

Green Solvent-Based Recycling of Riverine Plastic Waste

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Recycling polypropylene (PP) recovered from marine or riverine litter is particularly challenging. Biofouling, pigments, additives, and prolonged UV exposure degrade the polymer, reducing the effectiveness of conventional mechanical recycling. The low market value of recycled PP further limits industrial interest, highlighting the need for new pathways that both divert this waste stream and generate higher-value products. One promising route is solvent-based recycling, where collected materials are dissolved in selected solvents (e.g., xylene, toluene, acetone, hexane, DMF), enabling separation of the polymer from additives, dyes, and contaminants through filtration, centrifugation, or phase extraction [1,2]. Dissolution time and temperature strongly affect polymer recovery: higher temperatures increase yield but may accelerate degradation, so conditions must be optimized to maximize recovery while minimizing thermal or oxidative damage [3]. When degradation is controlled, recycled marine PP can retain properties close to virgin material. Because many common solvents are hazardous, identifying greener alternatives with suitable polymer affinity is crucial. **In this study, cymene was selected as a sustainable substitute for xylene due to its similar solubility behavior toward PP (Hansen parameters, Fig. 1). The optimal dissolution temperature was evaluated to achieve high recovery without inducing degradation. PP waste cups collected from the Aarhus River within the COP project served as the feed material.**

SOLVENT-BASED RECYCLING

PP was dissolved in cymene up to a level of 15 wt.% at 90, 100, 110, 120 and 130 °C under stirring at 300 rpm. The hot solution (40 mL) was poured into 160 mL of antisolvent (ethanol) and the system was kept at room temperature overnight, resulting in recovered polymer powders.

POLYMER CHARACTERIZATION

The obtained powders have been characterized by FTIR-ATR and DSC analyses

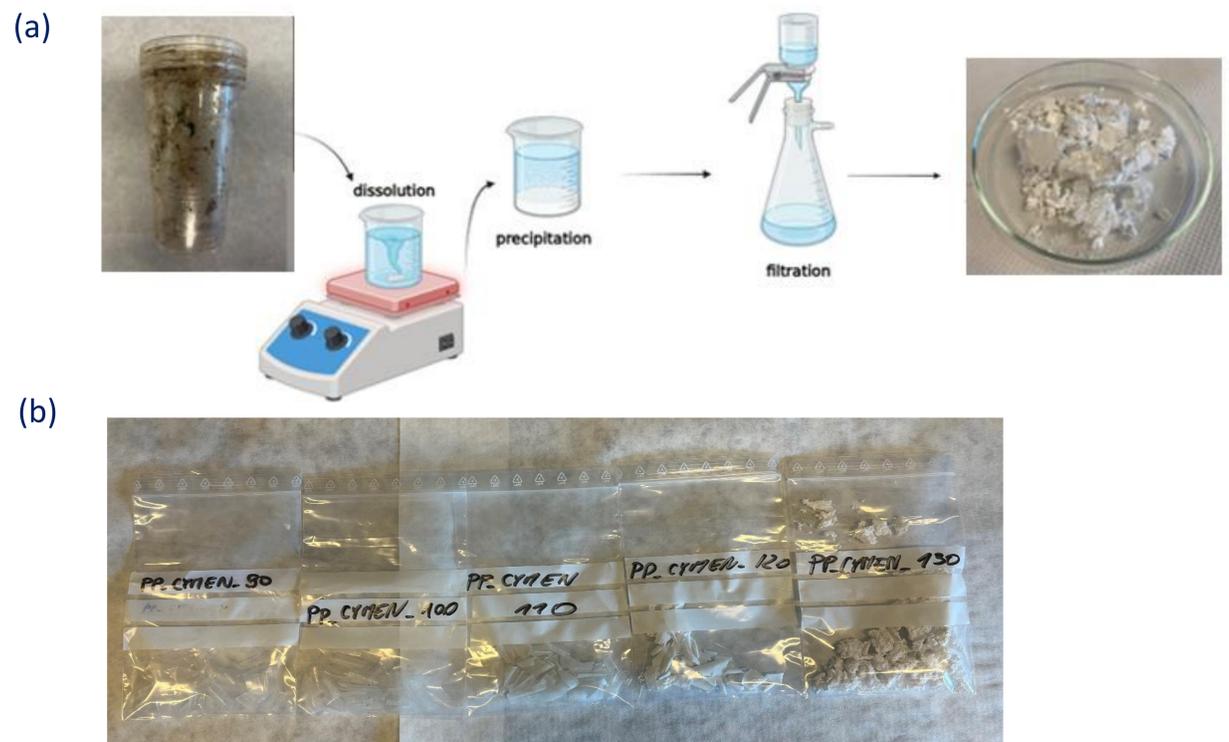


Fig. 2 (a) Scheme of the solvent in the dissolution-precipitation method for PP recycling, (b) recovered PP powders at different temperatures.

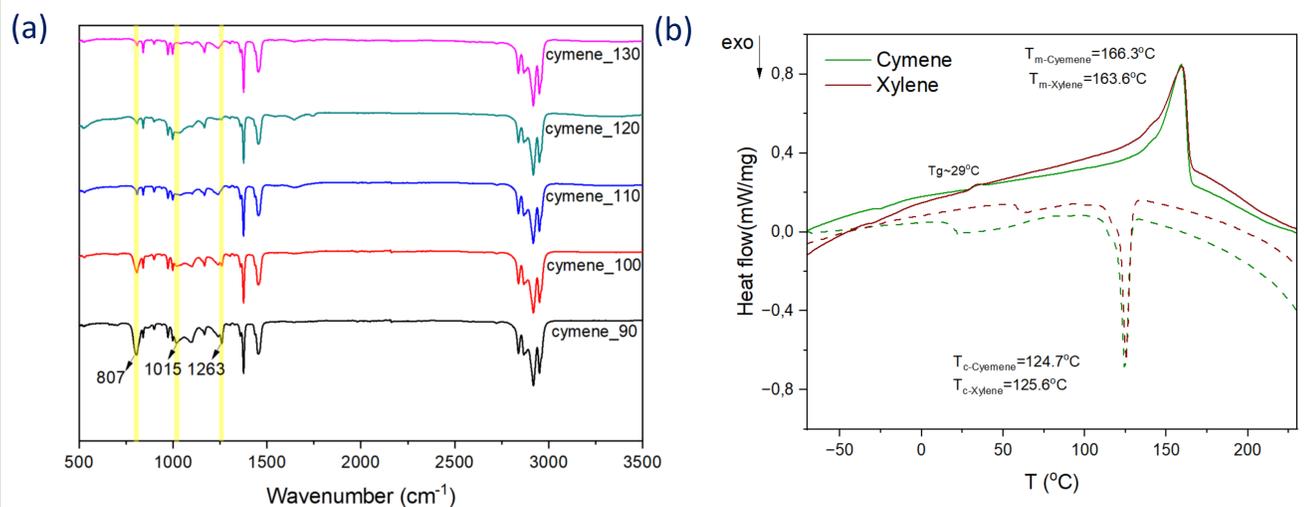


Fig. 3 (a) FTIR spectra of PP dissolved in cymene at different temperatures and (b) DSC curves of PP dissolved in cymene and xylene at 130°C.

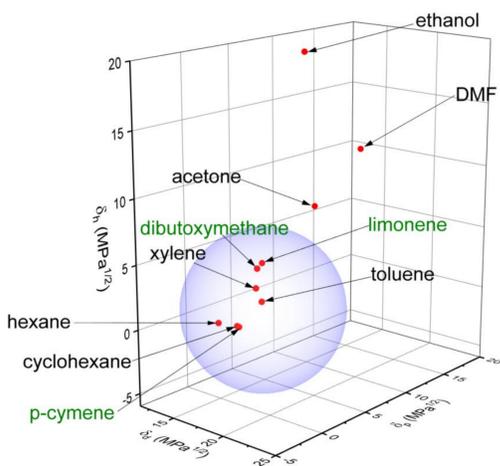


Fig. 1 Hansen solubility parameter sphere model for PP

CONCLUSIONS

- Notable differences in band intensities (linked to PP crystallinity, 807 cm^{-1} and 1015 cm^{-1}) appeared between samples processed at varying dissolution temperatures.
- These spectral variations confirm that the loss of transparency is caused by recrystallization-induced microstructural changes.
- PP recovered using the green solvent (cymene) exhibited thermal properties comparable to PP dissolved in a conventional solvent.

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