Engineering Polymers for a Beyond-the-bin Strategy to Recycle Mixed Plastic Waste

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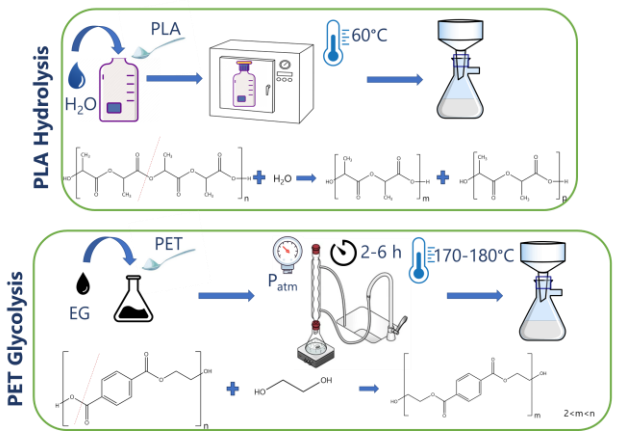
Introduction

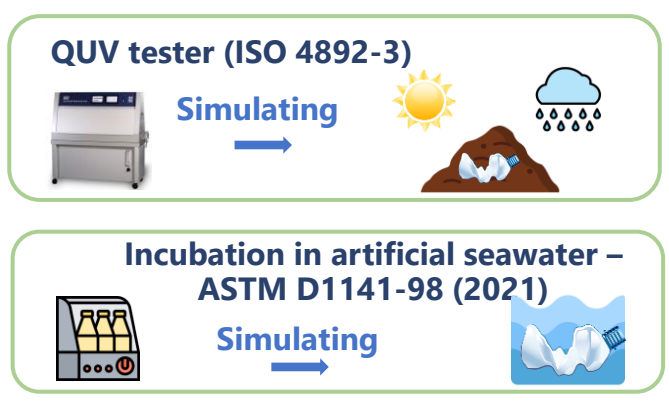
PLA and PET slow degradation rates raise concerns regarding environmental pollution. Due to similar applications and properties, post-consumer PLA is anticipated to contaminate PET waste streams, causing hazing and degradation in rPET. Selective enzymatic depolymerization of PLA/PET mixtures is herein suggested as an innovative route for plastic waste separation and recycling.

Experimental Part

Chemical depolymerization



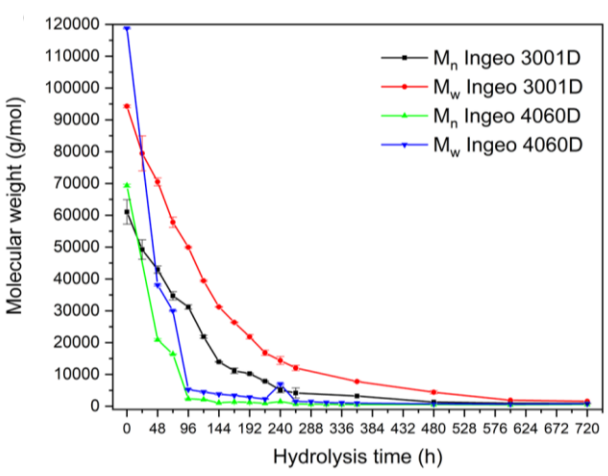
Accelerated weathering



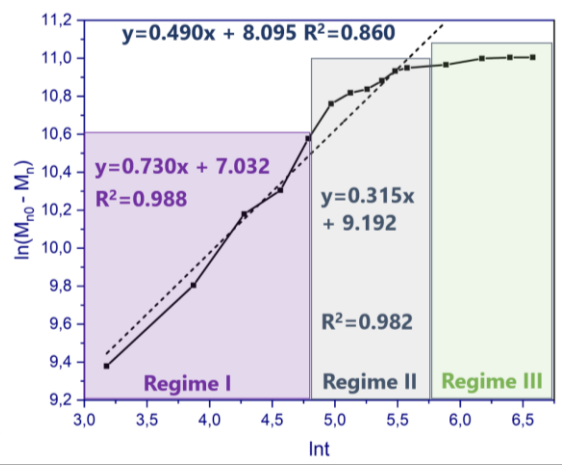
Results and Discussion

Chemical depolymerization & kinetics

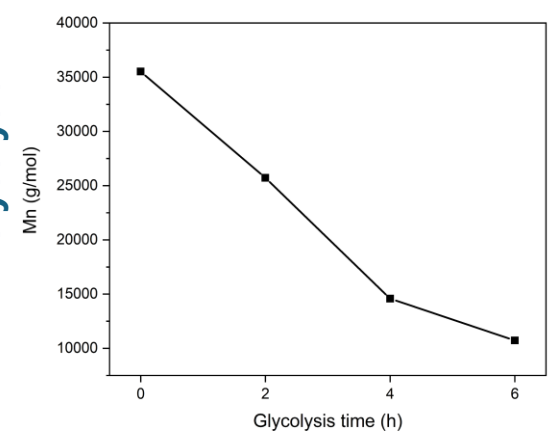
PLA Hydrolysis



$$r = -\frac{d\overline{M}_n}{dt} = kt^n \Rightarrow \overline{M}_{n0} - \overline{M}_n = \frac{k}{n+1} t^{n+1}$$



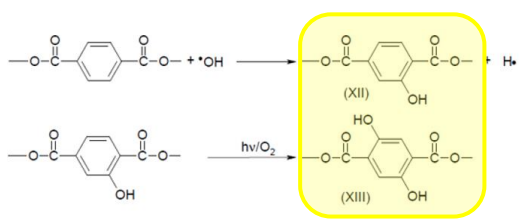
PET Glycolysis

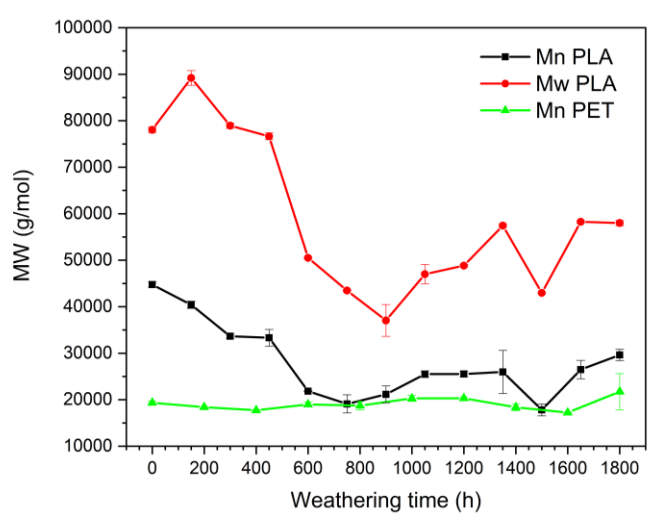


Non- autocatalytic end-group models						
$r = -\frac{d[COO]}{dt} = k[COO]^n$						
n	*k* units	$1000k_{plot}$	R^2	$1000k_{mean}$	RSD (%)	ΔS^2
0	meq/(kg h)	$1.1 \cdot 10^4$	0.970	$8.8 \cdot 10^3$	33.9	6.1
1	1/h	$2.1 \cdot 10^2$	0.985	$1.9 \cdot 10^2$	15.9	$1.8 \cdot 10^{-4}$
Power-law model						
$r = -\frac{dM_n}{dt} = k t^n$						
n	*k* units	$1000k_{plot}$	R^2	$1000k_{mean}$	RSD (%)	ΔS^2
-0.13	kg/(meq $h^{0.87}$)	4.87	0.960	4.89	10.1	$2.6 \cdot 10^{-10}$

Accelerated Weathering

PET photo-oxidation





Conclusions

Different PLA and PET waste models were prepared to simulate improper disposal:

- Kinetic models predicting the PLA and PET oligomers' molecular weight during hydrolysis and glycolysis were developed.
- PET: susceptible to UV radiation during accelerated weathering, but no chain scission due to hydrolysis or photolysis.
- PLA: susceptible to hydrolysis and photolysis, up to a critical value at 600 h of accelerated weathering.

Acknowledgement

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