Advancing the Bioeconomy: From Waste to Conversion-Ready Feedstocks

US Department of Energy Bioenergy Technologies Office

DoubleTree (Crystal City), Arlington, VA
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Feedstock Preparation for MSW Valorization

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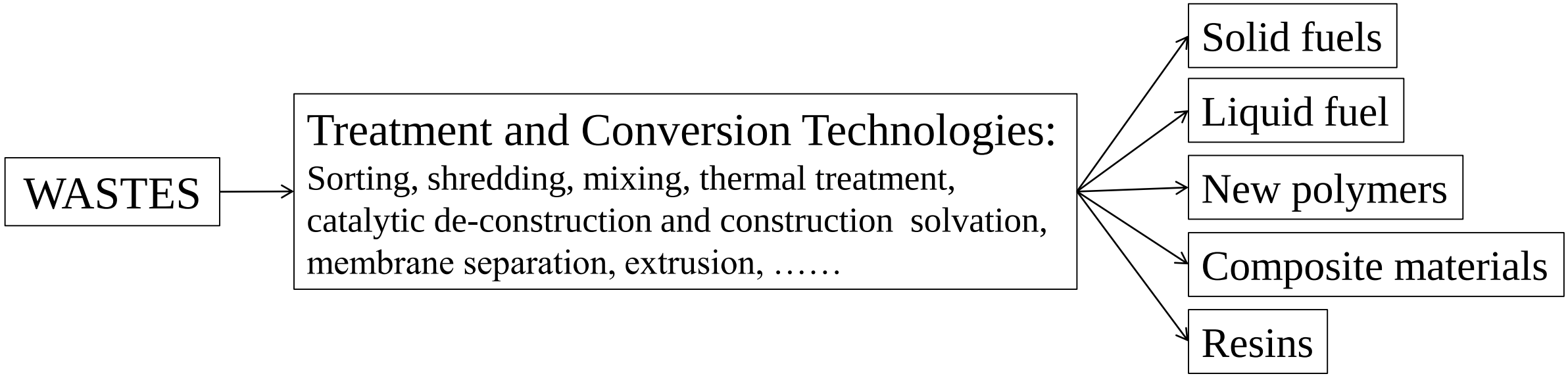
Glimpse over Potential Pathways for Waste Valorization



- There are many existing technologies* that are developed to the level that can treat/convert such materials
- ***Integration*** and ***modification*** of current technologies are probably required
- However, new concepts may be needed
- Emphasis should be placed on ***new products*** and the feedstock required

* The current presentation did not include biological treatment

What is MSW?

- MSW is loosely defined
- To enable a large spectrum of final products, we propose a wide definition of MSW, for example:

"***MSW is any waste that currently is not considered for recycling/reuse; for example: (i) household waste; (ii) yard trimming, (iii) industrial residues (plastic, fiber, sludge, textile, carpets, etc.), (iv) construction and demolition (wood and cardboard).***"

What is MSW?

Source: https://www.nytimes.com/2018/01/11/world/china-recyclables-ban.html
Credit: Ben Curtis/Associated Press

Matthew Cella Staff Writer, **U.S. News**, March 27, 2018

Waste Management: The Effects Of China's Recycling Import Ban Apr., 2018

Feedstock from MSW

According to the waste sources and material origin, MSW can be categorized to:

- ***Group 1***. *Household waste (**HHW**)*: a mishmash of materials that comprises 9-12% plastics, food, metal, glass, …
- ***Group 2***. *Plant based materials (**polysaccharides**)*: Yard trimming, wood waste, cotton, paper, cardboard, cartons, …
- ***Group 3***. *Fossil based polymers (polymers, industrial residues, textile)*: Majority (87%) is polyethylene (***PE***) and polypropylene (***PP***)

Common denominators: (1) high heterogeneities and inconsistencies;

(2) very difficult to flow

The above can be grouped in transfer stations

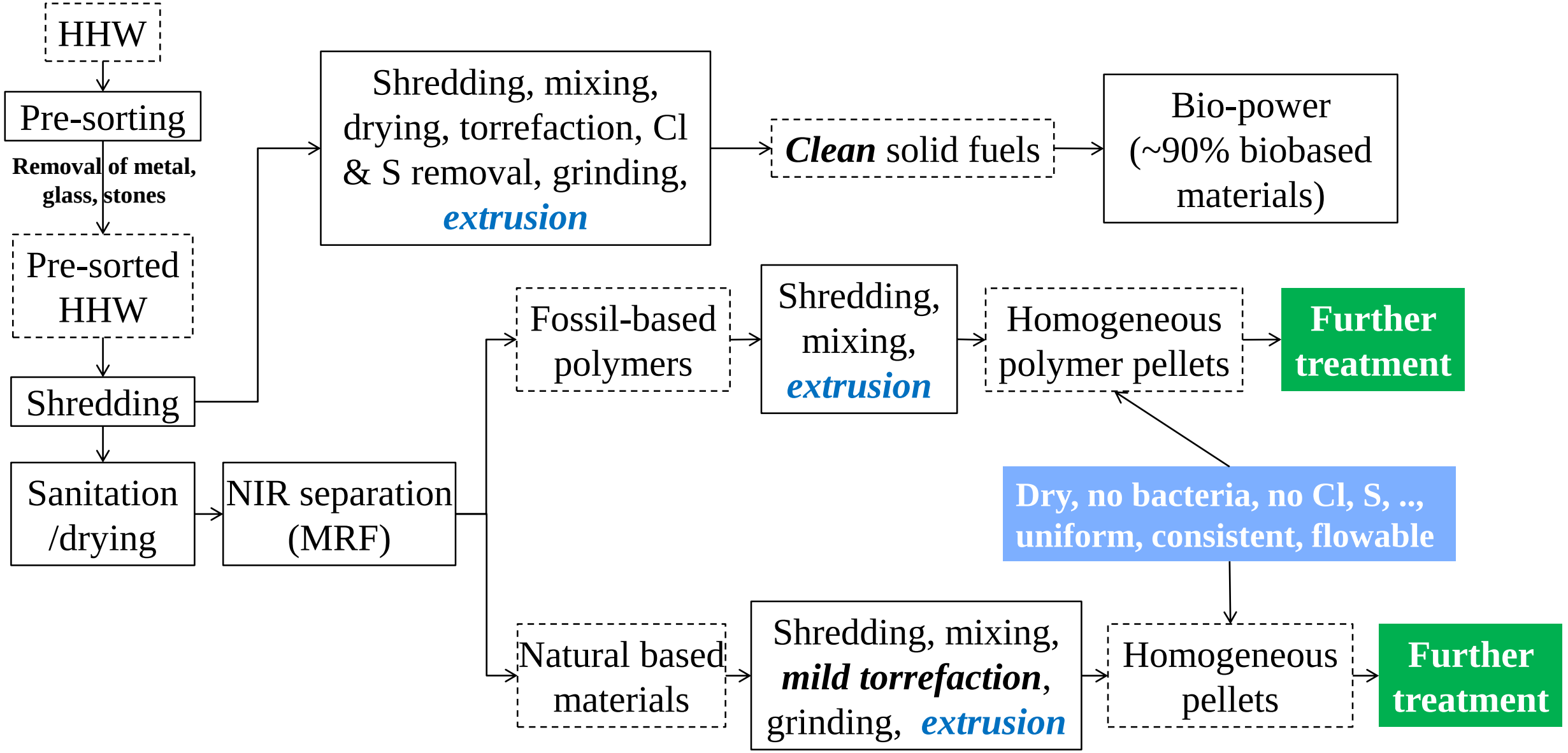
Transfer Station

https://www.hdrinc.com/au/portfolio/factoria-recycling-and-transfer-station

Specific Challenges in using Group 1 (HHW)

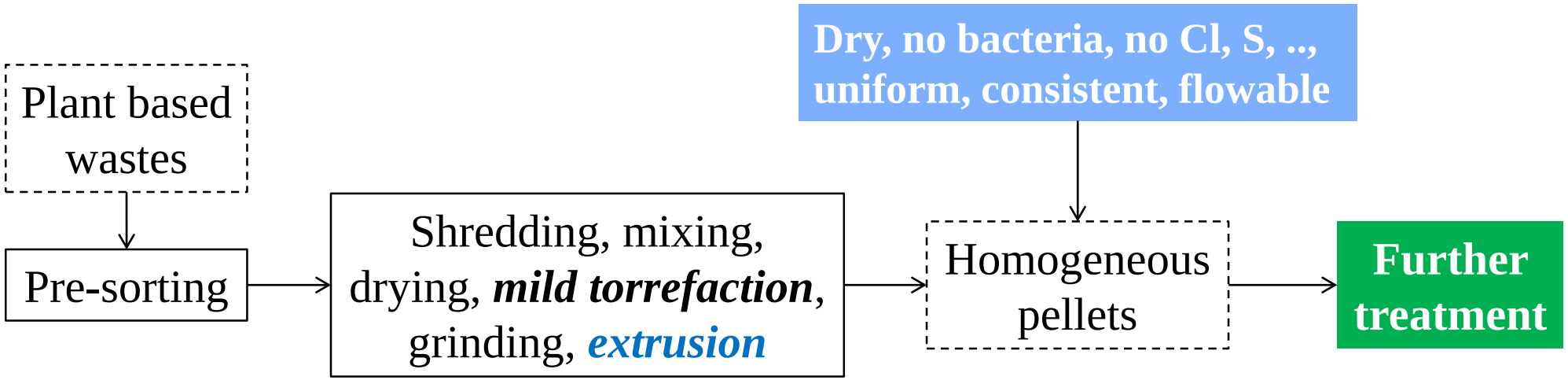
- Comprises blends of organic and non-organic materials, metals, stone, glass, …
- Health risks due to existing of bacteria
- Moisture content
- Hazardous materials, such as chlorine, sulfur, mercury, …

Addressing Challenges of HHW



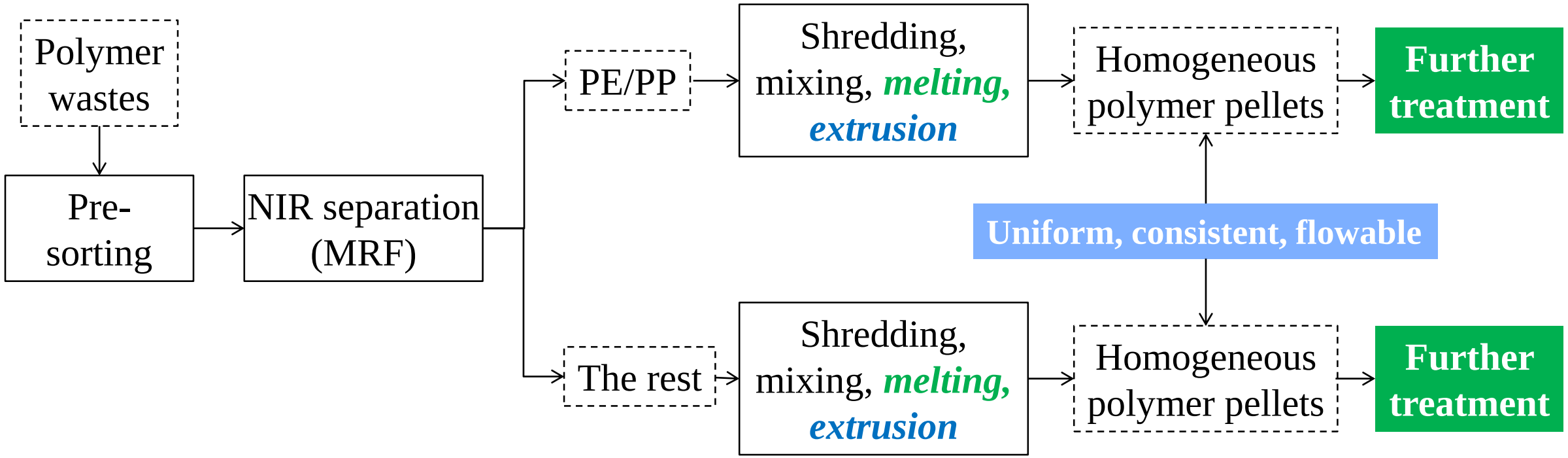
Addressing Challenges in Group 2 (Polysaccharide)

- High moisture content
- Comprising ash, minerals, hazardous materials
- Biohazards



Addressing Challenges in Group 3 (Fossil-Based Polymers)

- Contaminants and cross contaminants



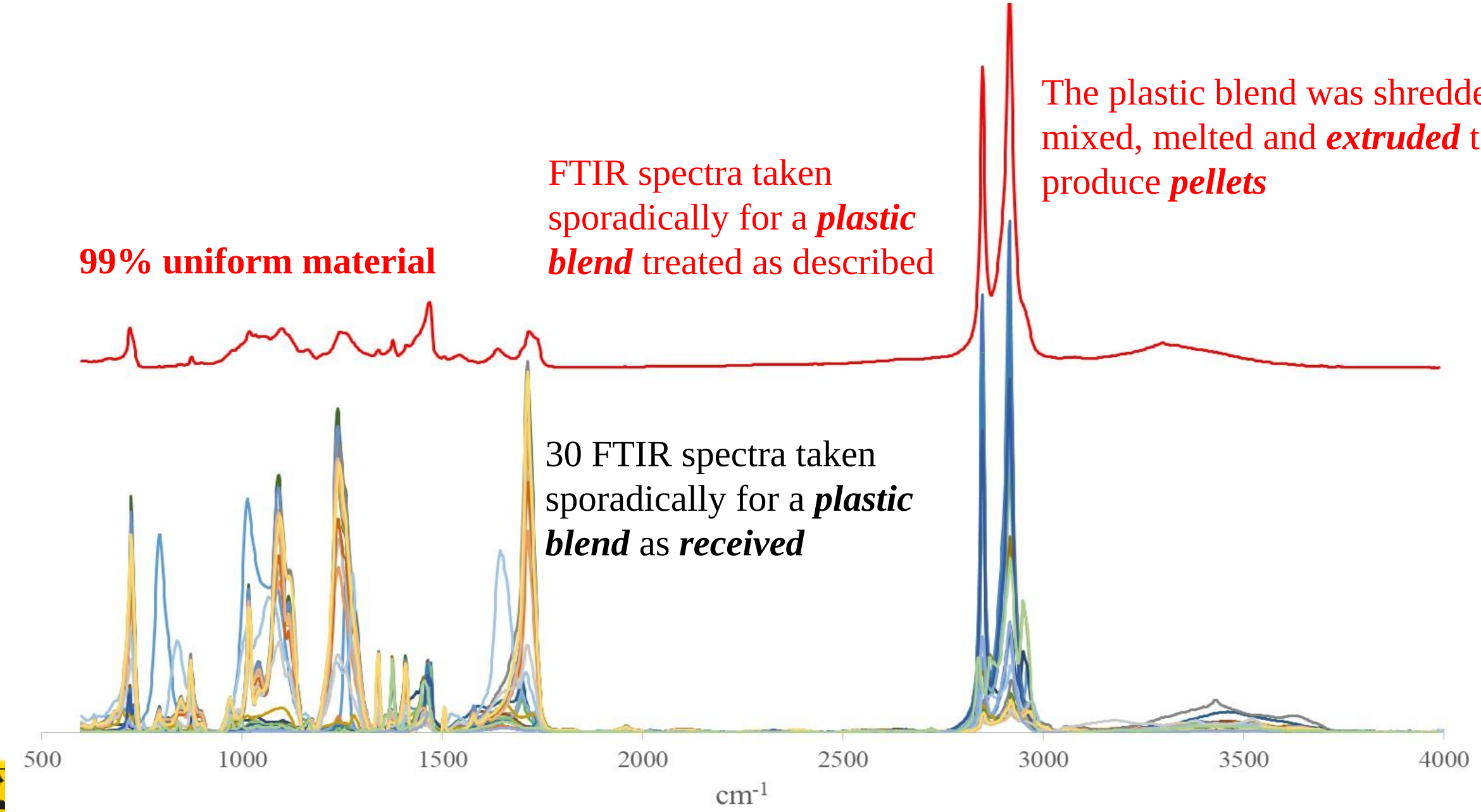
Measure of uniformity of plastic blends

99% uniform material

FTIR spectra taken sporadically for a ***plastic blend*** treated as described

The plastic blend was shredded, mixed, melted and ***extruded*** to produce ***pellets***

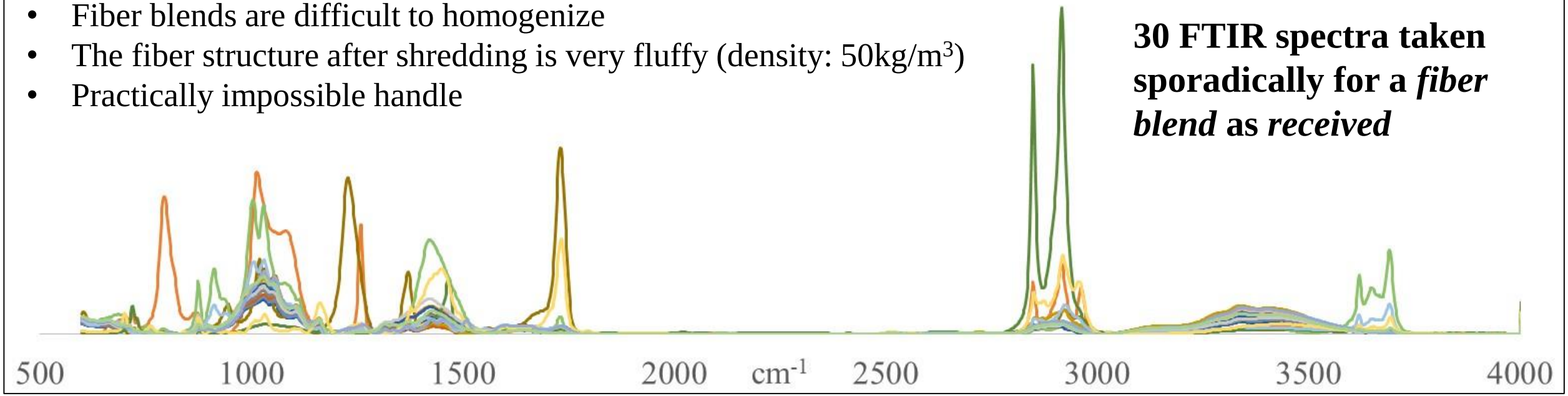
30 FTIR spectra taken sporadically for a ***plastic blend*** as ***received***

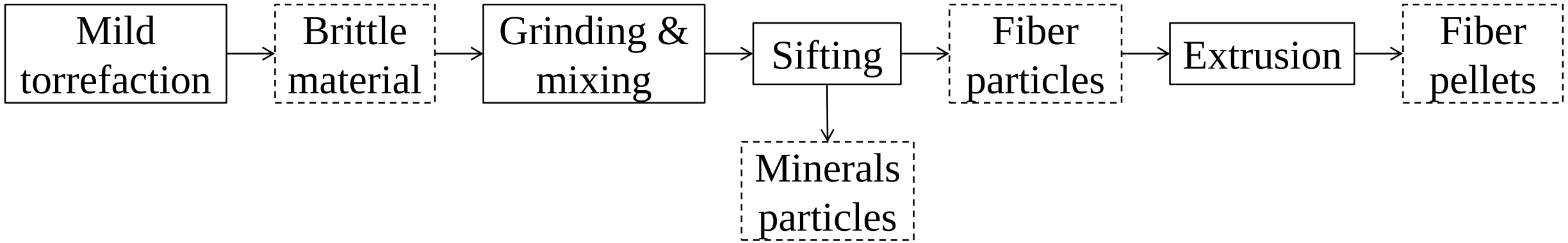


Homogenizing and cleaning fiber blends

- Fiber blends are difficult to homogenize
- The fiber structure after shredding is very fluffy (density: 50kg/m^3)
- Practically impossible handle

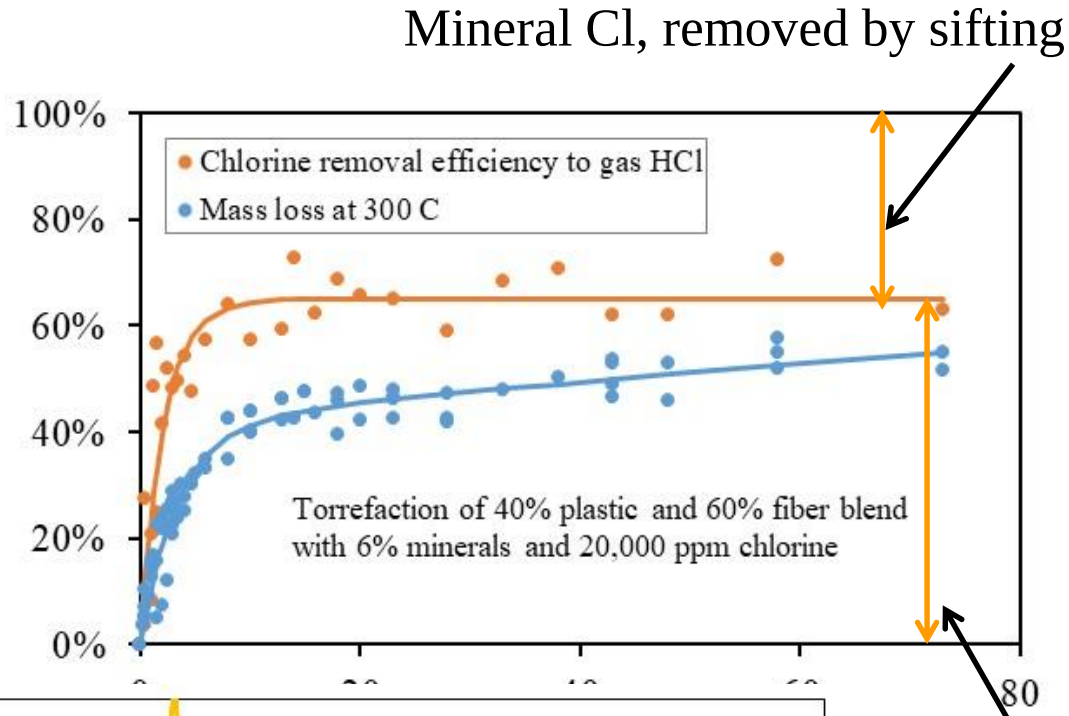
30 FTIR spectra taken sporadically for a *fiber blend* as *received*

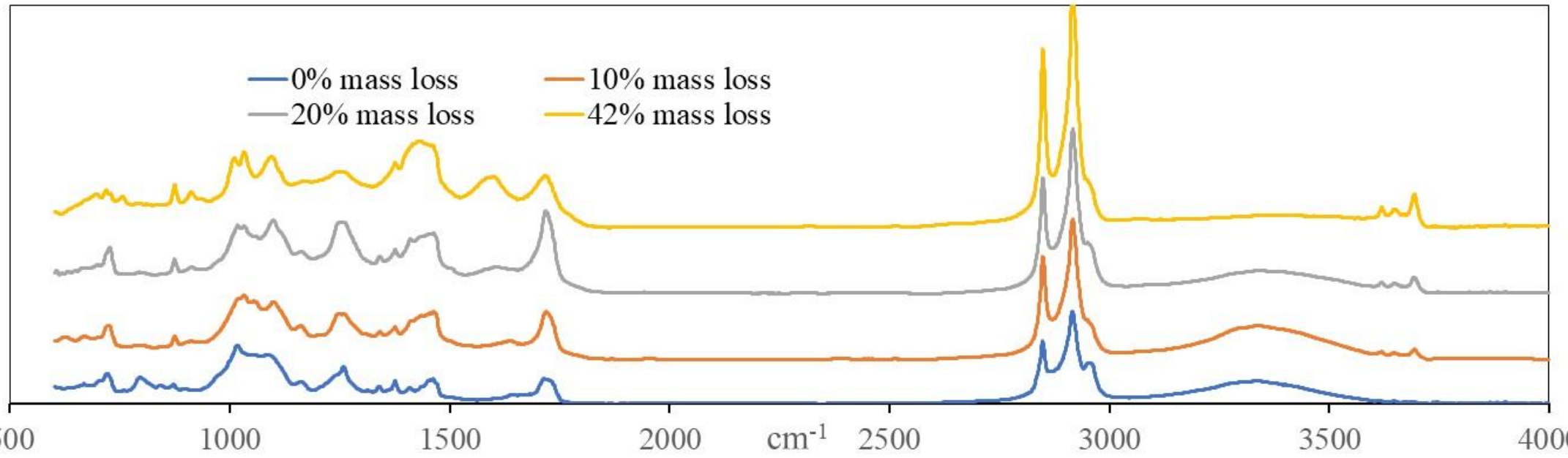




Homogenizing and cleaning fiber-plastic blends

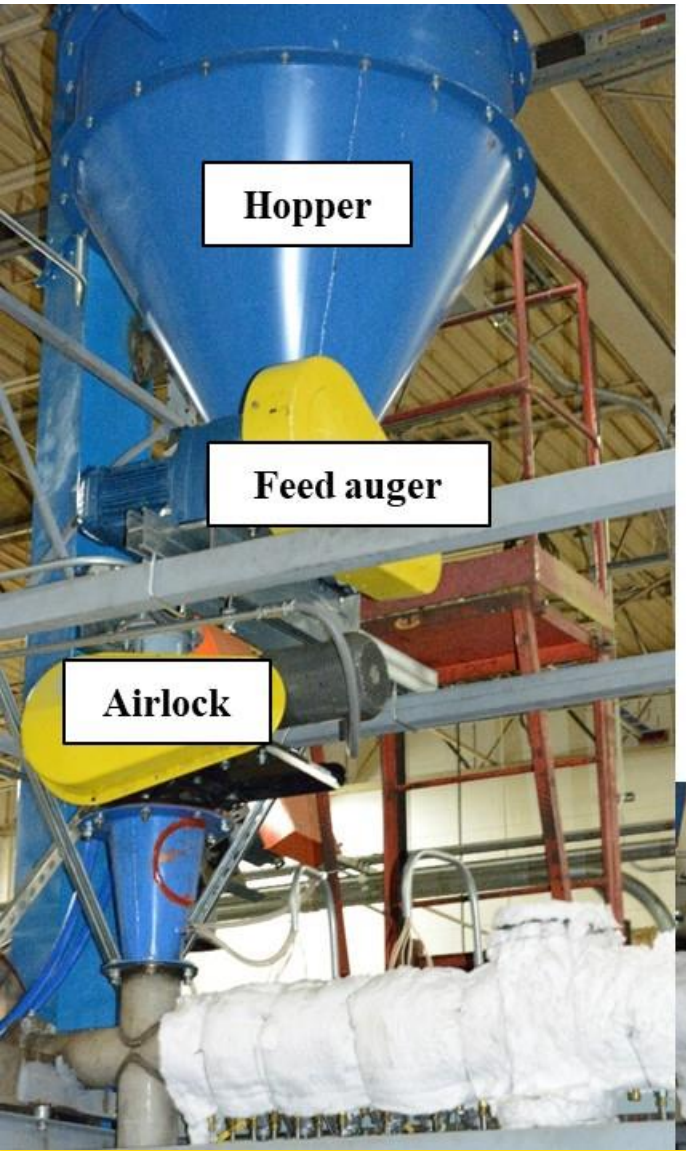
- Plot: Sample of 40% plastic-60% fiber blend (with 6% minerals) torrefied at 300°C,
- Cl: 70% in organic and 30% in mineral
- Mass loss and Cl release to gas vs. time
- At 40% mass loss, ***all*** organic Cl is released
- At 5-10% mass loss all inorganic Cl is separated by sifting

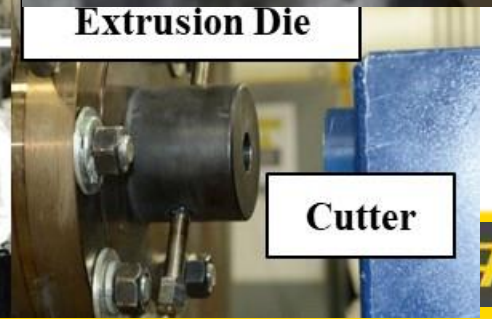




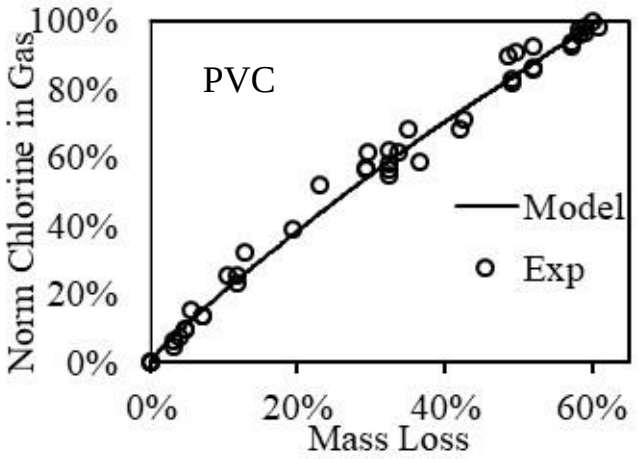
Waste Torrefaction: MTU Pilot Plant

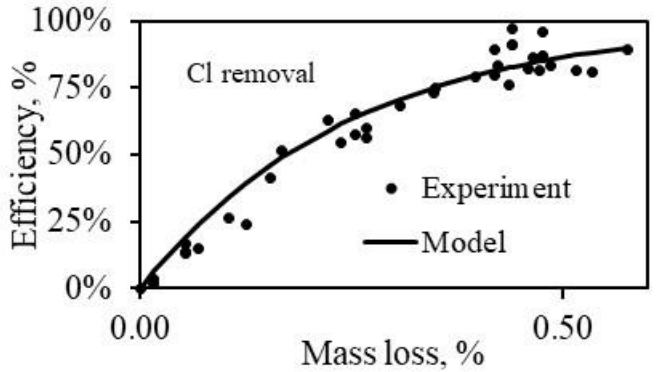
Industrial Plant: Convergen Energy/2021

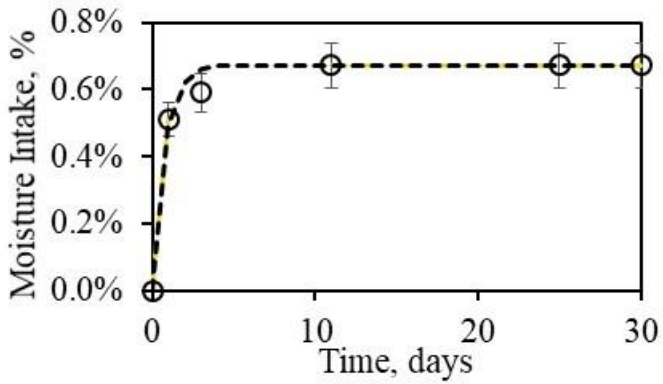


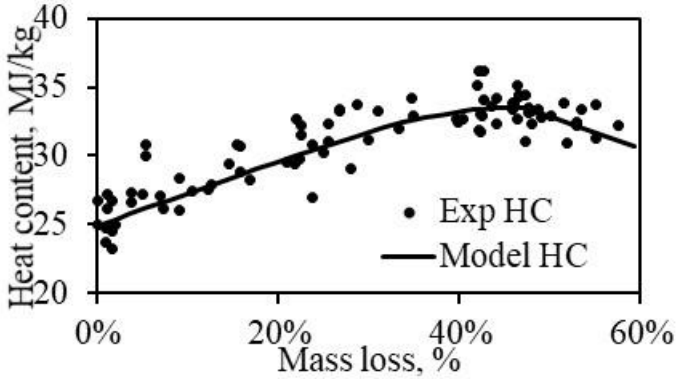


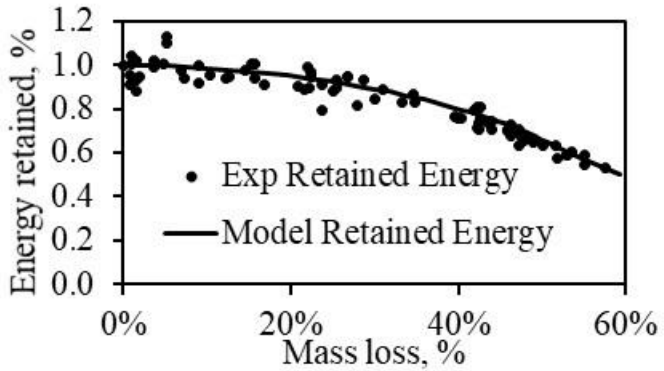
Results for Torrefied MSW

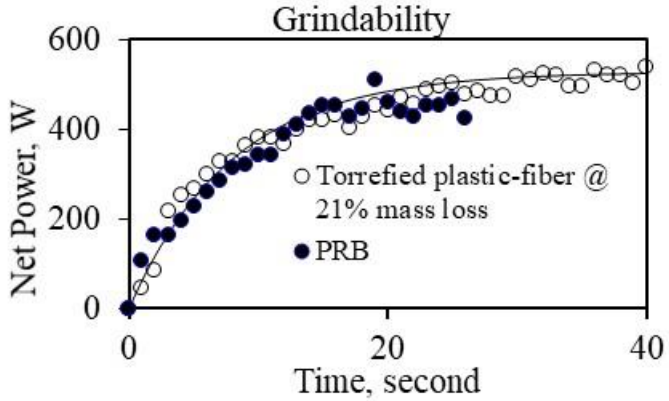












Further Glimpse over Waste Valorization

PE & PP

Catalytic de-polymerization

Olefin rich oligomers

Catalytic polymerization

New polymers

Sorting

The rest

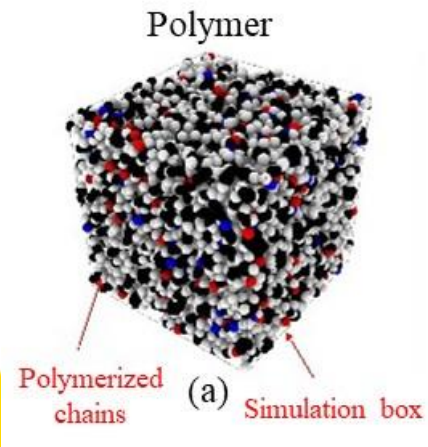
New polymer applications

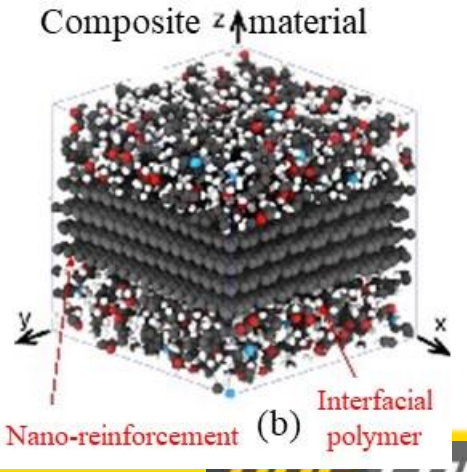
Molecular dynamic modeling

Composite materials

Mixed plastic wastes

Fibers: carbon, silica,..





Questions

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