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BOOK OF ABSTRACTS

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Boosting PLA Recyclability via Phenol-Rich Fractions from Fast Pyrolysis of Logging Residues

Mattia Di Maro¹, Elmeri Pienihäkkinen², Petri Widsten², Taina Ohra-aho², Giovanna Gomez D'Ayala³, Giovanni Dal Poggetto³, Giulio Malucelli⁴, Donatella Duraccio¹

¹Istituto di Scienze e Tecnologie per L'Energia e La Mobilità Sostenibili CNR Sede Secondaria Strada Delle Cacce, 73 10135, Torino, Italy. ²VTT Technical Research Centre of Finland Ltd., Tekniikantie 21, 02150, Espoo, Finland.

³Istituto per i Polimeri, Compositi e Biomateriali (IPCB) Via Campi Flegrei 34, Comprensorio "A. Olivetti" 80078, Pozzuoli, Italy. ⁴Politecnico di Torino - Dipartimento di Scienza Applicata e Tecnologia, Viale Teresa Michel 5, 15121, Alessandria, Italy

Abstract

Poly(lactic acid) (PLA) is a thermoplastic polymer derived from renewable resources, which is emerging as a viable alternative to conventional petroleum-based polymers for composite fabrication. It offers good mechanical performance, can be readily melt-processed, and is suitable for mechanical recycling. However, PLA is highly susceptible to thermal and thermo-oxidative degradation during melt processing and reprocessing, which significantly limits its recyclability and the retention of its mechanical and functional properties. A common strategy to mitigate this issue is the incorporation of antioxidants into the polymer matrix, which stabilize polymer chains by inhibiting degradation reactions and thereby help preserve PLA's performance over multiple processing cycles.

Within the framework of the European project BioPhenom: Multifunctional Biophenols for Safe and Recyclable Materials, and in alignment with sustainable development and circular-economy principles, this work investigates the use of phenol-rich fractions (PF) derived from the fast pyrolysis of logging residues as bio-based antioxidant additives for PLA. PLA was melt-mixed with two PF loadings (2 and 5 wt%), and the recyclability of the resulting materials was assessed by reprocessing the PLA/PF composites following an initial compression-molding step. The recycled composites were subsequently remolded and characterized, and the same processing steps were performed on unfilled PLA for comparison. Structural (FTIR, WAXD, GPC), thermal (TGA, DSC) and mechanical properties were evaluated before and after recycling.

The results show that PF acts as an effective stabilizing agent during the first processing cycle and significantly mitigates the decrease in molecular weight and mechanical performance upon recycling. Overall, the phenol-rich fraction enhances PLA's resistance to degradation, supporting improved material stability and recyclability.

Keywords

polylactic acid, recycling, composites, polyphenols, fast pyrolysis