

Investigation into efficient measuring method for microplastics with particle sizes of 300 μm or more in the wastewater treatment plant

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Takeaway

○ What did we do?

Investigated method of jointly using ATR and FT-IR microscopy methods in qualitative analysis for microplastics sized 300 μm or more.

○ What was achieved?

- Optimization of microplastics measurement
- Reduction in measurement errors

○ Message

The most efficient method to examine microplastics with particle sizes of 300 μm or more in wastewater.

FT-IR microscopy: the specular reflection method in FT-IR microscopy
ATR : Attenuated Total Reflection Method in FT-IR
(FT-IR: Fourier Transform Infrared Spectroscopy)

Contents

1 Microplastics

2 Background

3 Materials and Methods

4 Results

5 Conclusion

Microplastics

- **Microplastics (MPs)**

 - Less than 5 mm long

- **Impact on Ecosystem**

 - Many papers on MPs ingested by marine life.

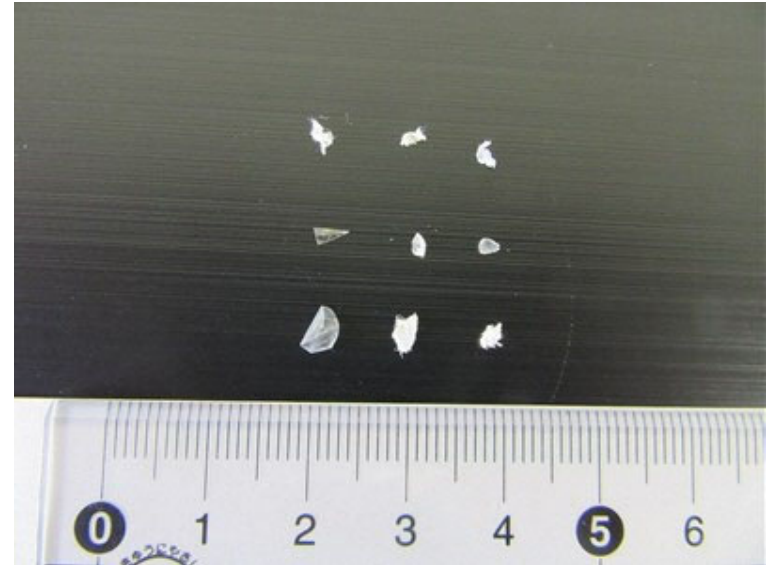


Figure 1 MPs found in wastewater

Microplastics: Authorized Methods

○ National guidelines

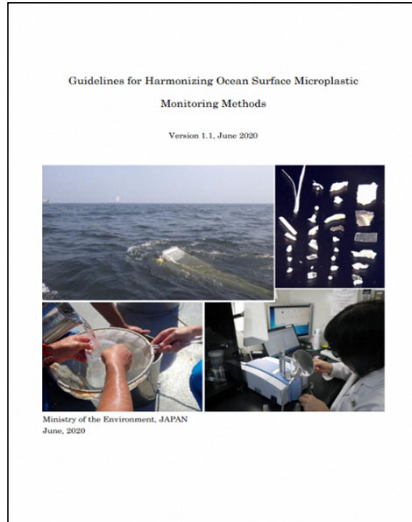


Figure 2 Guidelines for Harmonizing Ocean Surface Microplastic Monitoring Methods (MOE, GOJ, June 2020)

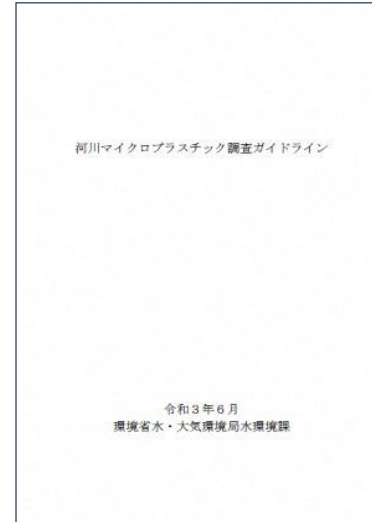


Figure 3 Guidelines for Examining Microplastics in Rivers (MOE, GOJ, 2021)

Guidelines for natural waters published, but no GLs for MPs in WTPs.

Background: Yokohama's Previous Work

Examining MPs in WTPs

○ 2019

- Particle size: 50 μm or more
- Method: FT-IR microscopy

○ 2020

- Particle size: 300 μm or more
- Method: ATR, MOE guidelines referred

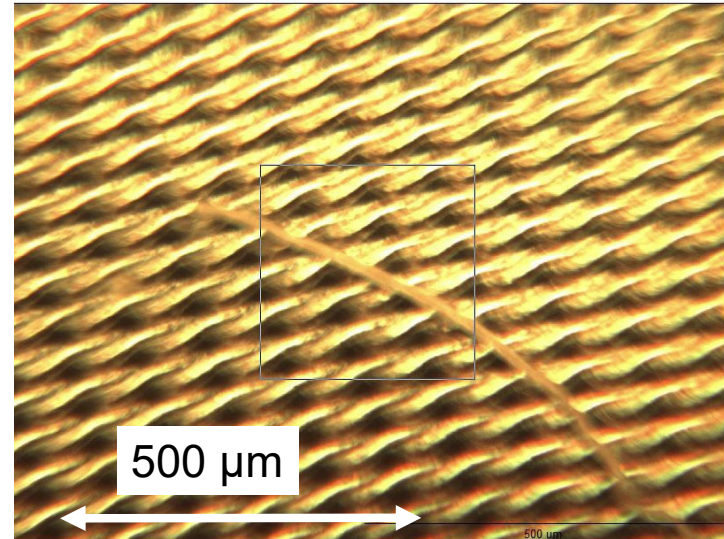
Background: Issues in the Planned Measuring Method

○ **Characteristic**

Wastewater with many fibrous MPs

○ **Issues**

- tweezing
- microscoping
- measurement errors

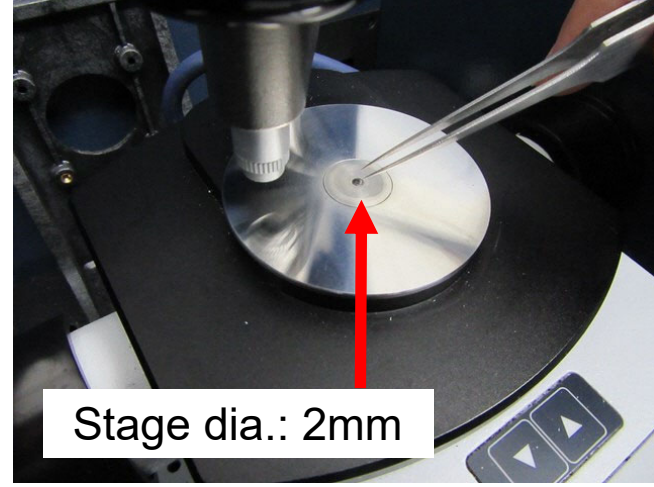
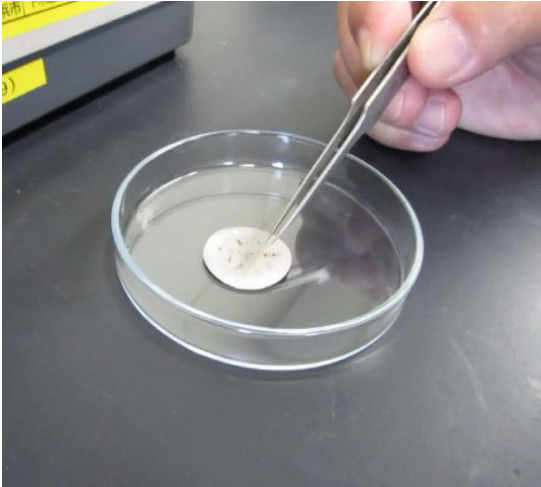


Picture 1 PET Fibers in Primary Effluent

Background: Picking Process

Stereoscopic microscope

Stage in FT-IR (ATR method)



Picture 2 Picking

ATR method needs picking for every particle

Our work: Summary

○ **Goal**

Optimizing MPs measurement and curbing errors.

○ **Content**

Investigated method of jointly using the ATR and the FT-IR microscopy methods in qualitative analysis for MPs.

In the FT-IR microscopy method, translocation is not needed.

○ **Samples**

Preliminary influent, primary influent, primary effluent, treated wastewater, primary sludge, gravity thickening sludge, primary scum

Materials and Methods: Measurement Methods Studied

Table 1 Summary of method in this study

		Method in this study
Sampling	Net Type	Nylon mesh with 300 μ m aperture
	Filtration Method	Collecting water with a metal bucket or a pump, then passing the water through a net
Pretreatment	Biological Digestion and Chemical Treatment	Oxidation with Hydrogen Peroxide and Bivalent iron
	Density separation	NaI

Materials and Methods: Measurement Methods Studied

Table 2 Summary of method in this study

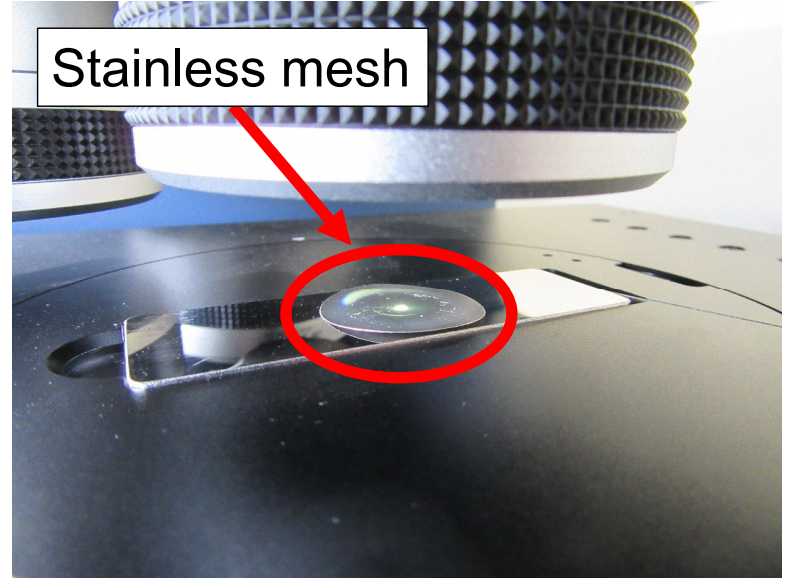
		Method in this study
Particle extraction	Filtration	Stainless mesh, 10 μ m
	Picking	Hand-picking with visual observation (only ATR)
Particle size and count measurement		ATR: Measuring with a stereoscopic microscope FT-IR microscopy: Measuring with image processing
Qualitative analysis		ATR and FT-IR microscopy

ATR: Solids with 1mm or more in length except fibrous objects
FT-IR microscopy: Solids with below 1mm and fibrous objects

Materials and Methods: FT-IR Microscope

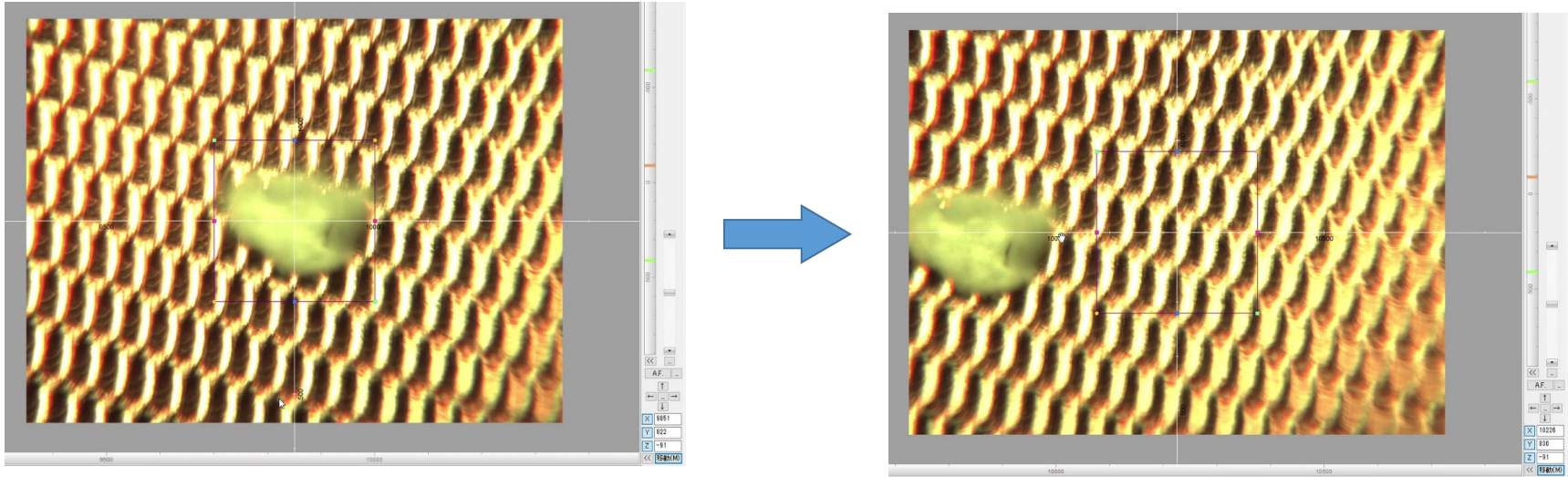


Picture 3 FT-IR microscope



Picture 4 FT-IR microscope stage

Materials and Methods: Analysis (by FT-IR Microscopy)



Picture 5 Qualitative analysis by FT-IR microscopy

Solids can be identified as MPs without tweezer work.

Results: Detected MPs

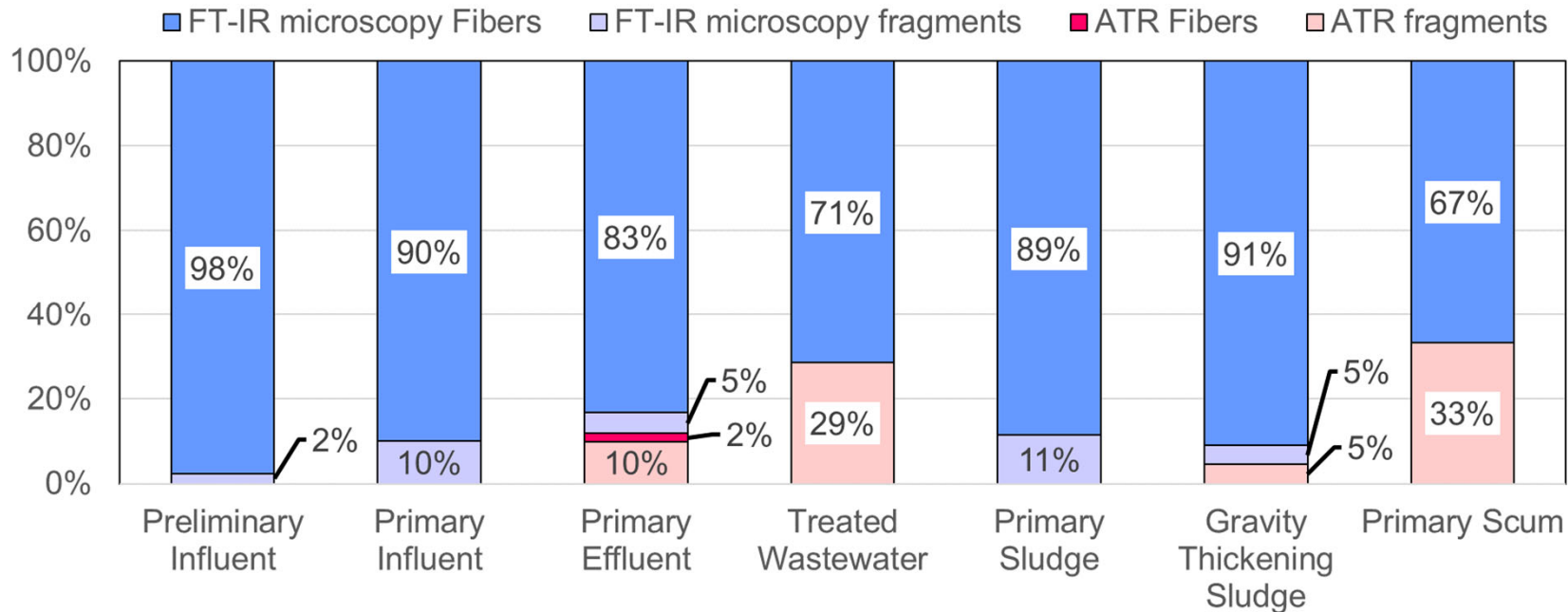


Figure 4 MPs shapes by the different methods

A majority of MPs were fibers detected by FT-IR microscopy.

Results: Suspected Microplastic Particles

Table 3 Number of suspected microplastic particles

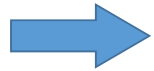
	Preliminary influent	Primary Influent	Primary Effluent	Treated Wastewater	Primary Sludge	Gravity Thickening Sludge	Primary Scum
ATR (particle size of 1 mm or more)	3	5	19	7	4	7	8
FT-IR microscopy (particles other than ATR)	319	133	327	76	384	317	57

※ The amount of sample varies for each sample.

A majority of particles are less than 1 mm and fibrous.

Results: Summary

- The majority of MPs were fibers detected by FT-IR microscopy.
- The majority of particles are less than 1 mm and fibrous.



There were many tiny particles hard to be picked.



- We eliminated the tweezing by using FT-IR microscopy.
- Our method reduces the cost of analysis and measurement errors.

Conclusion

Yokohama started working on plastic issues in 2019. Our team focused on MPs.



Using the national guideline to know the fate of MPs in a WTP



Difficulty in tweezing in the guideline



Investigating an alternative method by jointly using the ATR and the FT-IR microscopy



Reducing the cost of analysis and measurement errors by eliminating tweezing

Thank you for your attention.