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Sustainable Recycling of Bio-Based Composite Polyurethane Foams Using Green Chemicals

Abstract: Polyurethanes (PU) represent the most versatile materials produced in several forms (foams, coatings, sealants, and elastomers) and used in a large variety of markets, with a global production of 25.78 million metric tons in 2022 [1]. Among all PU materials, foams are the largest subgroup representing more than 60 % of the overall PU market. They are obtained by the simultaneous reactions between polyaddition between polyols and di-isocyanates and blowing between water and di-isocyanates. However, being thermosetting materials, their disposal and recycling are not trivial; indeed, at the end of life, they are generally fated to landfills or incinerators. At present, mechanical and chemical recycling routes (mainly based on glycolysis) have been reported in the literature within the framework of circular economy, aiming at recovering end-life materials and reintegrating them as feedstocks in the synthesis of new materials.

In this work, composite PUR foams for thermal insulation applications, obtained from bio-based polyols and sustainable fillers i.e., diatomite/blast slag (at 40 wt.%), undergo chemical recycling based on aminolysis. Aminolysis is carried out in the presence of sustainable diamines at different concentrations with respect to the foam mass (1:1 and 1:0.6) [2].

The resulting bio-based depolymerized systems are then used as a precursor in the synthesis of second-generation PU foams, by partially replacing isocyanates. It is found that the new-generation bio-based foams present thermal insulation properties comparable to those of the original foams, corroborating the possibility of performing upcycling and offering new perspectives to the circular economy concept.

Keywords: sustainability, bio-based materials, polyurethane foams, chemical recycling, bio-based diamines, second-generation materials.

References:

[1] www.statista.com
[2] Recupido et al, Ecotoxicological and Environmental Safety 2024, 269.

Biography: Federica Recupido is a Temporary Researcher at IPCB-CNR. She graduated as a chemical engineer in 2016 at the University of Salerno (Italy). She got her Ph.D. degree in 2022 at Aristotle University of Thessaloniki (Greece), whereas part of her Ph.D belonged to the European Joint Doctoral Program in Complex Wetting Phenomena (PINT-GA-2013-607861) funded by the EU (Marie Sklodowska-Curie actions). In 2021, she joined IPCB-CNR, where she currently works on the design and development of composite functional polymeric materials and more specifically, foamed polyurethane materials with tunable properties, obtained from renewable precursors and bio-based fillers, for different applications (automotive, construction building, cultural heritage).

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