Transformations of Microplastics in Biosolids Through HydroThermal Carbonization: A Morphological SEM Study

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The problem

Microplastics (MPs) in biosolids pose significant environmental and health risks due to:

- the presence in terrestrial and aquatic ecosystems
- the potential for bioaccumulation
- the ability to adsorb contaminants

A Promising Approach

HydroThermal Carbonization (HTC):

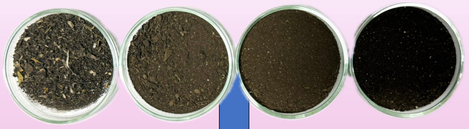
- converts biosolids into valuable products e.g. hydrochars
- operates in mild, supercritical conditions: T=180-350 ^{o}C, autogenous pressure <20 MPa
- effectively degrades MPs

Our proposal

Goal: reduction of the environmental risks of MPs in biosolids by HTC
Material: biosolids and hydrochars
Methods: HTC of biosolids (200, 210 and 220 ^{o}C, 2 h; Parr Instrument), Identification and imaging of MPs: scanning electron microscopy (SEM; Hitachi SU8600) and confocal Raman microscope (CRM; Witec Alpha 300)

Methods

SS HTC-200-2 HTC-210-2 HTC-220-2



Density separation (sat. $CaCl_2$, 3x)

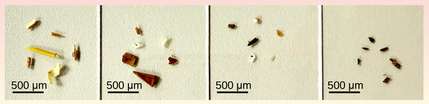
Sedimentation (48 h)

Vacuum filtration (GF-5 filters)

Oxidation (15% H_2O_2, 3x)

CRM and SEM analysis

SS 200-2 210-2 220-2



Sample selection:
Five MPs chosen by visual identification (light microscope, 50x), identified by CRM, observed under SEM

Results

Identification by CRM:

- in SS: 60% PET, 40% PS; laser power 8-10 mW
- in HTC: larger distribution, difficult to collect spectra due to degradation; laser power 1-2 mW.

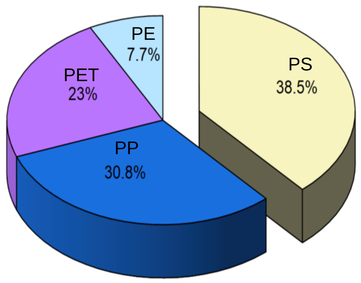
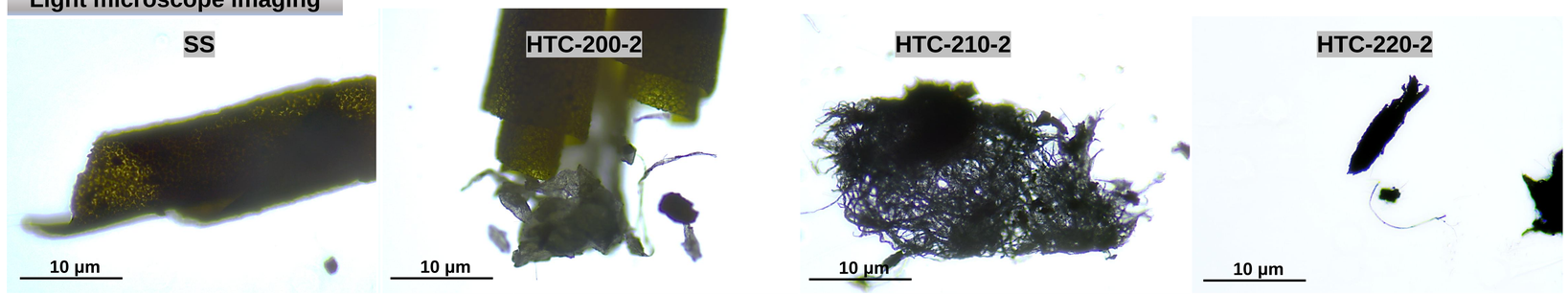


Figure 1. MPs types distribution in hydrochars

Light microscope imaging



SEM analysis

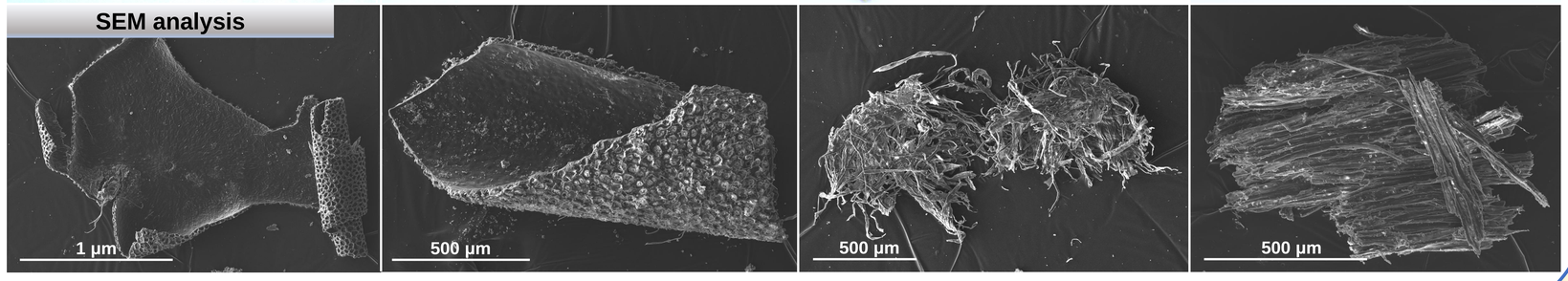


Figure 2. PS-MPs observed in SS and hydrochars

Conclusions

1. **HTC from 200 °C to 220 °C induces progressive morphological changes in microplastics, with increasing fragmentation and surface degradation.**
2. **SEM analysis shows structural transformations** such as rough, porous surfaces, indicating thermal and mechanical stress.
3. **Microplastics are not fully decomposed under set conditions**, but their altered morphology may affect detectability and environmental impact.
4. **Confocal Raman microscopy supported by SEM offers a powerful approach** to study microplastic transformations during biosolid HTC treatment.

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