Valorization of a post-consumer poly(lactic acid) residue by mechanical recycling

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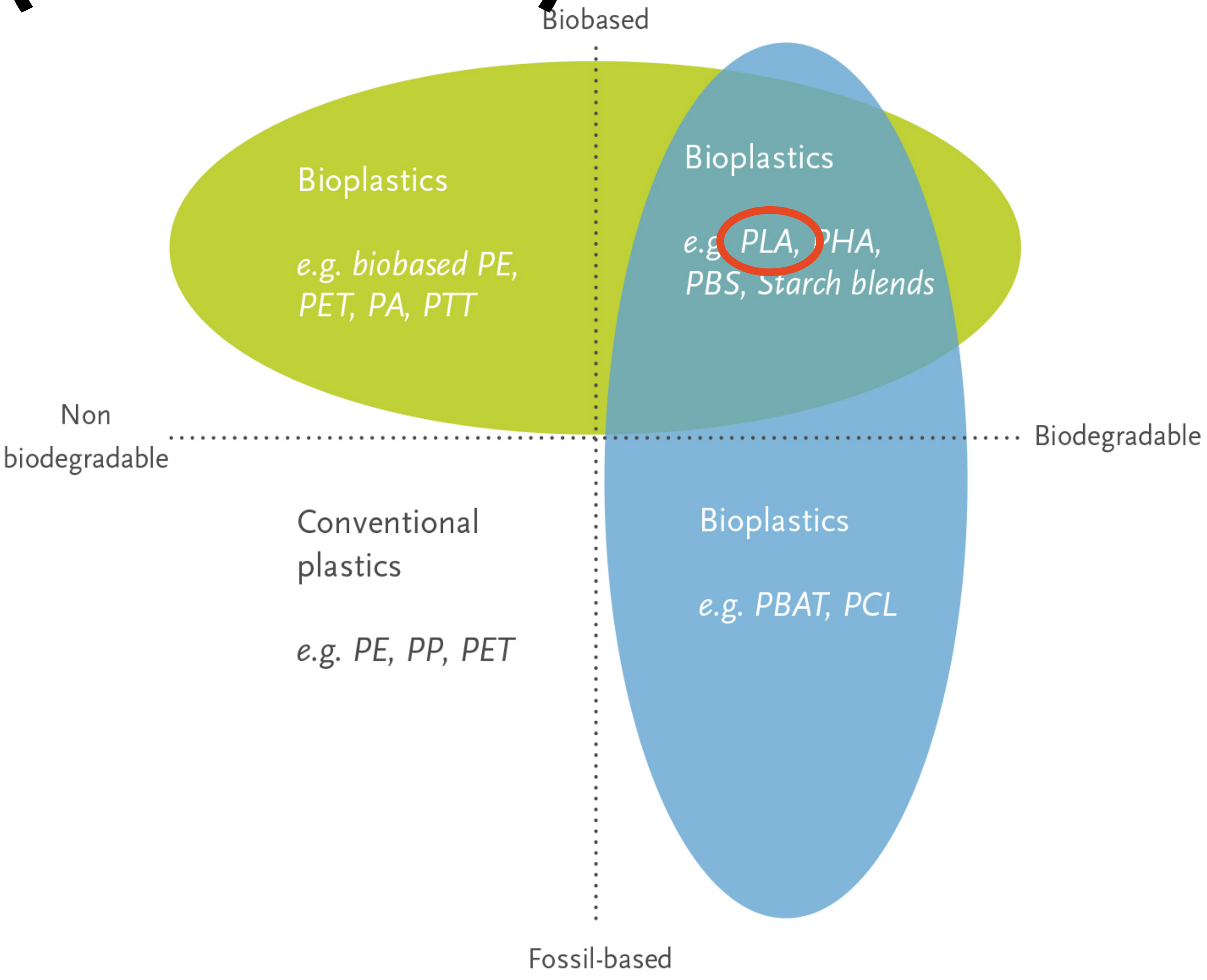
Bioplastics and poly(lactic acid)

Massive use of fossil-oil based plastics leads to environmental issues.

Bioplastics emerge as an alternative to conventional plastics in some applications.

Poly(lactic acid) (PLA) is amidst the most stablished bioplastics.



Bioplastics and poly(lactic acid)

Poly(lactic acid) (PLA) is an aliphatic polyester.

PLA is relatively cheap, safe in food contact and has acceptable optical and mechanical properties

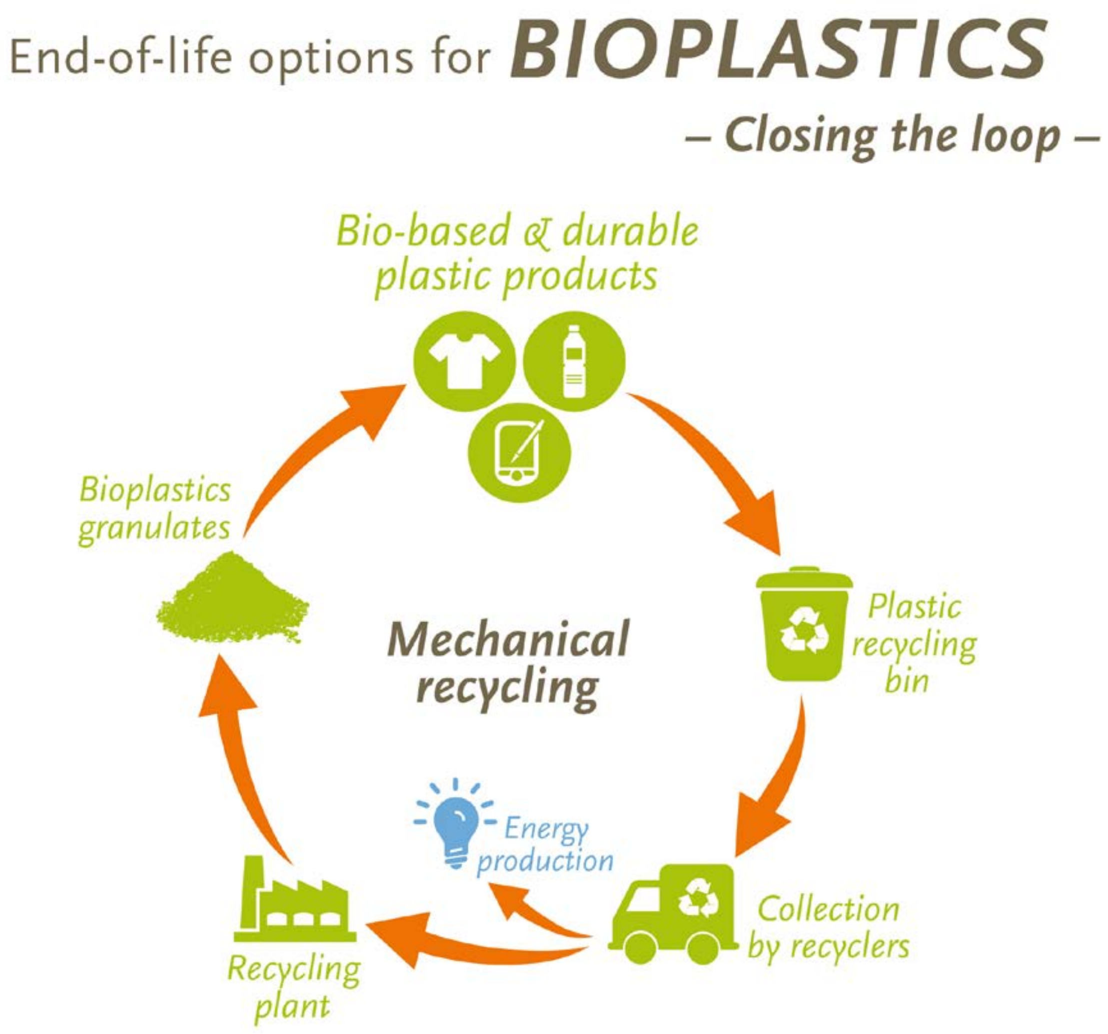
Poly(lactic acid) (PLA) is used in biomedical, textile and **packaging** applications.

Valorization of PLA wastes

PLA is biodegradable, but degradation rate depends on environmental conditions.

A circular economy approach implies the **valorization** of plastic waste.

Among the alternatives **mechanical recycling** poses several advantages.



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Challenges of recycling

Recycling leads to a decrease of the performance of plastics.

Mechanical recycling is a complex and expensive process.

A **centralized recycling approach is not feasible** for PLA.

Distributed recycling could be an interesting **alternative**.

- Collection
- Sorting
- Washing
- Shredding
- Reprocessing

Main objective

Study a case of distributed mechanical recycling: PLA cutlery coming from a local shop.

With special focus on the structure and properties of the materials

Methodology

Collection of used spoons

Cold washing

Demanding washing

Grinding

Extrusion and compression molding

Results: Intrinsic viscosity

Mechanical recycling led to the **degradation** of the polymer.

Service life

Washing and grinding

Reprocessing

Could **negatively affect** the properties of recycled materials

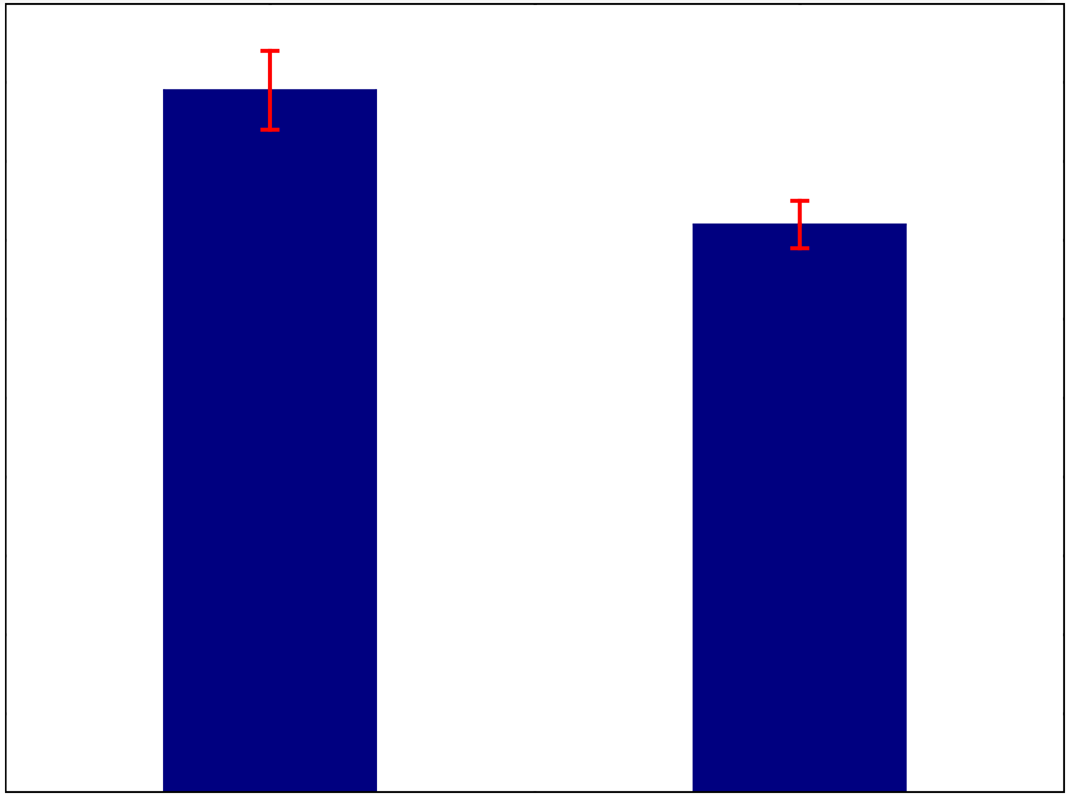

Fig. 1. Intrinsic viscosity of the samples

Results: Differential Scanning Calorimetry

The recycled material crystallizes more easily tan the virgin plastic.

Melting temperature shifts toward lower values in the recycled polymer.

Both changes are a sign of the **degradation of PLA during recycling**.

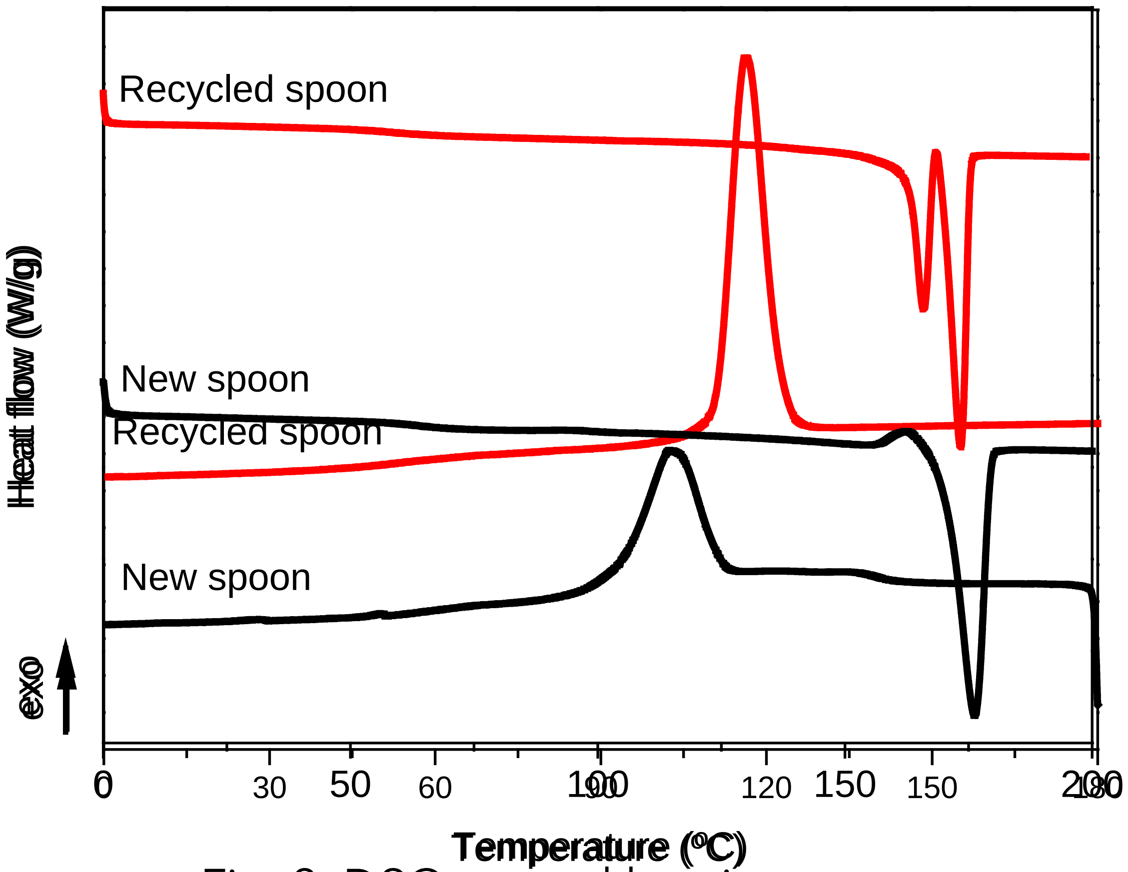

Fig. 3. DSC second heating scans

Fig. 2. DSC cooling scans

Results: Thermogravimetric Analysis

Thermal stability plays a very important role on the processing of plastics

Mechanical recycling led to an important **decrease of the thermal stability**

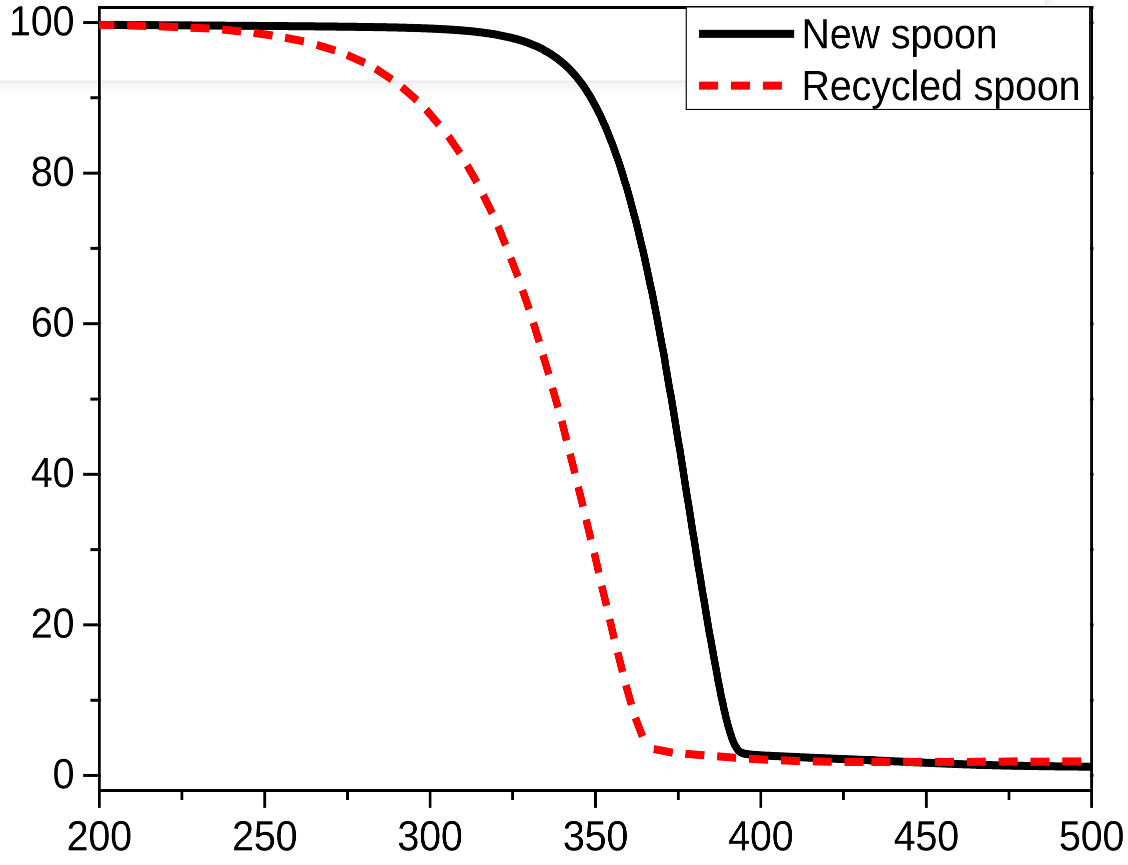

Fig. 4. TGA curves of the samples

Results: Vickers Hardness

Recycled spoons show **lower hardness** values than new spoons

This result is in good agreement with the **degradation of the polymer** during recycling

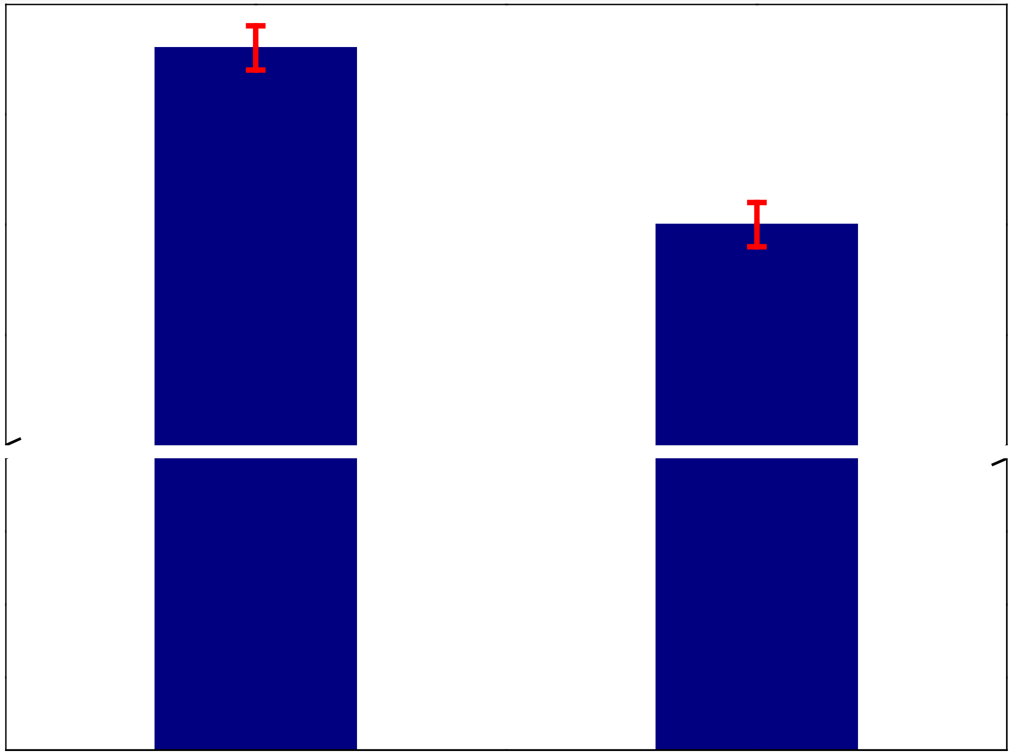

Fig. 5. Vickers hardness of the samples

Conclusions

Recycling led to the degradation of PLA, along with the reduction of the properties of the recycled material

This decrease could negatively affect the distributed recycling approach for PLA

It is important to develop accessible and cost-friendly upgrading methods to improve the recyclability

Thank you for your attention

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