs were also confirmed in candidate MP substances (Fig. 10). Checking the infrared spectra and comparing them to the library data, which is included as standard with IRSpirit™-TX systems, determined that the spectra were not from plastics. It also revealed that the materials consisted of organic matter (cellulose and lectin) that was not decomposed by the oxidation treatment, inorganic matter (SiO_2) that was not separated by gravity separation, and other such substances.

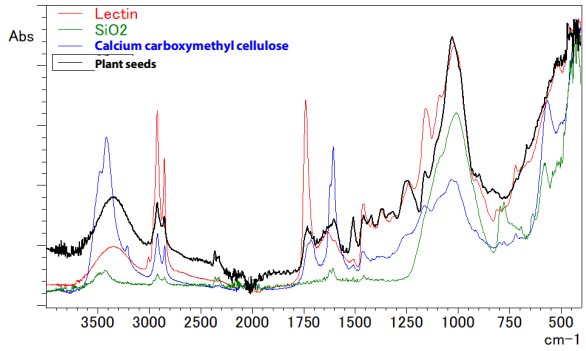

Fig. 10 Examples of Infrared Spectra from Non-MP Substances in Candidate MP Substances

■ Conclusion

This article demonstrates that the MAP-100 microplastic automatic preparation device can be used to pretreat soil samples from rice and vegetable fields after pretreating the soil in advance by sieving. FTIR data analysis of the candidate MP substances collected using the MAP-100 confirmed that the substances contained PE.

MPs have attracted attention as an environmental problem for marine, lake, and river water environments, but there are also many reports of MPs being present in soils and sediments. Shimadzu supports a wide range of research into MPs by offering a variety of solutions, from automatic preparation systems for recovering MPs from environmental samples to instruments for analyzing the composition of MPs.

References

1) Naoya Katsumi, Hiroshi Okochi (2021), Accumulation of microcapsules derived from coated fertilizer in paddy fields, Chemosphere, Volume 267 129185
2) Takahito Ikenoue (2023), Horizontal distribution of surface microplastic concentrations and water-column microplastic inventories in the Chukchi Sea, western Arctic Ocean, Science of The Total Environment, Volume 855, 159564
3) Ministry of the Environment, "2025 Environmental Technology Verification Program," March 2024
https://www.env.go.jp/policy/etv/pdf/list/r05/140-2305b.pdf,
(Refer to information from March 6, 2025.)
4) Ministry of the Environment, "River and Lake Microplastics Investigative Guidelines"
Water Environment Management Division, Environmental Management Bureau, Ministry of the Environment, March 2025
https://www.env.go.jp/content/900543325.pdf
(Refer to information from May 9, 2025.)

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