Microplastics Detection and Characterization using FTIR Microscopy

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Introduction

Microplastics are becoming increasingly prevalent pollutants, causing adverse effects to the marine ecosystem and other ecosystems that depend on it. Since they are minute pieces of not easily-degradable plastics, size ranging from few microns to several millimeters, they remain in the environment for a long time.

Dissection of a dead seabird (left). Some microplastics were found in the stomach (right)

Therefore, the hazardous impact of increasing amount of microplastics in the aquatic system calls for more scientific research to understand the impact and explore the solutions. The FTIR (Fourier-Transform Infrared) and FTIR microscopy techniques have shown that they are very powerful techniques to detect and characterize a variety of microplastics.

In this work, we describe the analysis of primary microplastics and secondary microplastics. Primary microplastics are generally plastics that are used as raw materials for industrial polishing and scrubbing agents, and are already 5.0 mm in size or less before entering the environment. On the other hand, secondary microplastics are microplastics that are created from the degradation of larger plastic products once they enter the environment through external processes such as ultraviolet rays and crush.

Instruments and Measurement Parameters

Microplastic detection, characterization and mapping were carried out using Shimadzu IRTracer-100 FTIR spectrophotometer with AIM-9000 FTIR automated microscope system and ATR (Attenuated Total Reflectance) accessory.

Shimadzu IRTracer-100 FTIR spectrophotometer (left) attached to AIM-9000 Infrared Microscope (right)

Instrument	Shimadzu IRTracer-100 and AIM-9000
Measurement mode	Transmission
Resolution	4.0 cm^{-1}
Number of scan	50 times
Aperture size	100 x 100 µm Or 50 x 50 µm

Measurement Parameters

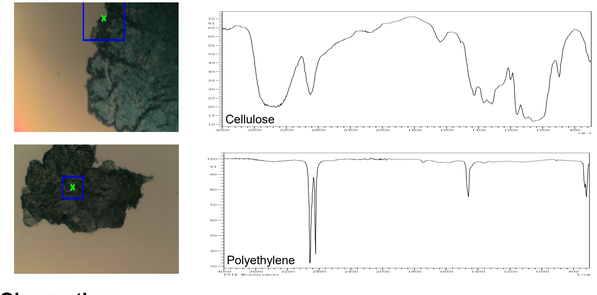
Analysis of Primary Microplastics

Sample :
Primary microplastics in facial washing milk (cleanser)

Pretreatment :
Microplastics dispersed in water was suction filtered using cellulose filter paper.

Measurement :
The micro plastic collected on the filter paper was moved to diamond cell to measure transmission. Area without plastics was set as background.

Microplastics on cellulose filter paper



Observation:
From transmission spectra of primary microplastics, we were able to see that the sample was a mixture of polyethylene (PE) and cellulose.

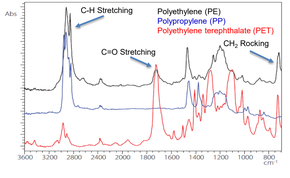
Since the material of the filter paper used for pretreatment is also cellulose, we further looked into it to check if the cellulose component was a result of the filter paper and not from the sample. After carrying out appropriate spectral subtractions, we determined that the obtained results was correct – the sample contained cellulose and PE components.

Analysis of Secondary Microplastics

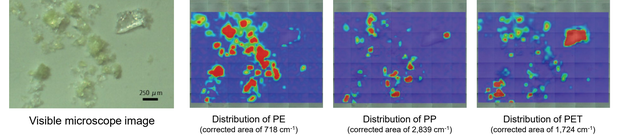
Sample :
Secondary microplastics in the natural water (ocean)

Pretreatment :
Microplastics dispersed in water was suction filtered using PTFE filter paper. PTFE filter has only infrared absorption in the vicinity of 1,200 cm^{-1}, which is a convenient filter to directly measure through a filter.

Measurement :
The micro plastic collected on the filter paper was directly measured by the transmission method. Area without plastics was set as BKG position.



Data obtained from the FTIR systems were matched with library database to identify and quantify microplastics



Visible microscope image | Distribution of PE (corrected area of 718 cm^{-1}) | Distribution of PP (corrected area of 2,839 cm^{-1}) | Distribution of PET (corrected area of 1,724 cm^{-1})

Conclusion

FTIR and FTIR Microscopy are very useful technique to detect, quantify and characterize microplastic samples. Using the Shimadzu IRTracer-100 FTIR Spectrophotometer and AIM-9000 FTIR Microscope system, we were able to successfully analyze microplastics from the real-world samples.

The ease of use and mapping features make the measurement process very easy to yield extremely accurate data.