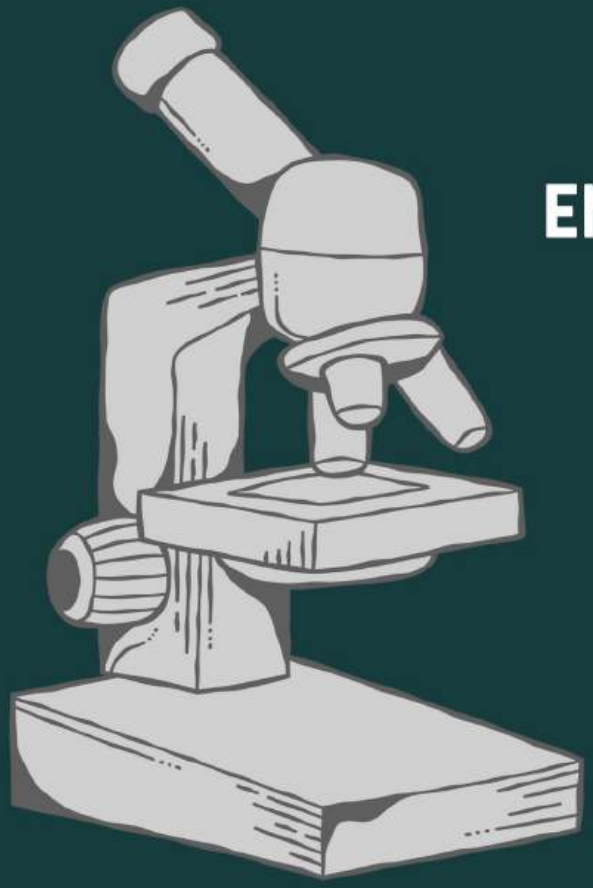

CREATING AN IN-HOUSE FTIR SPECTRAL LIBRARY FOR ENVIRONMENTAL MICROPLASTIC IDENTIFICATION

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Introduction

- Plastics are synthetic polymers that are mostly made from fossil fuels.

- Different constituent polymers produce different plastics with different applications
- Common plastics and their uses include:
    1. Polyethylene - bottles, disposable bags
    2. Polystyrene - Styrofoam cups
    3. Polyamide- textiles

What are microplastics?

- Plastic particles that range in size from 1 micrometer (μm) to 5 millimeters (mm)
- Their abundance raises serious environmental, human and ecosystem concerns
- It is critical to efficiently identify microplastics and track the sources to remediate the pollution.
- Fourier Transform Infrared Spectroscopy (FTIR) has been used as the major protocol for identification of microplastics.
- Commercial libraries are available but are limited in scope due to the complexity of the microplastics (degradation, size, shape etc.) in the environment.

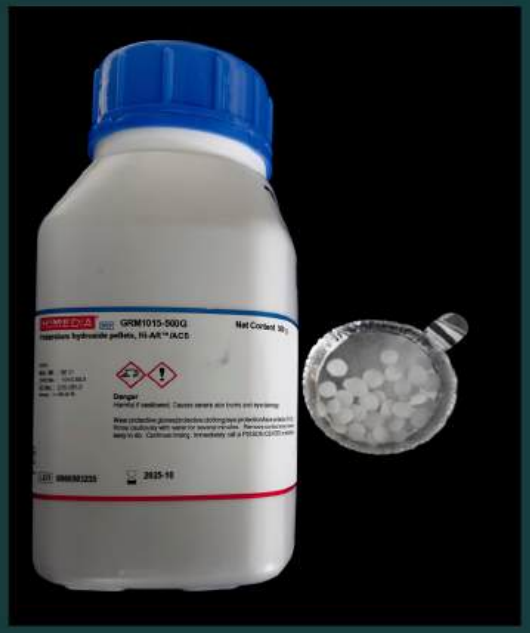
Research Objectives

- To create an in-house FTIR spectral library for environmental microplastic identification
  - ✓ To see if the digestion process in sample preparation affects the FTIR spectra and subsequent identification of the microplastics.
  - ✓ To see if the size and shape of the particle affect microplastic identification.
  - ✓ To compare the accuracy of the in-house library to the commercial library for environmental microplastic identification.

Research methods

- 22 different polymer types were sourced from the Centre for Marine Debris Research, Hawai'i Pacific University
- Most of the polymer pellets ranged in diameter from approximately 2.8–5.1 mm
- Cellulose acetate (CA), crumb rubber (CR), expanded polystyrene foam (EPS), and polyester (PEST) were supplied as powder, crumbs, foam beads, and squares of cut fabric, respectively

Sample preparation



Microplastic standard samples were prepared according to the procedure that we used for environmental microplastic identification

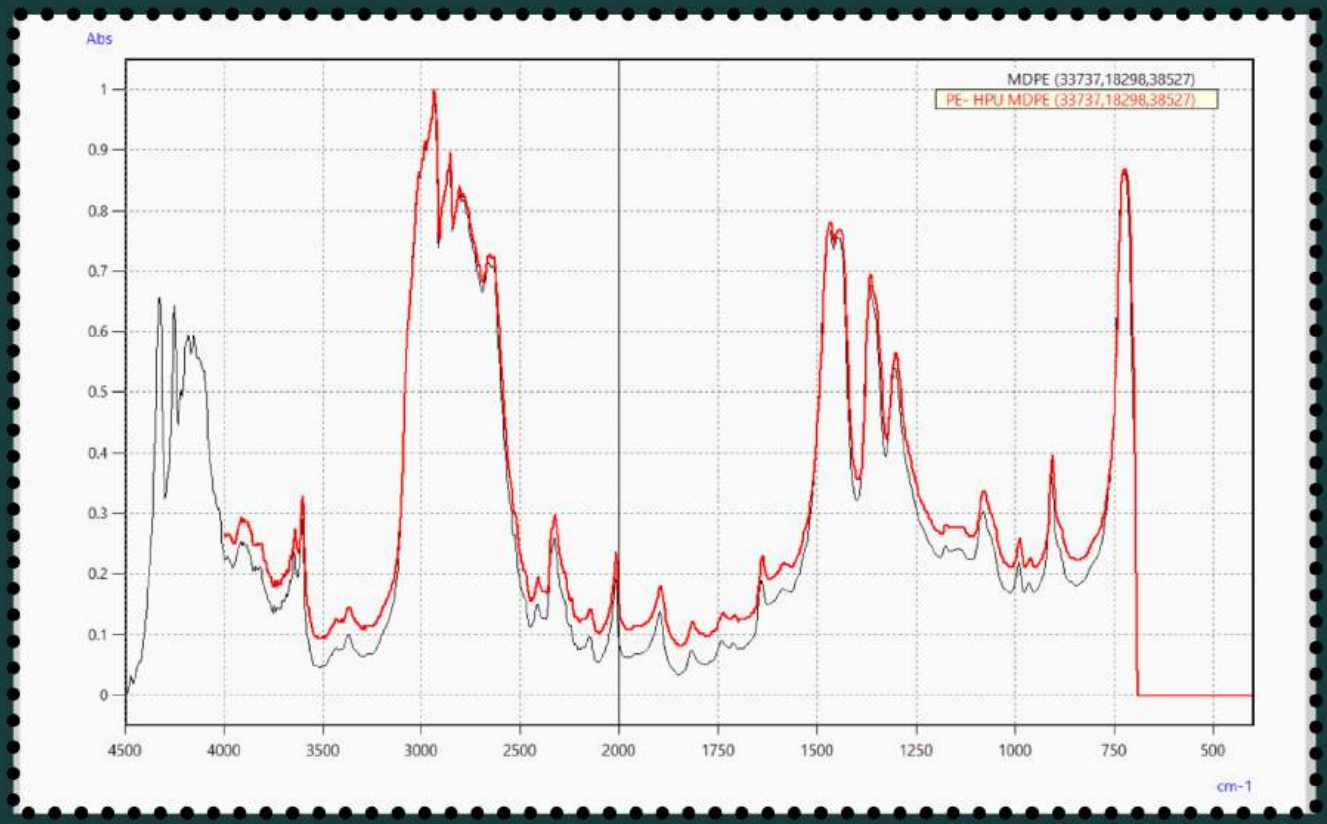
1. Standard samples were cut down to smaller fragments to mimic environmental microplastics
2. Standard samples were heated and elongated to make fibers and investigate the effect of shape on IR spectrum
3. Standard samples were digested with potassium hydroxide to determine the effect

FTIR measurement

- Spectra were taken and stored with Shimadzu AIM-9000
- Lab solution was used for spectral processing averaging 30 spectra collected by AIM 9000
- The in-house library was created using the 22 microplastics from the standard sample.

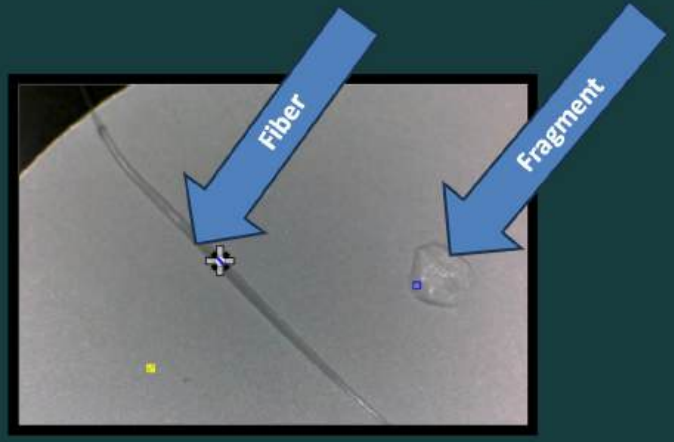
Effect of digestion

- FTIR spectrum overlays almost perfectly, suggesting that KOH digestion does not affect the FTIR spectrum significantly.
- Potassium hydroxide could be used in the standardization of sample preparation for identification

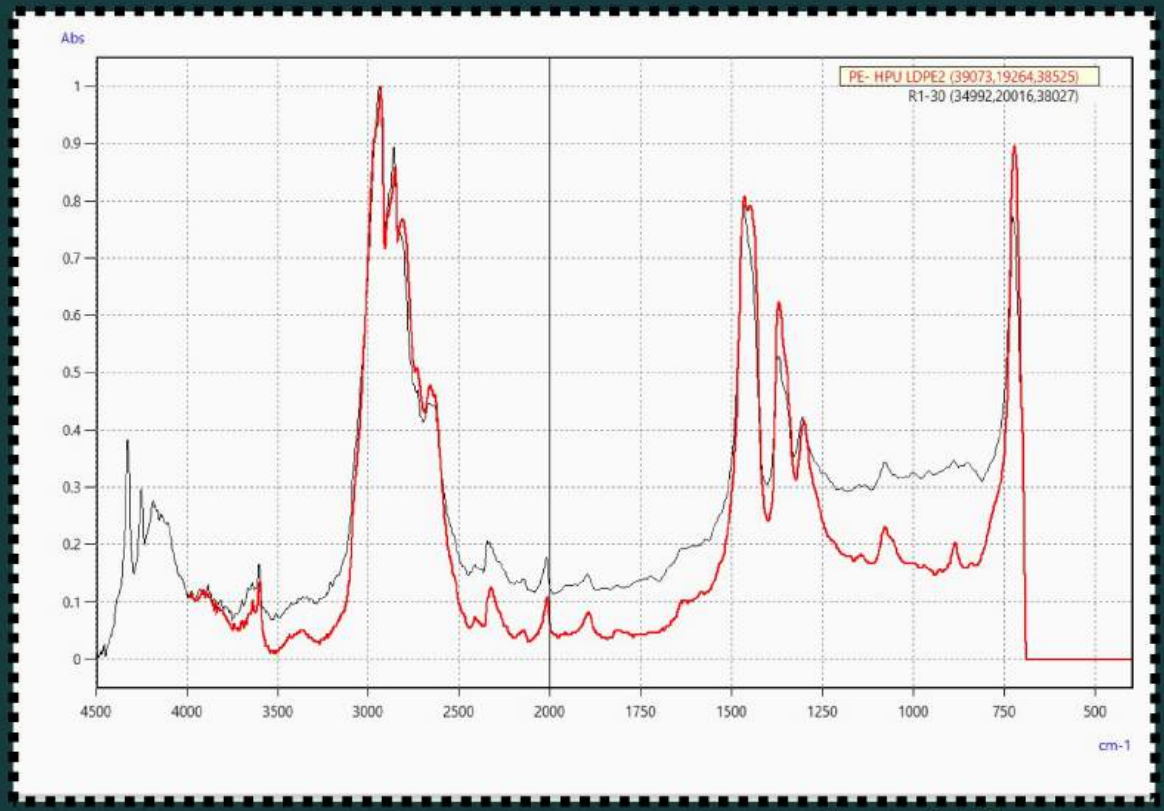


Key: Red- Undigested
Black - Digested

Effect of shape

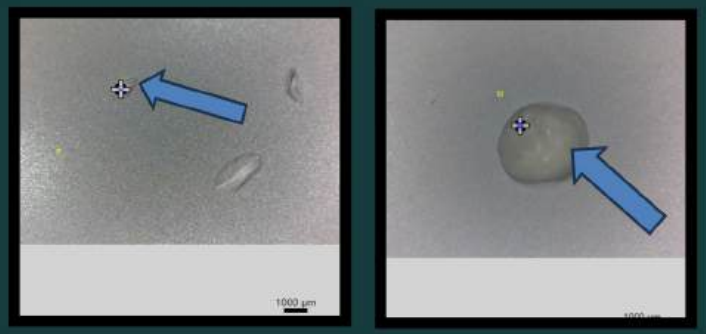


- FTIR spectrum of fragment vs fiber for the same microplastic revealed very similar patterns
- Observed difference could be attributed to variability in aperture size of FTIR during measurement.

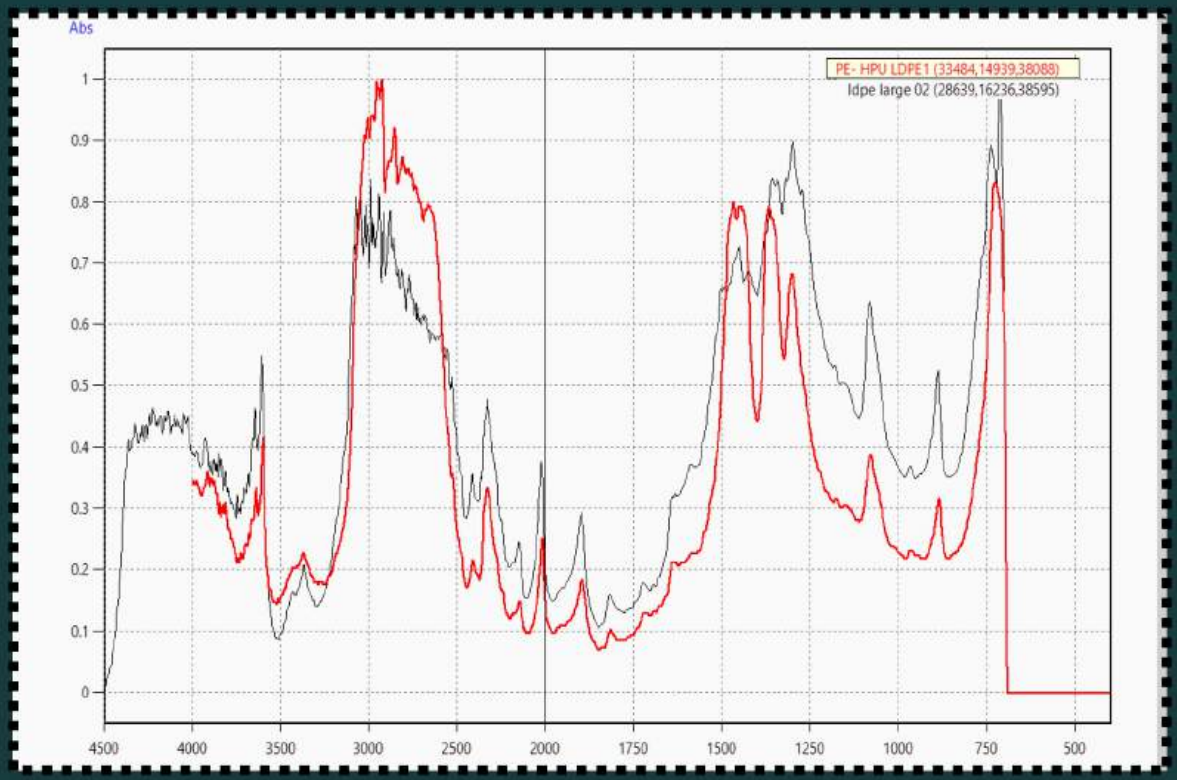


Key: Red- fragment
Black - fiber

Effect of size

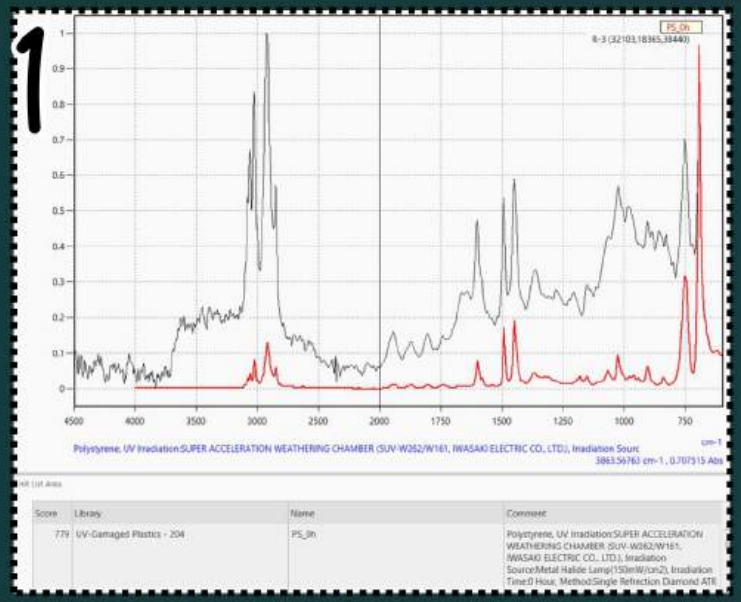


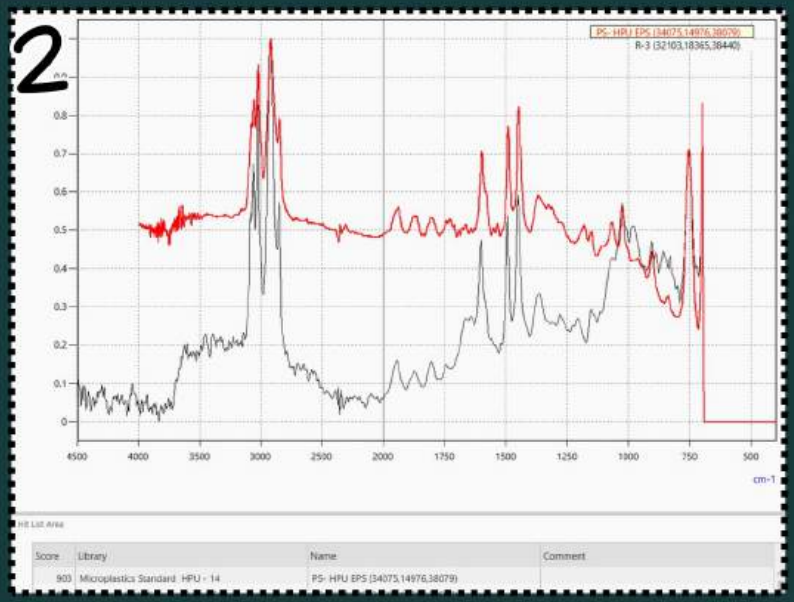
- Overlayed spectrum of fragment vs fiber for the same microplastic revealed similar peaks
- Observed difference in the level of noise which was again attributed to variability in size of aperture of FTIR
- Size of fragment is not likely to affect identification



Key: Red- small
Black - large

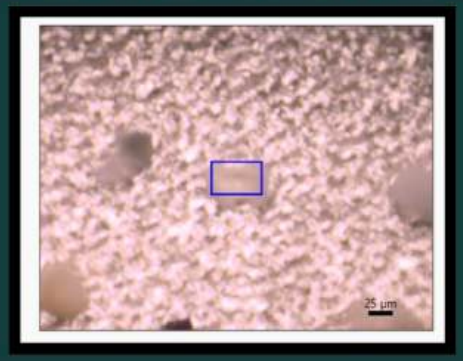
Commercial (1) vs in-house library (2) - Polystyrene

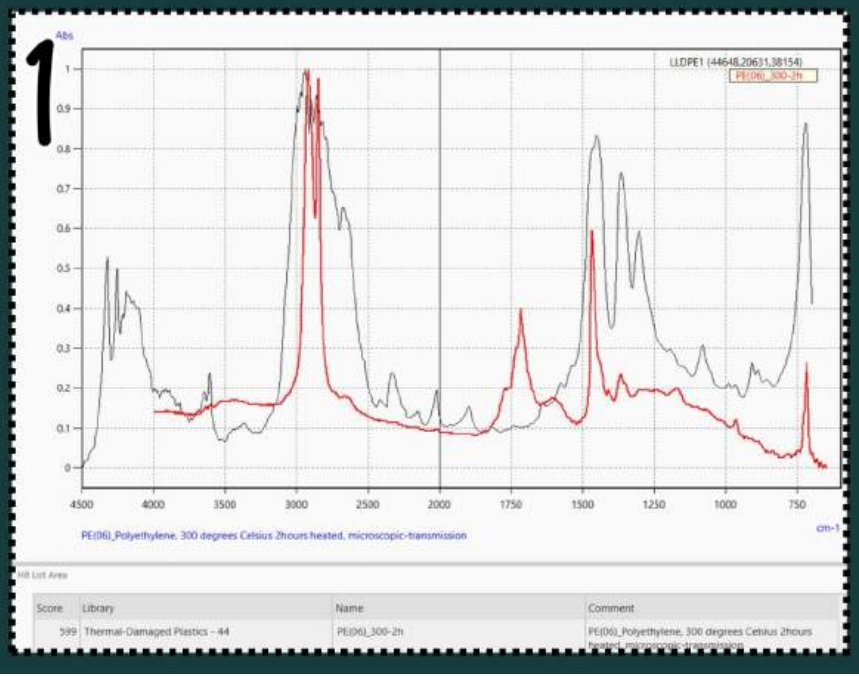


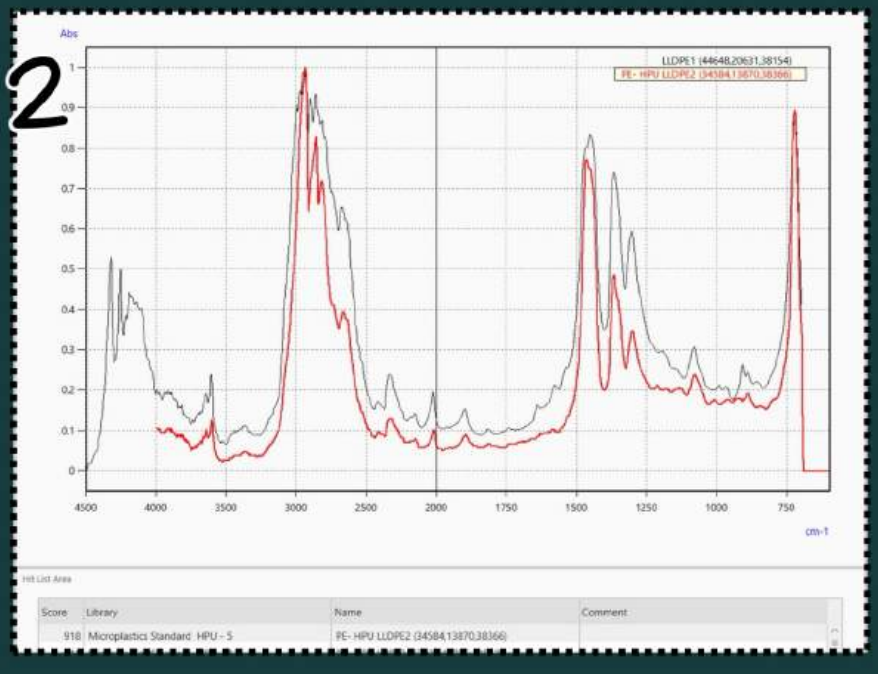


- More microplastics were identified by the in-house library in some previously recognized environmental samples
- Demonstrated ability to compete with and outperform commercial libraries

Commercial (1) vs in-house library (2) - Polyethylene







Conclusions

- Potassium hydroxide digestion does not alter the microplastic FTIR spectrum significantly and could be used for environmental sample preparation
- The size and shape of the fragments within the microplastic range does not significantly affect identification
- The in-house library outcompeted the commercial library in some samples, showing its applicability
- The in-house library presents an improvement on existing methods of microplastic identification

Acknowledgements

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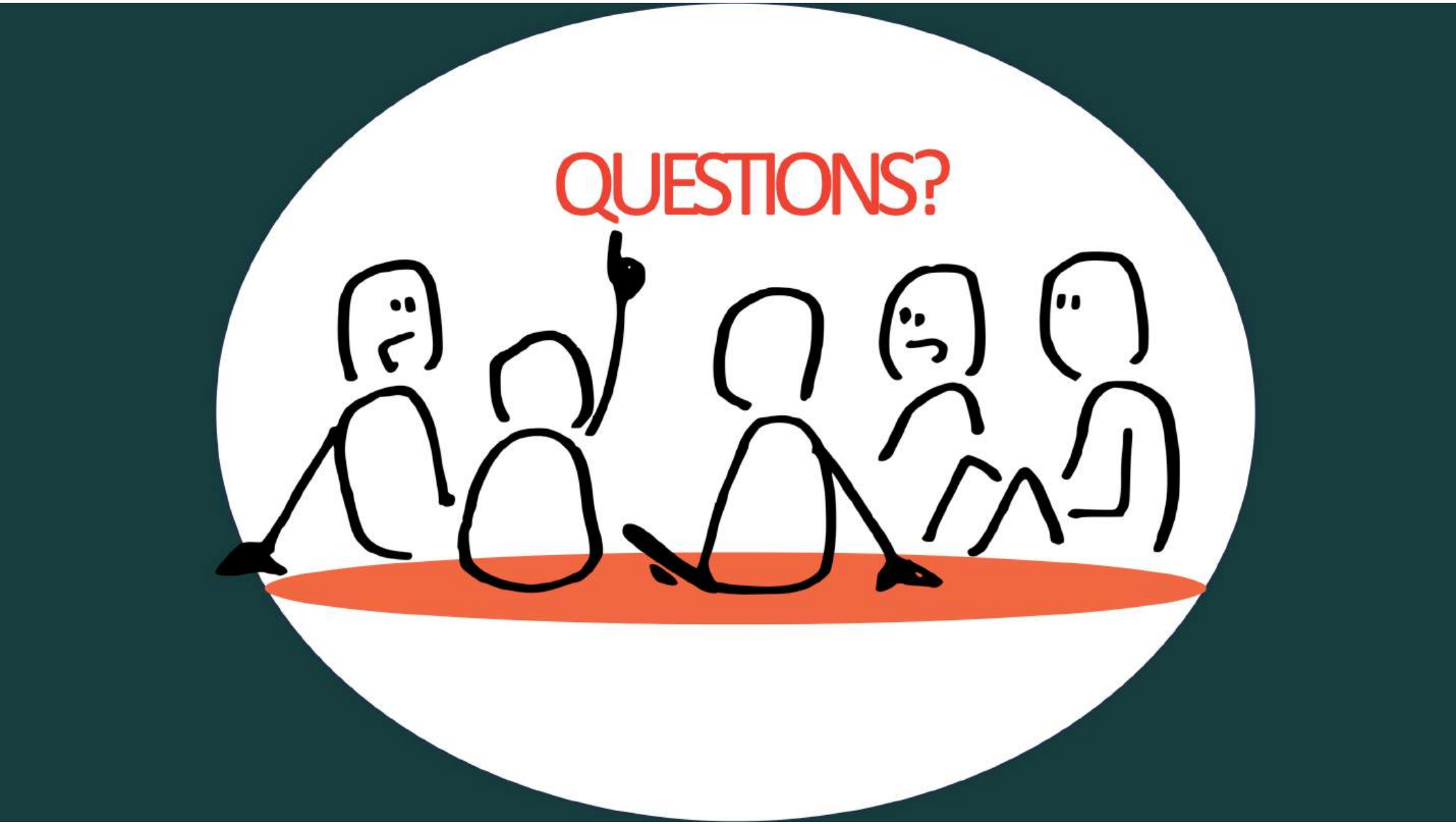
QUESTIONS?