UNIVERSIDAD
POLITÉCNICA
DE MADRID

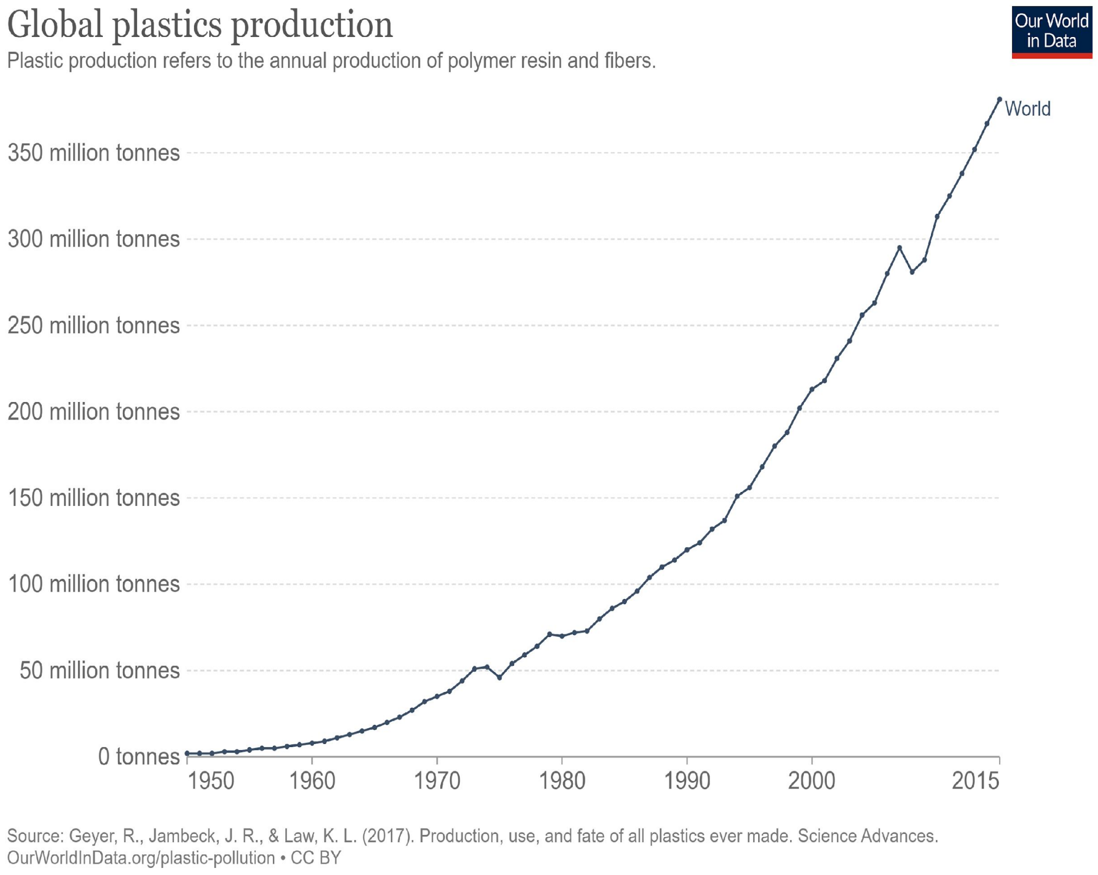
Incorporation of degraded fractions of PLA waste into PLA to produce biobased and biodegradable materials with improved properties

C. Pedrosa, J. Asperilla, P. Campayo, **F.R. Beltrán**, M.U. de la Orden, J. Martínez Urreaga.

9th International Conference on Sustainable Solid Waste Management
15-18 June 2022

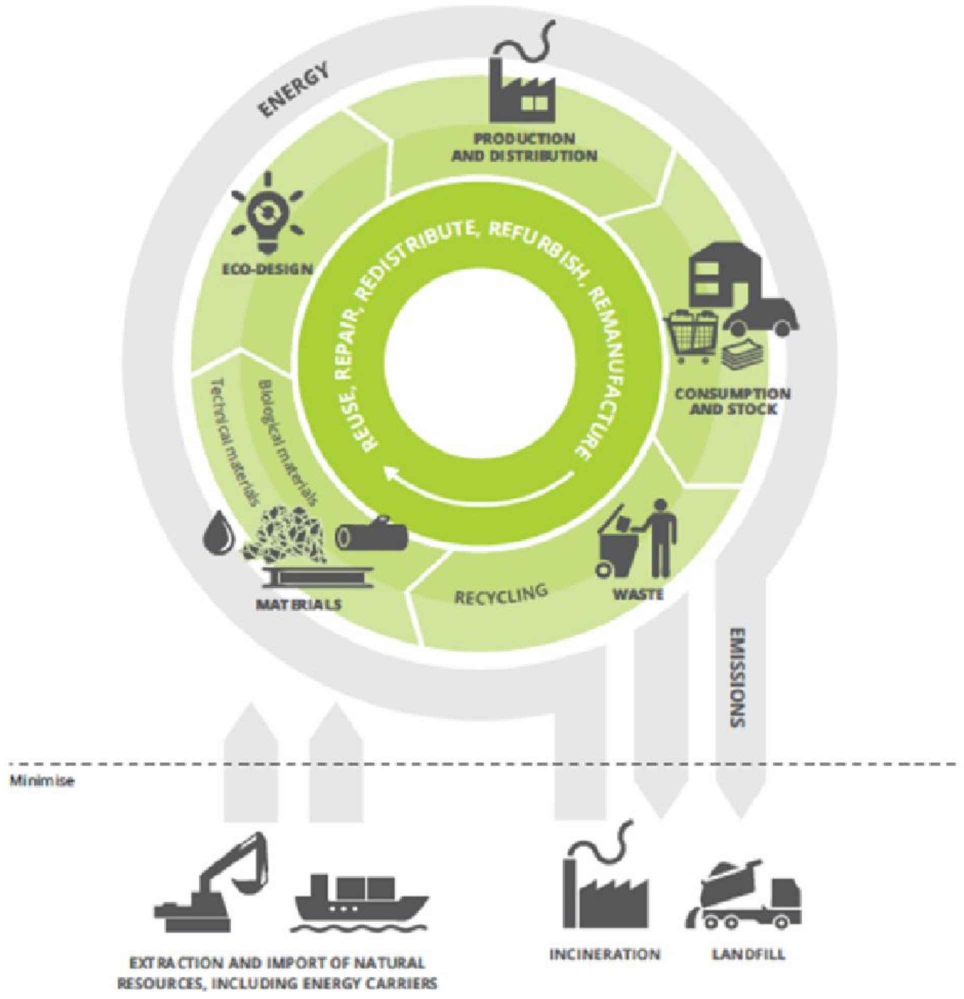
Introduction

- Plastics are one of the most used materials due to their good properties.
- Conventional plastics, mostly produced from petroleum, lead to a several environmental problems.
- Bioplastics emerge as a potential solution to some of the issues.
- Poly(lactic acid) (PLA) is the most stablished bioplastic in the market.



Introduction

- Waste management is still important for bioplastics.
- Mechanical recycling is an interesting option for some applications and grades.
- **But, what happens with severely degraded materials?**



Source: Towards a circular economy – Waste management in the EU
European Parliamentary Research Service **Scientific Foresight Unit (STOA)**

Objective

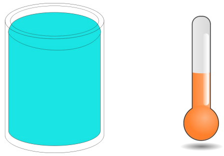
The main aim is to evaluate the possibility of using severely degraded PLA fractions to produce bioplastic materials with improved properties

Valorization

Methodology

Neat PLA

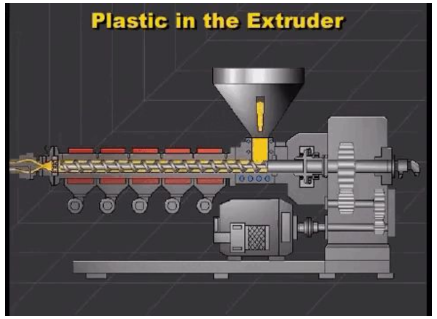
Accelerated degradation:
Hydrolysis at 60 °C for 7, 12 and 21 days



H7, H12 and H21

Neat PLA

Extrusion



Compression molding

- PLAV
- PLAV+10% H7
- PLAV+20% H7
- PLAV+30% H7
- PLAV+10% H12
- PLAV+20% H12
- PLAV+30% H12
- PLAV+10% H21
- PLAV+20% H21
- PLAV+30% H21

Results and discussion: Molecular weight

- Molecular weight plays an important role in the performance of the materials and on the processing conditions.
- Hydrolysis leads to a severe reduction of the molecular weight of PLA.
- Blending of PLAV and hydrolyzed fractions leads to the appearance of low molecular weight peaks in the distribution.

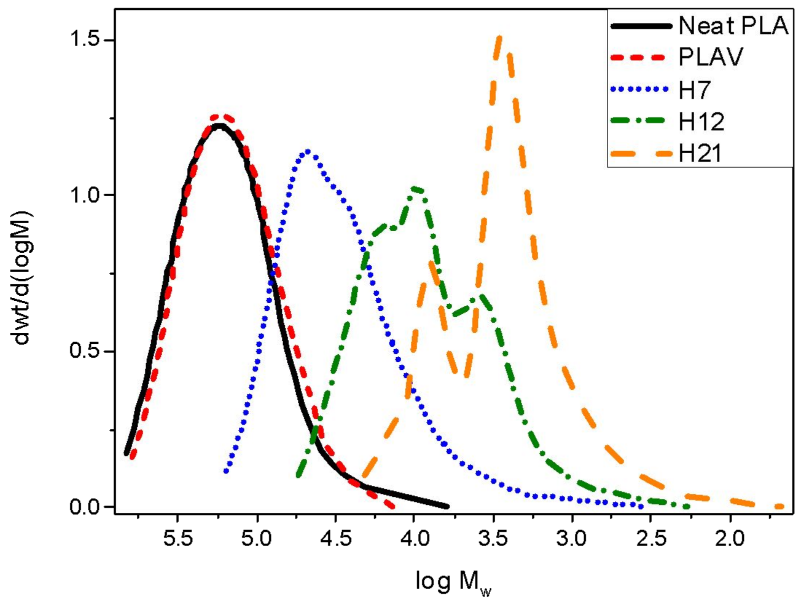


Figure 1. Molecular weight distribution of hydrolyzed samples

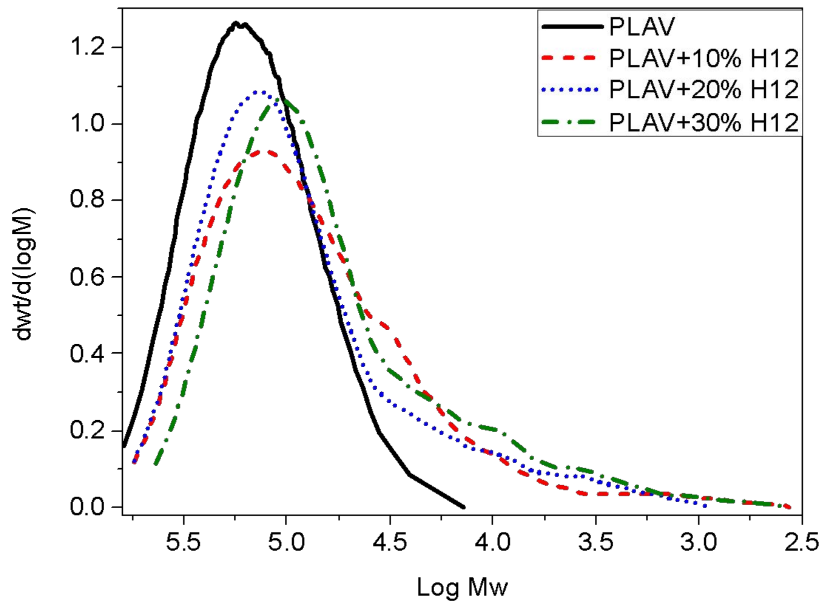


Figure 2. Molecular weight distribution PLAV and PLAH12 blends

Results and discussion: Thermal behavior

- All samples show the characteristic behavior of PLA: glass transition, cold crystallization and melting.
- Differences in melting and especially in cold crystallization.
- This decrease could be due to a plasticizing effect of the shorter polymer chains.

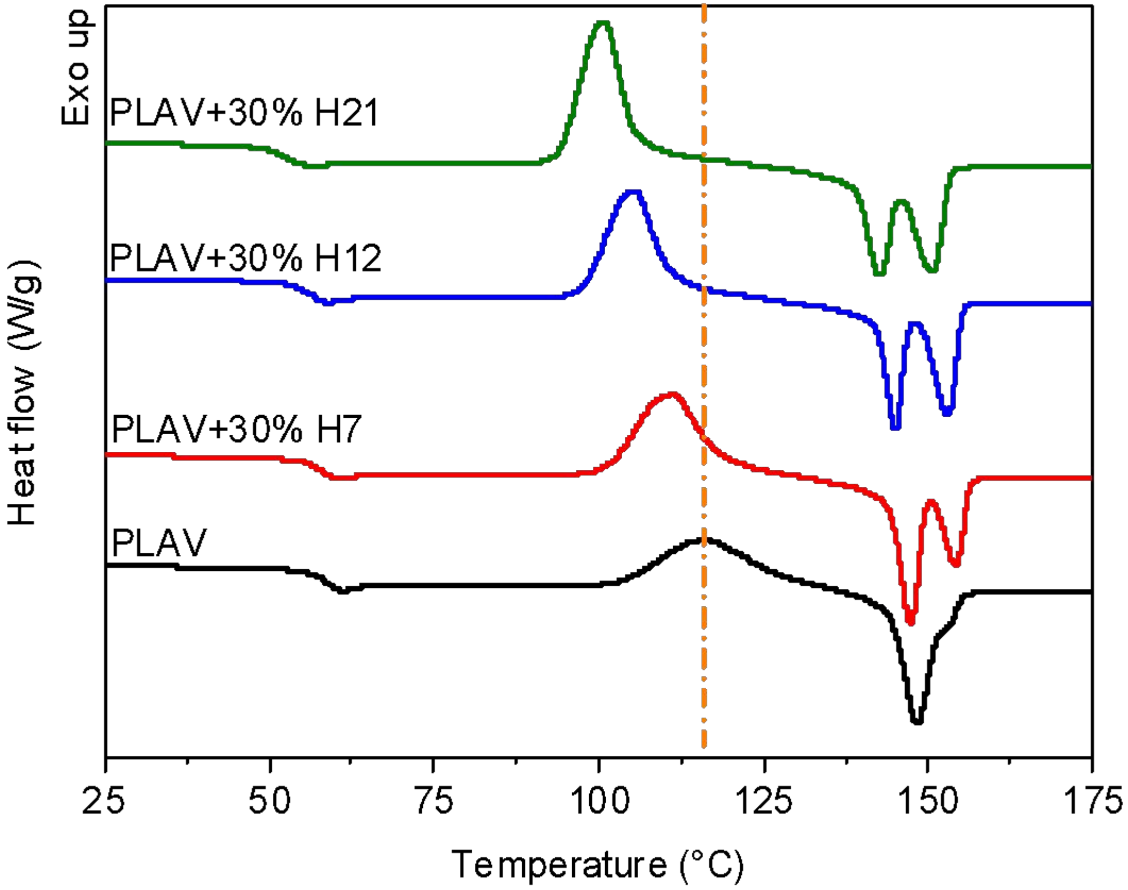


Figure 3. Second heating scans of different samples

Results and discussion: Thermal stability

- Overall decrease of the thermal stability of PLA.
- This decrease can be related to the presence of shorter polymer chains, which decompose earlier.
- In any case, the onset decomposition temperature is within the processing window of PLA.

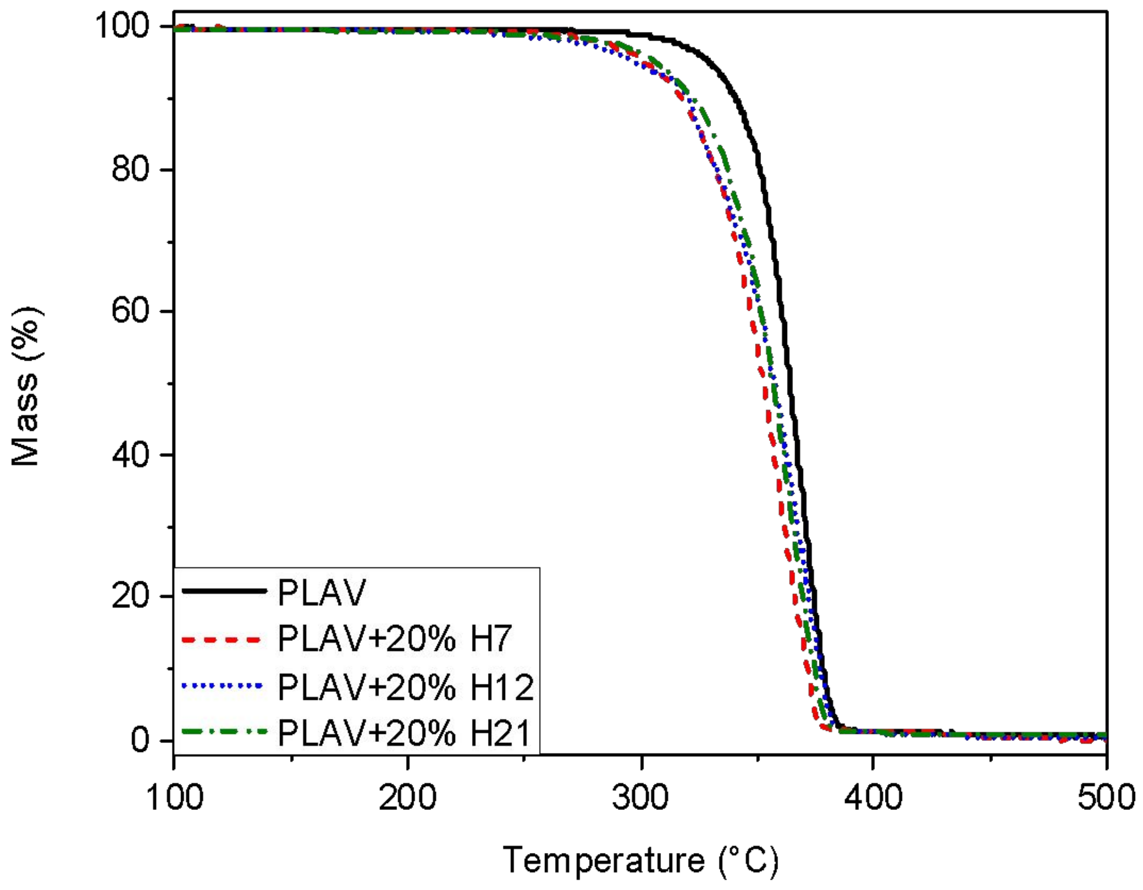


Figure 4. TGA curves of different samples

Results and discussion: Mechanical properties

- Hardness slightly decreases as hydrolysis time and amount of hydrolyzed material increases.

- Nevertheless, the changes are small suggesting that even with 30 % of the most degraded sample, acceptable mechanical properties are achieved.

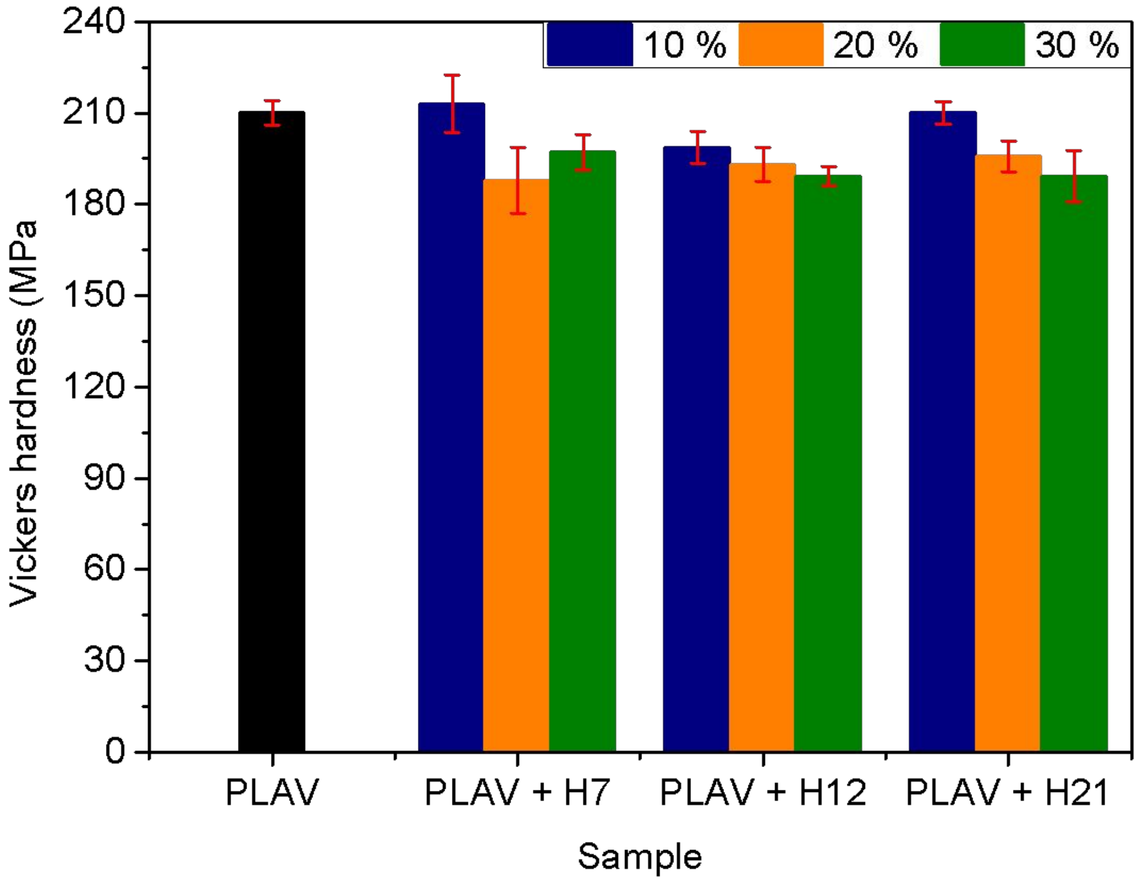


Figure 5. Hardness values of different samples

Conclusions and challenges

Incorporation of severely degraded fractions could have a plasticizing effect on PLA.

Despite the decrease of the molecular weight, thermal stability and mechanical properties are still acceptable.

Can the plasticizing effect be enhanced?

Thank you for your attention!

Questions?

Contact info: f.beltran@upm.es