Raman-Based Characterization of Aged and HTC-Transformed Microplastics from Sewage Sludge

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Abstract

Hydrothermal carbonization (HTC) at 200 °C for 2 h effectively reduced microplastics (MPs) in sewage sludge by ~75% through fragmentation, degradation, and partial carbonization. However, the transformed wastewater-aged MPs showed degraded Raman spectra, making polymer identification difficult.

Introduction

- Sewage sludge is an important source of environmental microplastics (MPs) *[1-2]*.
- Understanding MP behaviour is essential for assessing HTC environmental impacts.
- **Objective: to investigate changes in MPs' abundance and characteristics after HTC treatment.**

Methodology

- HTC process conditions: 200 °C, 2 h.
- MPs isolated by chemical digestion+density separation and observed under optical microscope.
- MPs characterised by ATR–FTIR and Raman microspectroscopy.
- Raman results compared with the weathered MP reference dataset *[3]*.

Results

Before HTC:

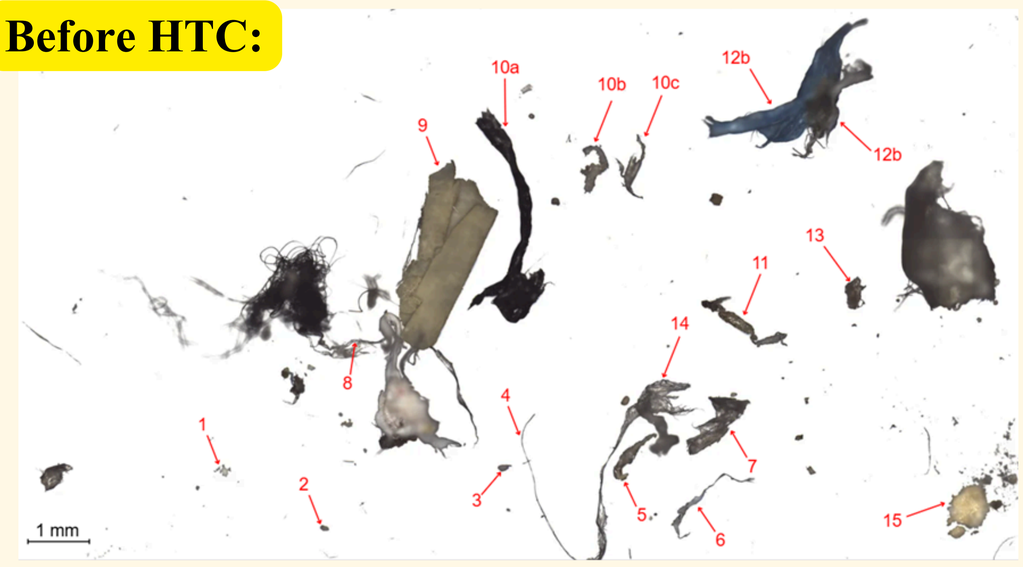

Fig. 1. Confocal image of sludge MPs.

After HTC:

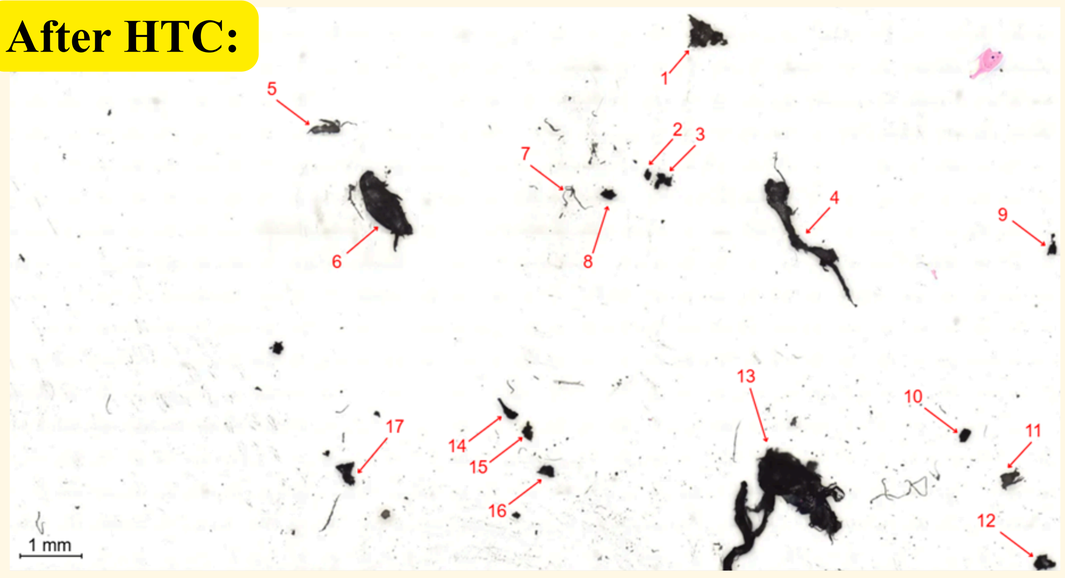

Fig. 2 Confocal image of hydrochar MPs.

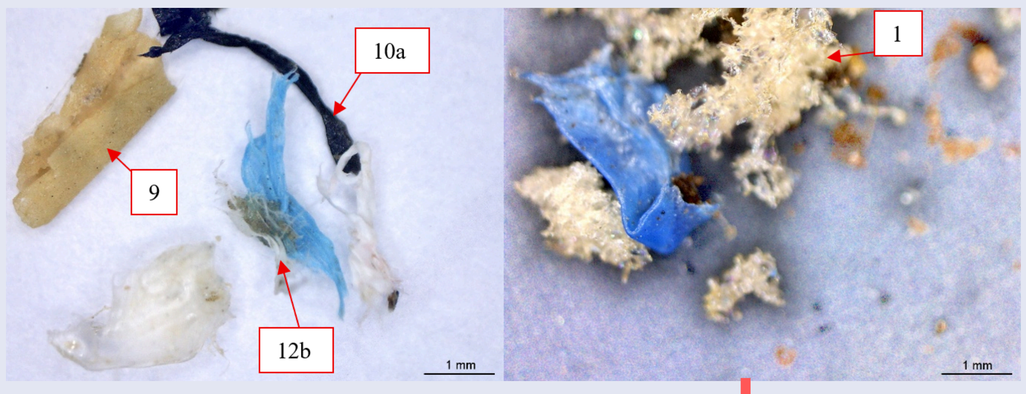

Fig. 4. Representative MPs observed in raw sewage sludge.

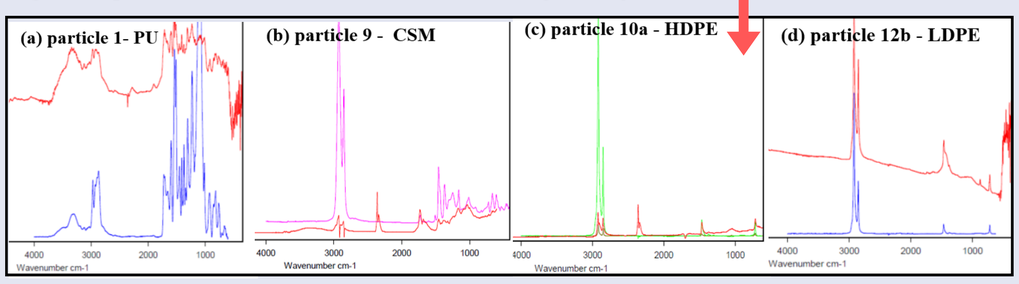

Fig. 5. Representative FTIR spectra of identified MPs vs reference polymers (Bruker libraries)

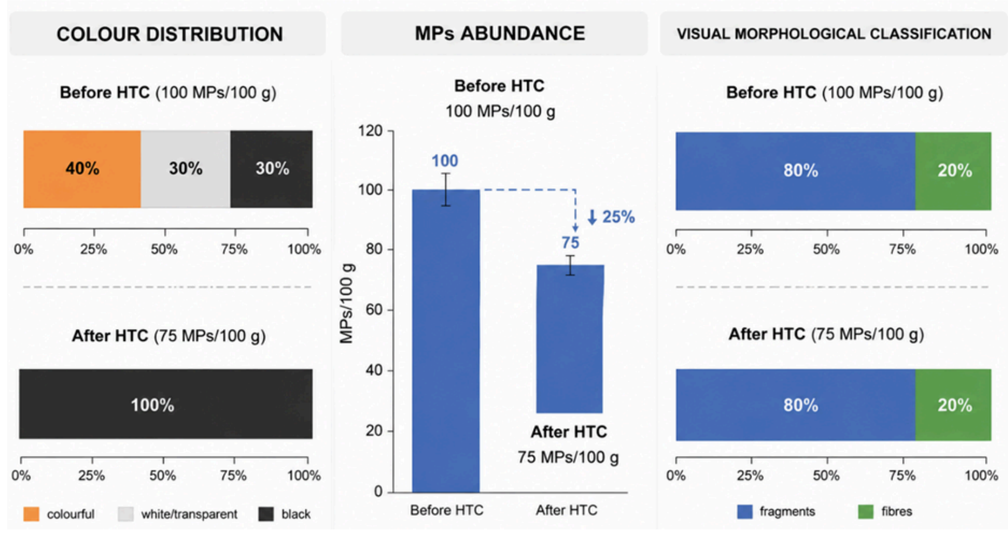

Fig. 3. Changes in MPs' abundance, colour, and shape distribution before and after HTC.

Tab.1 Identified MPs based on comparison with the weathered MPs dataset *[3]*.

Polymer assignment	Sludge MPs (%)	Hydrochar MPs (%)
PA-like	44.4	29.4
PP-like	22.2	5.9
PET-like	11.1	5.9
PVC-like	11.1	–
PS-like / carbonized	5.6	47.1
PC-like	–	5.9
Unidentified	5.6	5.9

Conclusions

PA-like particles dominated the sludge, and PS-like/carbonized spectra became dominant in hydrochar.

HTC caused:

- **reduction the MPs number in sludge by ~25%,**
- strong fragmentation, surface degradation, and partial carbonization of MPs,
- Raman-based MPs identification more difficult.

References:

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