Assessing Biobased and Recycled Polymers for a More Sustainable Toilet Flush System Design

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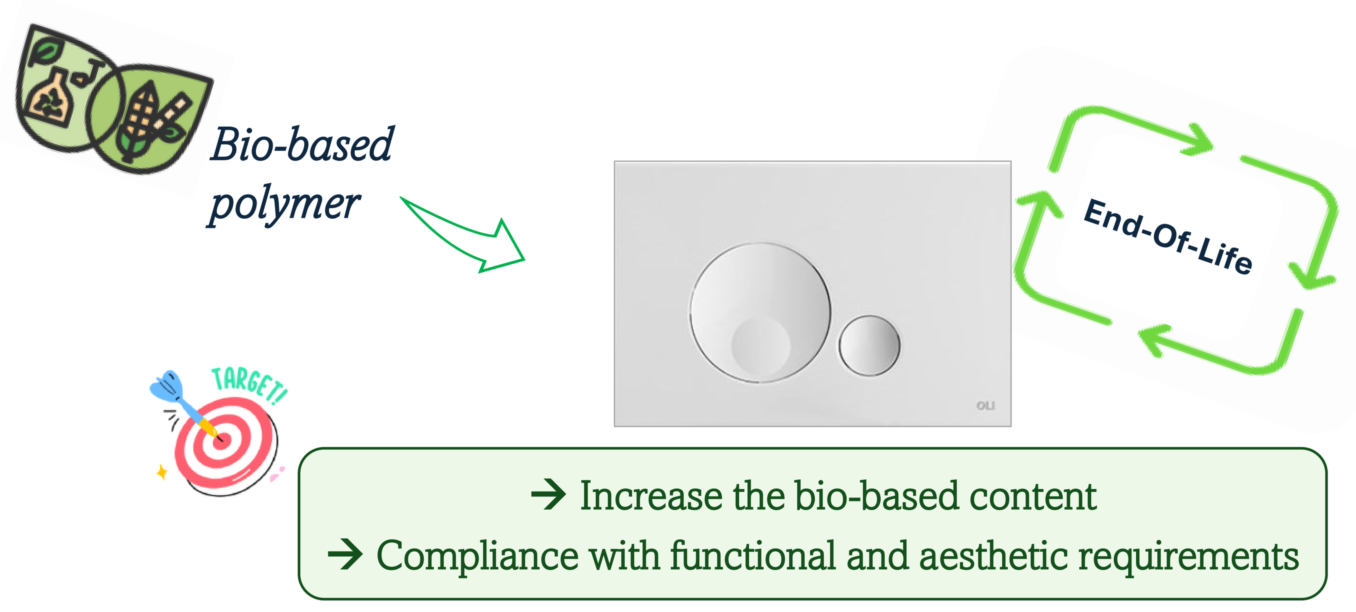
Challenge

Massive production of polymers,[1] combined with their fossil-origin and low recycling rates, is causing severe environmental issues. Finding sustainable polymer solutions that can compete in properties and still being cost competitive is a major challenge to industry today.

OLIPush Project

"OLIpush - Redesign for greater circularity and a smaller environmental footprint" project focuses on finding more sustainable polymers to use in structural and functional components of a flush toilet system.



Task 1

Survey of commercially available bio-based polymers able to replace the fossil-based acrylonitrile-butadiene-styrene (**ABS**) in flush plates

1 – Identification of key properties of the fossil-based ABS.

2 - Comprehensive survey of commercial bio-based polymers to meet requirements.

Properties	Fossil-ABS	Bio-1	Bio-2
Injection molding	Yes	Yes	Yes
Physical properties			
Density	1.05 g/cm³	1.05 g/cm³	1.05 g/cm³
Melt flow index	18 g/10 min [(A)]	18 g/10 min [(A)]	28 g /10 min [(A)]
Mold shrinkage	0.04 to 0.70%	0.04 to 0.70%	0.4 – 0.7%
Water resistance	0.2 – 0.45%[(B)]	0.2 – 0.45%[(B)]	0.3%
Mechanical properties			
Flexural modulus	2.2 MPa	2.2 MPa	2.4 MPa
Resistance to impact	19 KJ/m²	19 KJ/m²	16 KJ/m²
Thermal properties			
Deflection temperature	83 ºC [(C)]	83 ºC [(C)]	95 ºC [(D)]
Vicat softening temperature	104 °C [(E)]	104 °C [(E)]	95 ºC [(E)]

[(A)] test conditions 220 °C / 10 kg; [(B)] Immersion 24h;
[(C)] test conditions: Izod, 1.8 MPa, unannelated, 23 ºC;
[(D)] test conditions: charpy notched, 1.8 MPa, 23 ºC ;
[(E)] test copnditions: 1 kg, 50 °C/h.

Chosen Bio-based polymers

Task 2

Evaluation of end-of-life poly(propylene) (**PP**) and poly(oxymethylene) (**POM**), originally produced by OLI-Sistemas Sanitários S.A. company, to assess their potential for reintroduction into the production process.

Characterization

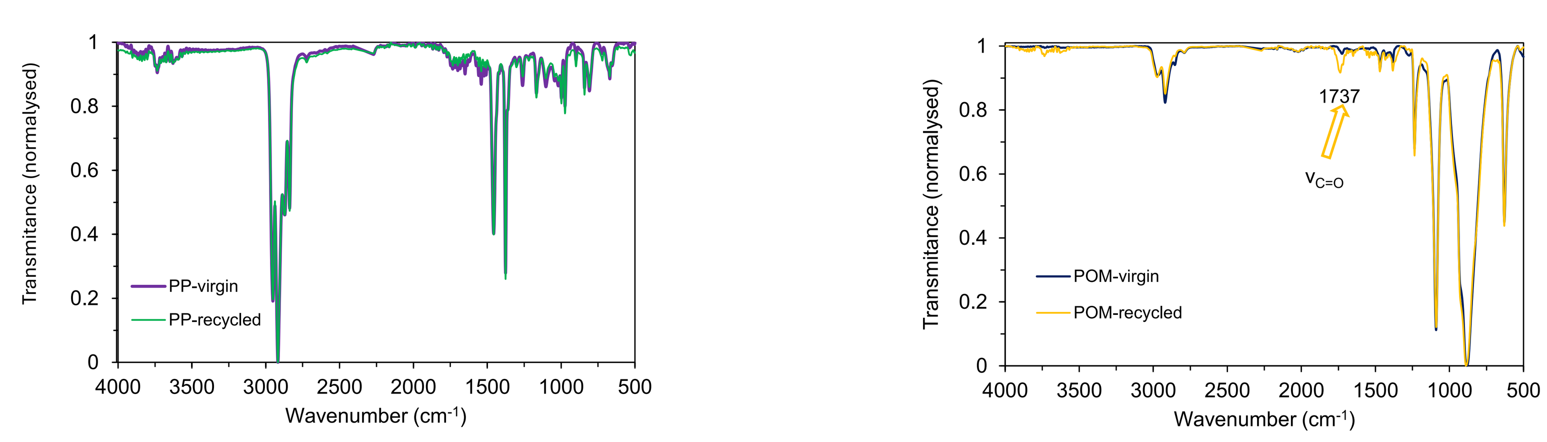


Figure 1 – Normalized FTIR of virgin and recycled PP and POM specimens

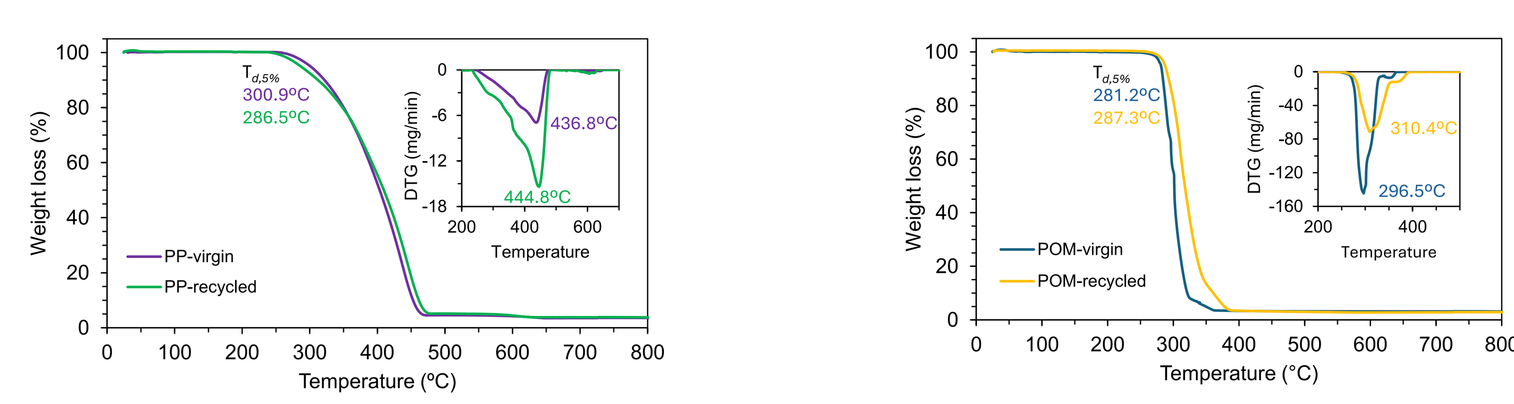


Figure 2 – TGA thermograms of virgin and recycled PP and POM. Inset: DTG of the corresponding polymers

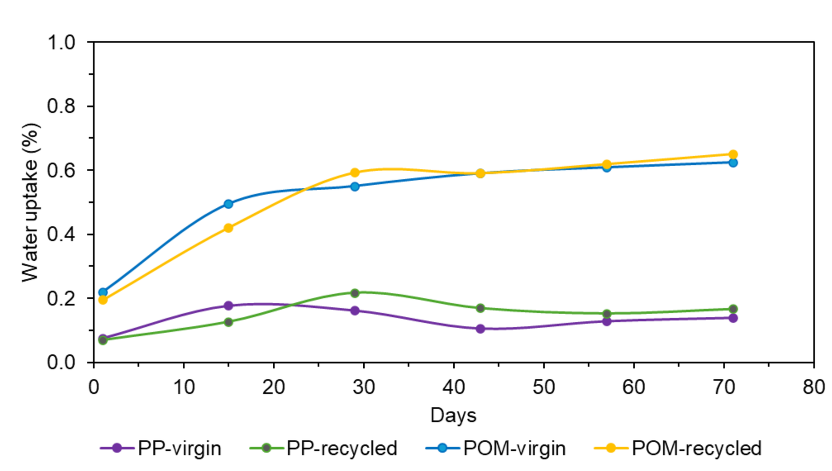


Figure 3 – Water uptake by immersion of virgin and recycled PP and POM specimens

Results

- ✓ The FTIR spectra of virgin and recycled PP show negligible changes in polymer structure. In contrast, FTIR spectrum of recycled POM shows a more intense band at 1737 cm^{-1}, attributed to C=O function, which may indicate some degree of thermal- or photo-oxidation side reactions.
- ✓ TGA thermograms shows decreased thermal stability for recycled PP and increased for recycled POM, as compared to the virgin counterparts.
- ✓ Water uptake results shows that even after 70 days of immersion in water, both virgin and recycled PP and POM showed similar behaviour, respectively.

Acknowledgements

Study developed under Project "Agenda ILLIANCE" [C644919832-00000035|Project nº 22], financed by PRR—Plano de Recuperação e Resiliência under Next Generation EU from the European Union; also under CICECO-Aveiro University, UIDB/50011/2020 (DOI 10.54499/UIDB/50011/2020), UIDP/50011/2020 (DOI 10.54499/UIDP/50011/2020), LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through FCT/MCTES (PIDDAC); and under the project/support UID/00481 – Centre for Mechanical Technology and Automation (TEMA). PSSL acknowledges "Agenda ILLIANCE" for research contract.

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Financiado pela União Europeia NextGenerationEU