Eco-friendly polyurethane resins: BHET-driven integration for end-of-waste solutions in a circular economy perspective

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The enormous worldwide employment of single-use plastic materials is leading to ever-increasing waste generation. Therefore, the use of the latter as feedstock for the production of waste-derived materials has emerged as a hot topic within both the scientific community and the industrial area. However, to boost the creation of an effective and reliable market for secondary raw materials, an essential requirement for circular materials is the ease of implementation in current processes and products[1].

In this perspective, we have started to investigate bis(2-hydroxyethyl) terephthalate (BHET), a low molecular weight diol as the main product of the glycolysis of polyethylene terephthalate (PET), as a promising circular component in the formulation of more sustainable ready-to-market polyurethanes[2]. This approach is particularly appealing considering that the end-of-life of a preeminent thermoplastic polymer on a global scale (i.e. PET) would serve as feeding for the most prevalent thermosetting polymer worldwide[3] (i.e. PUs), thereby offering an alternative route for closing the loop on a not negligible portion of PET waste in an end-of-waste perspective.

In this contribution, we explored an innovative approach to implement BHET as a secondary raw material in the formulation of NCO-terminated prepolymer tailored for thermosetting resins. BHET was seamlessly integrated into the prepolymer formulation, avoiding any modifications to the industrial process and demonstrating outstanding compatibility with other components within the mixture. The impact of BHET concentrations and its relative ratio with polyether and polyester constituents of the prepolymer on the final resins were systematically evaluated, showcasing the feasibility of fine-tuning the physical, chemical, and mechanical properties of polyurethanes while preserving market-level properties. In conclusion, we proved the successful incorporation of a significant amount of BHET (up to 20% w/w) into novel, eco-friendly prepolymers using a solvent-free methodology, without necessitating additional steps in the industrial workflow.

[1] Bucknall, D.G., Philos. Trans. R. Soc. A (2020) 378, 2176.
[2] Mariotti, N., Viada, G., Galliano, S., Menozzi, A., Tammaro, F., Gianelli, W., Bonomo, M., Barolo, C., J. Clean. Prod. (2023) 408, 137161.
[3] https://plasticseurope.org/knowledge-hub/plastics-the-facts-2022/

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