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Evaluation of mechanical recycling of poly(lactic acid):
Effect on the physical ageing and migration

F.R.Beltrán, A. Torre, V. Lorenzo, M.U. de la Orden, J. Martínez Urreaga

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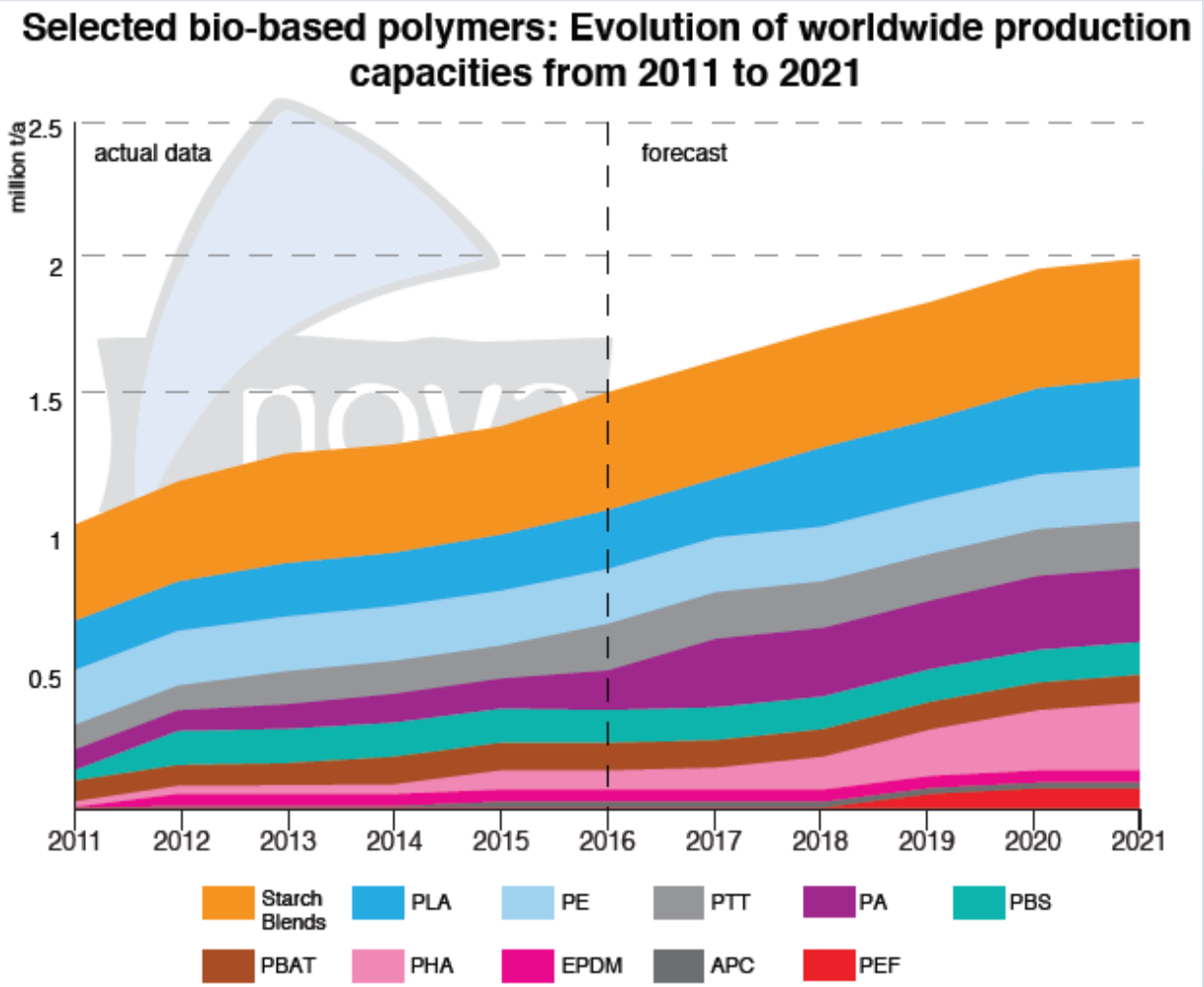
Poly(lactic acid) (PLA)

- Is a bioplastic coming from renewable resources.
- Is mainly used in packaging applications.
- Its production will grow 10%/year between 2016 and 2021.



Source: nova-Institut GmbH

Mechanical recycling: An alternative for waste valorization

Increased production:
Moral and social conflicts

Mechanical recycling

Increased consumption:
Environmental issues

Performance of recycled materials

Objectives

- Previous studies revealed that mechanical recycling causes a decrease on molecular weight and on some properties of PLA.

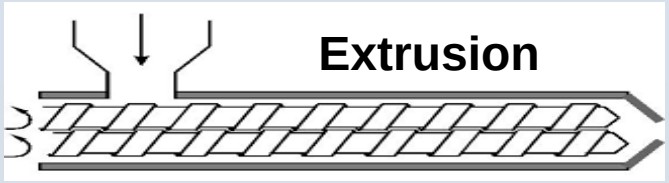
- Our main objective is to continue the study the effect of the mechanical recycling of PLA on:

  ✓ Physical ageing

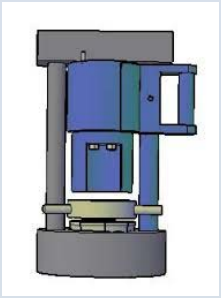
  ✓ Degradation and migration in food simulants

Methods

PLA: Ingeo™ 2003D



Compression molding



Virgin PLA (PLAV)

468 h
50 ° C

40 h
UV light

85 ° C
NaOH
Surfactant

Recycled and Washed PLA (PLARW)

Test conditions

Physical ageing

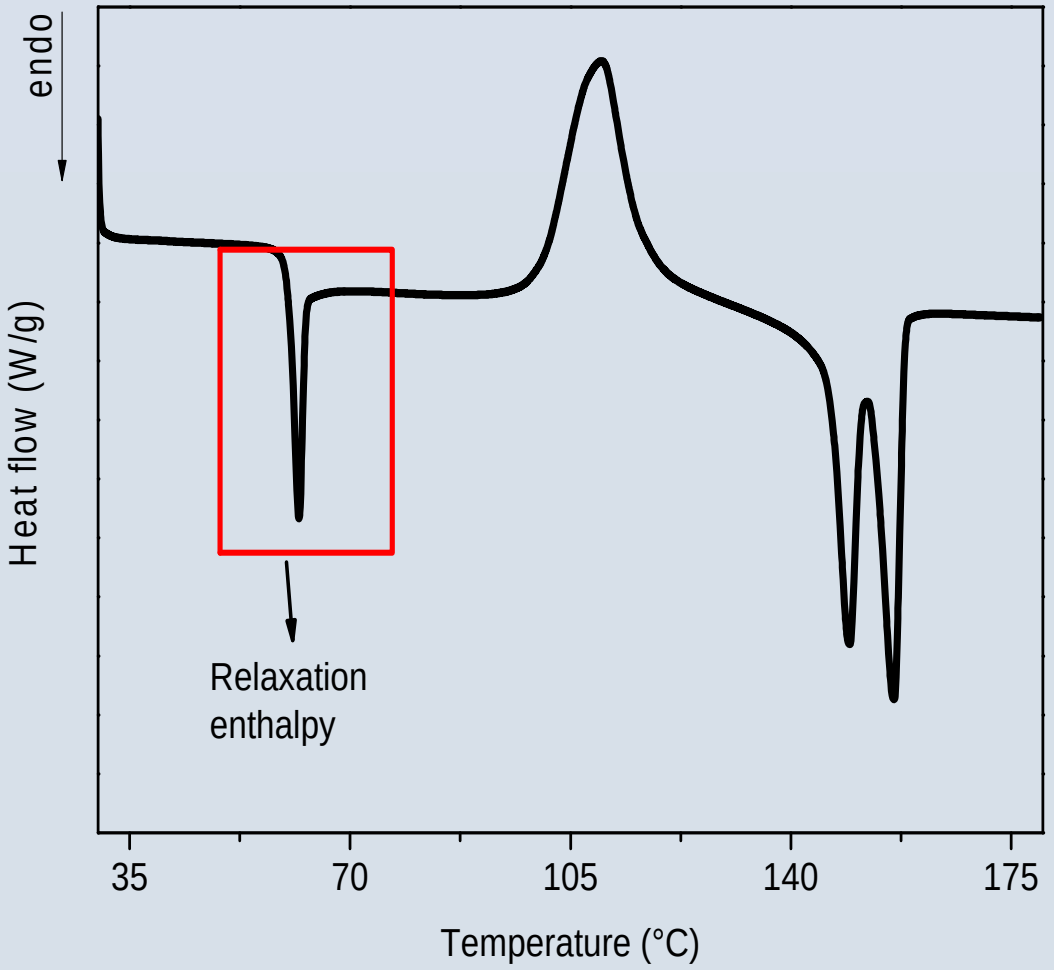
- Differential Scanning calorimetry
- Ageing temperature: 40 ° C

Migration tests

- Water and acetic acid (3%)
- Temperature: 40 ° C

Mechanical recycling and physical ageing

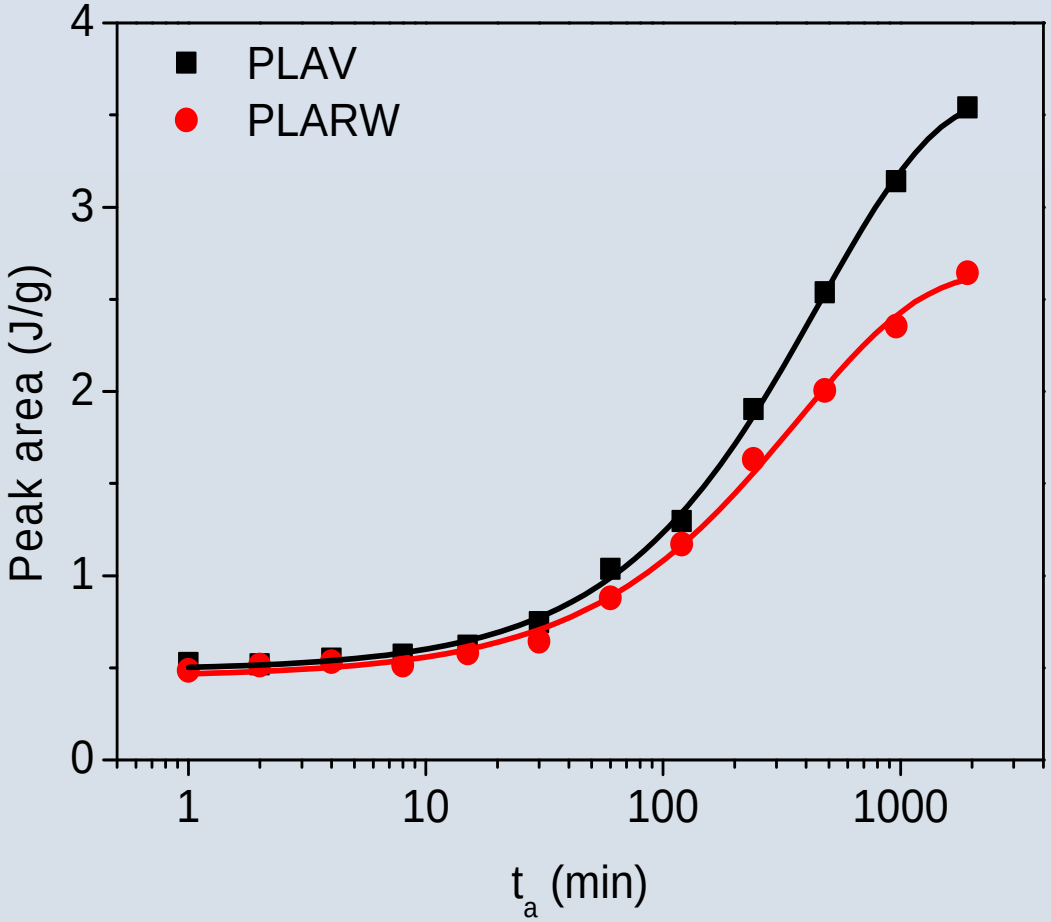
- Physical ageing is the densification of the amorphous zones of PLA.
- It can affect the mechanical and gas barrier properties of PLA.
- It can quantified by the relaxation enthalpy.



DSC heating scan of PLA

Mechanical recycling and physical ageing

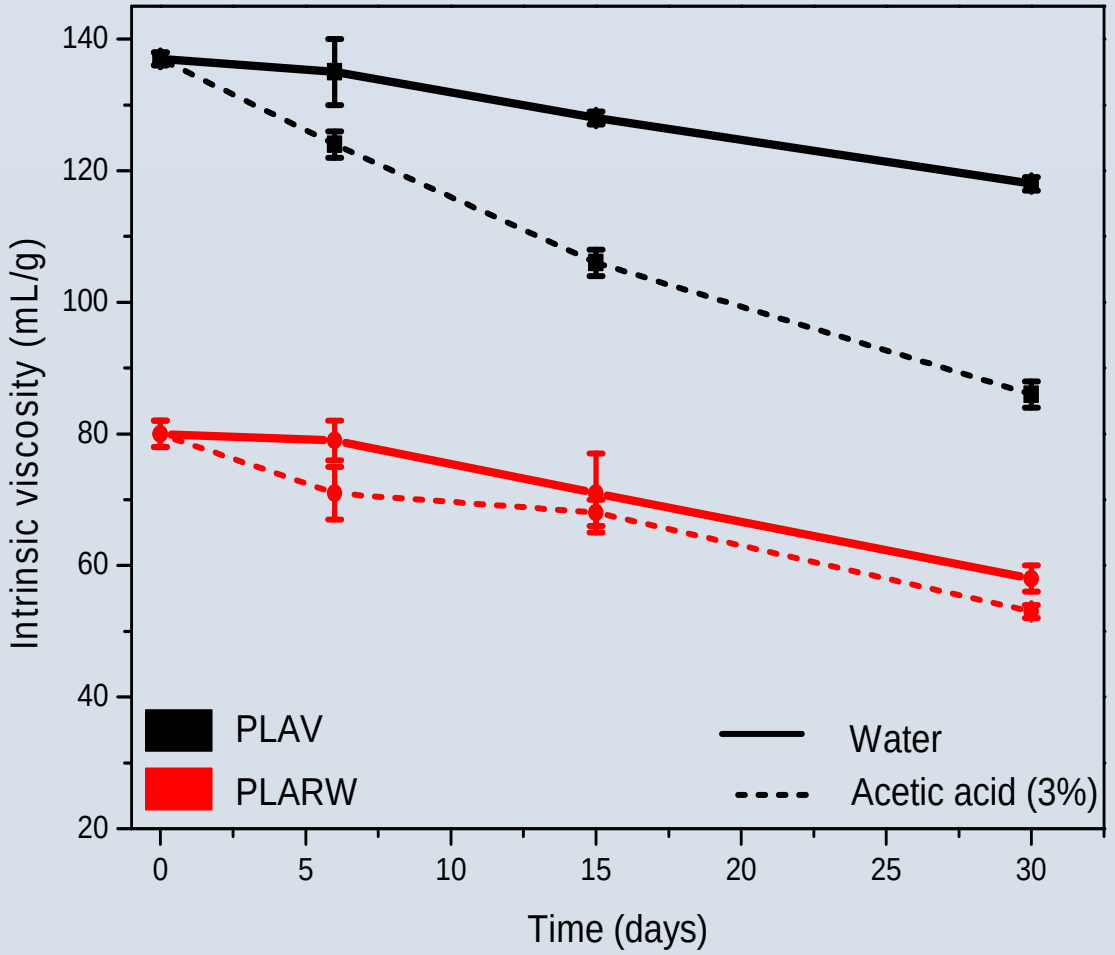
- Results show that recycled PLA present lower values of the relaxation enthalpy (ΔH_∞).
- This means that recycled PLA is less prone to physical ageing than PLAV.



Evolution of the relaxation enthalpy with ageing time

Mechanical recycling and migration

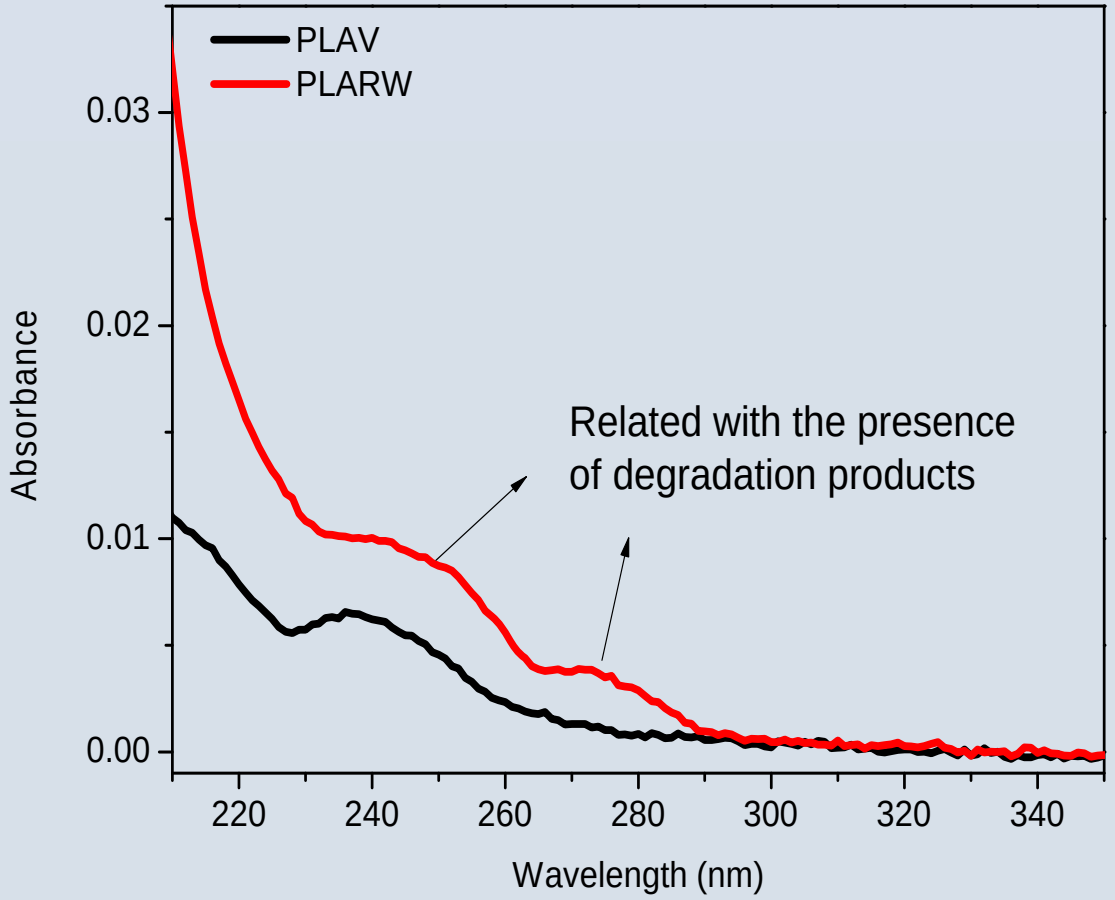
- Degradation of PLA in contact with food is crucial in packaging applications.
- Mechanical recycling caused a severe degradation on PLA.
- Degradation rate in water is similar for both materials.



Evolution of intrinsic viscosity of the different samples

Mechanical recycling and food simulants

- Migration of degradation products is relevant in food packaging applications.
- UV-Vis spectra of the immersion media shows that PLARW liberates more degradation products than PLAV after 6 days of immersion.



Migration of degradation products after 6 days of immersion in water

Conclusions

- Mechanical recycling poses an alternative for the valorization of PLA wastes.
- Recycled PLA seems to be less prone to physical ageing, which might affect mechanical and gas barrier properties.
- Mechanical recycling did not affect the stability of PLA against water.
- Migration of degradation products into food simulants is higher in mechanically recycled PLA.

Conclusions

Mechanical recycling causes some small changes in PLA. However, recycled PLA could be reused in packaging applications

Thank you for your attention

Contact info:
f.beltran@upm.es

Questions

Contact info:
f.beltran@upm.es