One-pot depolymerization-repolymerization of PET waste into sustainable photocurable liquid copolyesters for high-performance additive manufacturing

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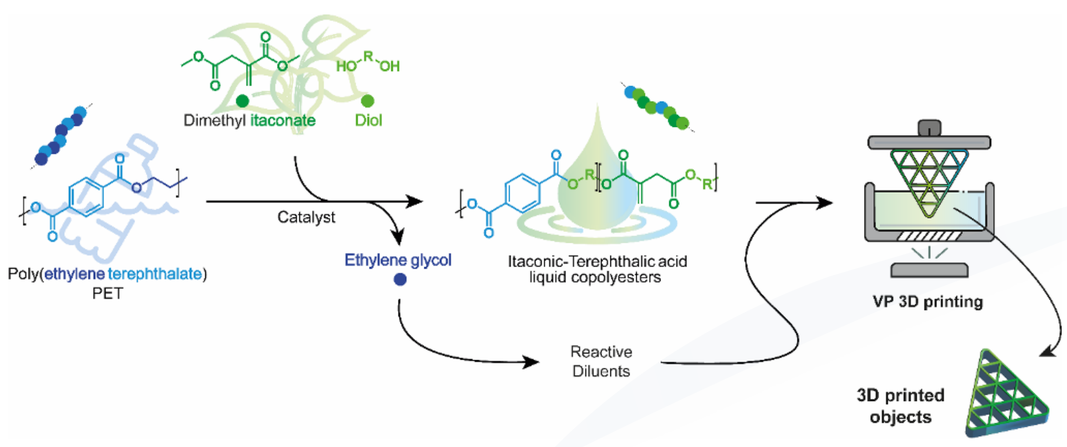
Introduction and background

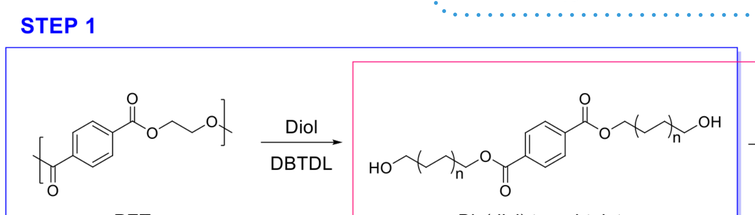
Marine pollution is mainly caused by plastic waste, such as ***waste PET***, which takes an extremely long time to degrade. This makes it urgent to reduce plastic production and spread since mechanical recycling has recovered only **37.6%** of plastic waste in Europe[1,2].

In this work, we propose a sustainable *one-pot, two-step* method to convert post-consumer PET into **high-performance photocurable polyesters** for VP 3D printing[3].

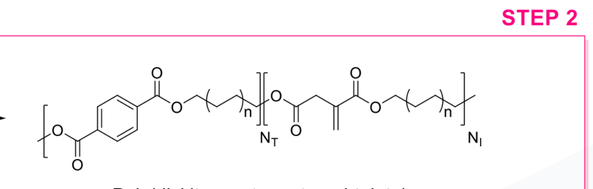


Polymer synthesis and chemical characterization

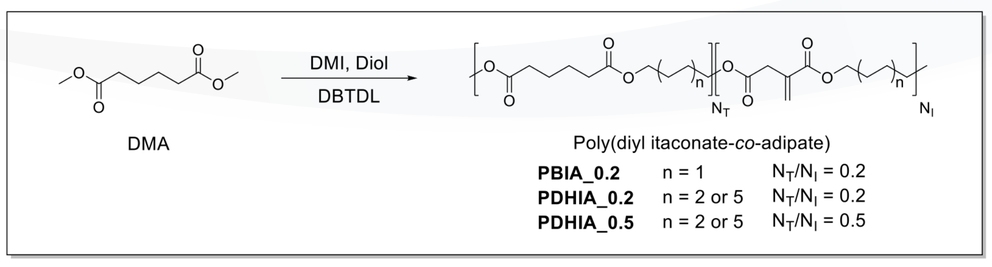
STEP 1



STEP 2

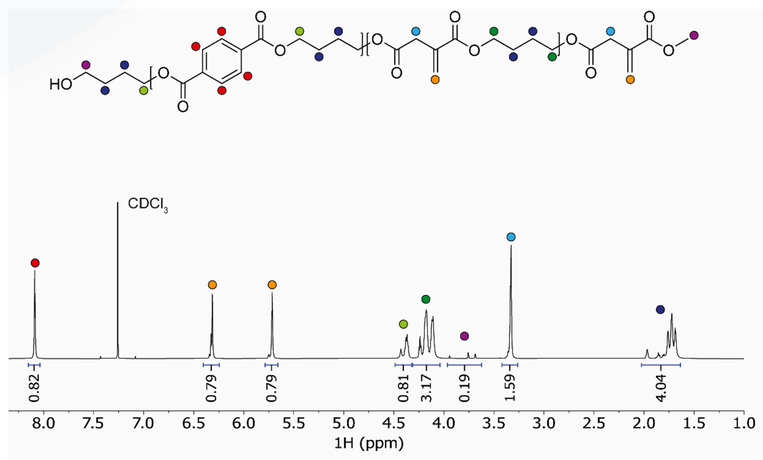


PBIT_0.2	n = 1	N_T/N_I = 0.2	**PDHIT_0.2**	n = 2 or 5	N_T/N_I = 0.2
PBIT_0.5	n = 1	N_T/N_I = 0.5	**PDHIT_0.5**	n = 2 or 5	N_T/N_I = 0.5

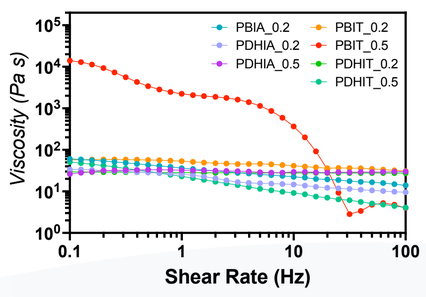


PBIA_0.2	n = 1	N_T/N_I = 0.2
PDHIA_0.2	n = 2 or 5	N_T/N_I = 0.2
PDHIA_0.5	n = 2 or 5	N_T/N_I = 0.5

^{1}H-NMR *and* ***ATR-IR*** *characterization*



19 photocurable VP formulations utilised the synthetised rPET polyesters at 25%, 50%, and 75% concentrations, along with a ***reactive diluent*** mixture of 2-hydroxyethyl methacrylate (HEMA), 1,6-hexanediol diacrylate (HDDA), and ethylene glycol phenyl ether acrylate (EGPEA) in a **10:7:37** weight ratio.



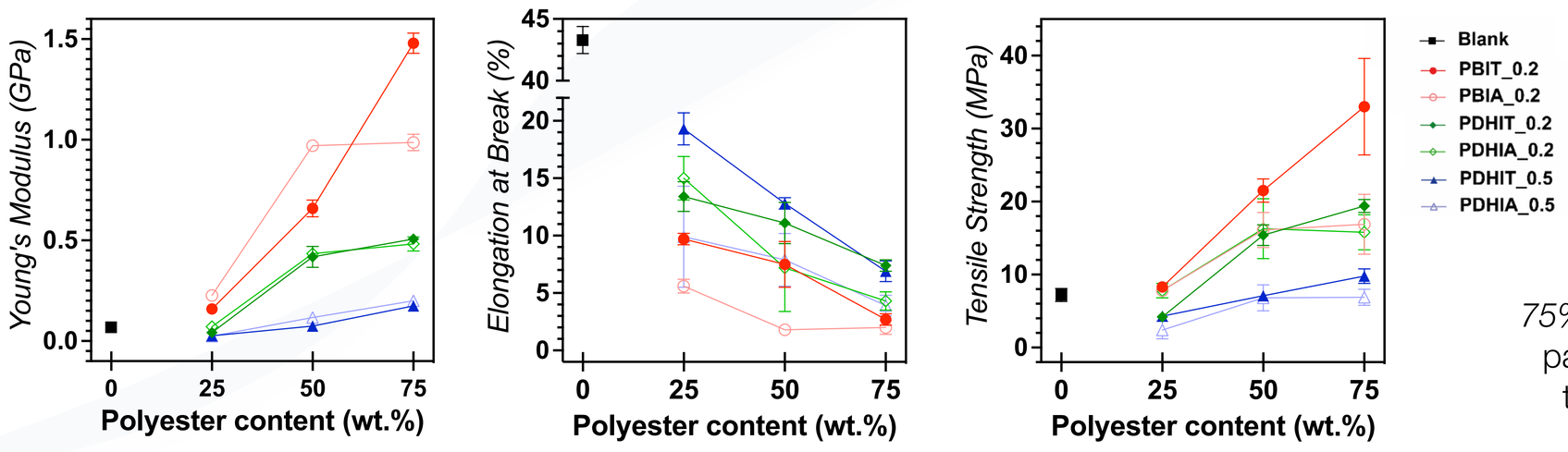
Rheological *characterization*

GPC-SEC *analysis*

TGA analysis

Mechanical and thermal characterization

Tensile and ***3PB*** test



Increasing of the ***mechanical properties*** *and* ***thermal stability*** *of the resins from T_{deg} of 359 °C up to 372 °C in* ***PDHIT_0.5***

75% PDHIA_0.5 honeycomb-patterned hollow tennis ball, thus containing *22 wt.%* of recycled PET.

Conclusions and bibliography

The resulting photocurable resins, containing up to **22 wt.%** recycled PET and 83 wt.% total sustainable content, showed excellent mechanical and thermal properties. The best formulation achieved a Young's modulus of **1.4 GPa** and tensile strength of **54 MPa**, record values for itaconic acid-based 3D printing resins demonstrating the potential of this recycling strategy to create high-performance, sustainable materials for additive manufacturing.

1. Eurostat, Recycling rate of plastic packaging waste in the European Union (EU-27) from 2010 to 2020 [Graph].
2. F. Cao, L. Wang, R. Zheng, L. Guo, Y. Chen and X. Qian, RSC Adv., 2022, 12, 31564–31576.
3. 3. Carmenini et al., One-pot depolymerization-repolymerization of PET waste into sustainable photocurable liquid copolyesters for high-performance additive manufacturing, Green Chemistry, 2025, Submitted.

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