

MULTIPLE RECYCLING OF PLA WITH TAILOR-MADE MULTIFUNCTIONAL REACTIVE POLYMER ADDITIVES



Faculty of Chemistry
Warsaw University of Technology

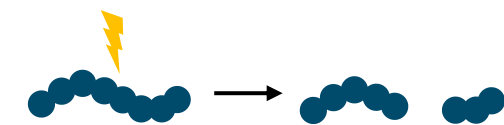
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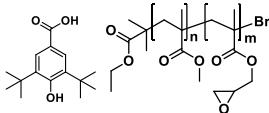
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Context

Mechanical recycling produces materials characterized by **worse** physico-mechanical **properties** than virgin materials



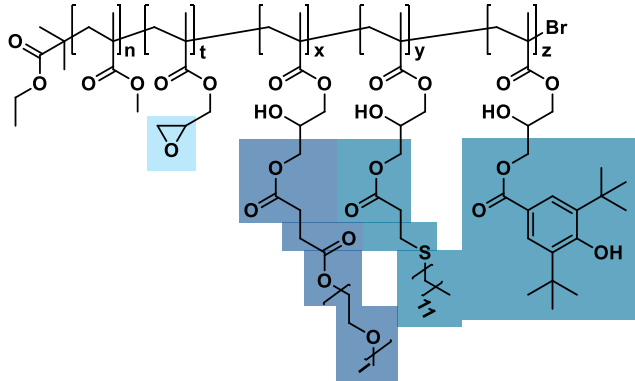
Polymers degrade during processing.



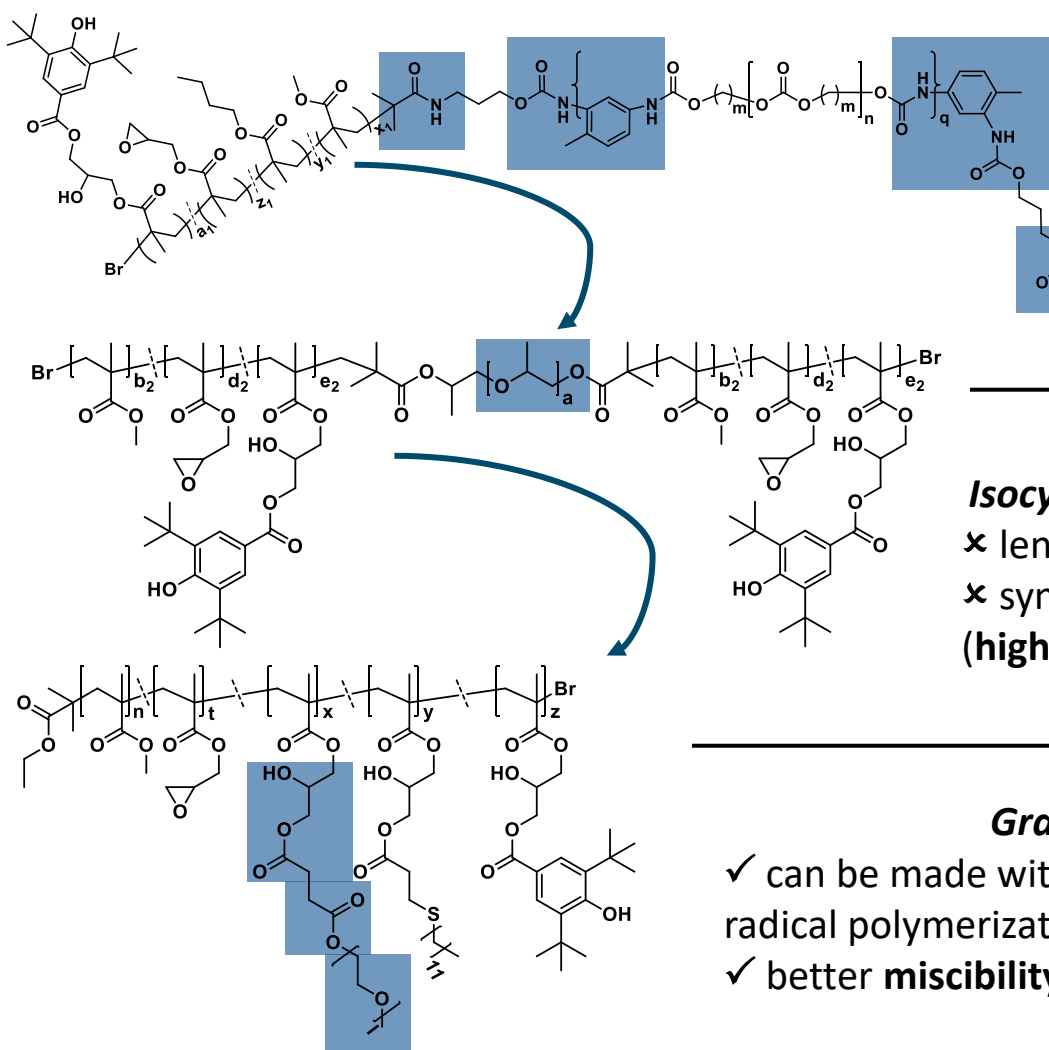
Additives used to enhance polymer performance can **migrate** or **leech out**.

Solution

Reactive, multi-functional additive acting as **chain extender**, **antioxidant**, and **mechanical properties enhancer**.



Method evolution



Providing H-bonds for mechanical strength

- ✗ concerns about isocyanide toxicity
- ✗ **no proof** of mechanical strength enhancement by H-bonds

Tailoring additive's properties

- ✓ chain-extension properties can be tuned by **adjusting** N_{epoxy} and additive's **wt%** in a blend
- ✓ additional properties (antioxidant, mechanical properties enhancement) can be **tuned by** reacting epoxides with appropriate **specialty compounds**

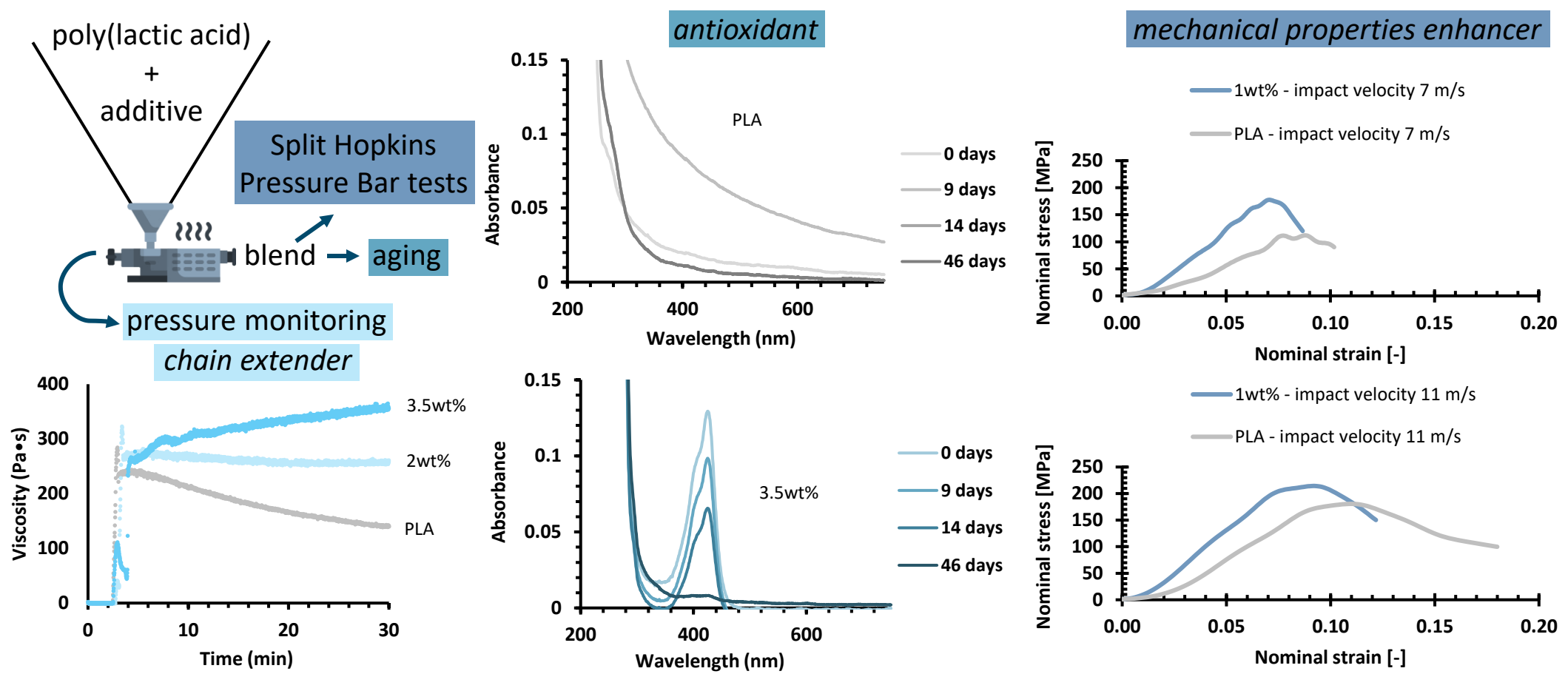
Isocyanide-free block copolymers

- ✗ lengthy product **purification**
- ✗ synthesized with ARGET ATRP (**high cost**)

Graft copolymers

- ✓ can be made with ATRP (**high control**) or free-radical polymerization (**low price**)
- ✓ better **miscibility** with recycled polymer

Performance of different additives

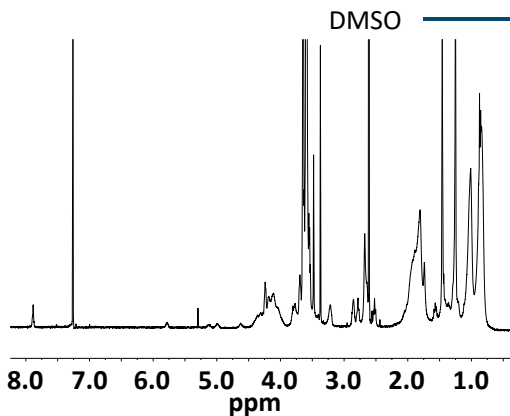
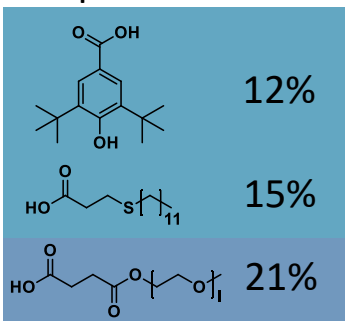


Scaling up

5g → 500g	
1. ARGET ATRP	
MMA:GMA	3:1
Conversion	75%
M_n	28 000
M_w	53 000
\bar{D}	1.9
N_{epoxy}	83



2. Modification with specialty compounds (one pot reaction)
Amount of epoxides opened with:



need for additional purification
↓
cross-linking
↓
useless product