Increasing bio-based and circular content of a thermosetting polyurethane for encapsulation of optoelectronic devices: a multivariate investigation

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In recent years, the use of polyurethanes (PUs) has enormously increased in the industrial context for their versatile synthesis and tuneable physicochemical properties. Nowadays polyurethanes are used in different realities, from building construction to automotive, up to the biomedical field. Thanks to the optimization of prepolymers and formulations, polyurethanes have proven to be excellent substitutes for less efficient metal and plastic materials [1,2]. However, the wide use of fossil-based components leads to negative environmental impacts and poor sustainability. Bio-based and recycled precursors can be valid candidates for an industrial symbiosis toward more sustainable and circular PUs [3].

In this work, a facile and solvent-free procedure has been presented for a new and eco-friendly PU formulation in optoelectronic field. The formulation has been optimized starting from a commercial polyurethane resin for LED encapsulation provided by Demak® Polymers, whose fossil-based components have been substituted with bio-based and recycled ones. Virgin bis(2-hydroxyethyl) terephthalate (BHET) was directly implemented in the formulation as waste-derived material without any further treatments. Throughout this optimization process, market-level values of optical transparency, UV light and thermal stability have been maintained in the modified polyurethane. Nevertheless, the real implementation of such new materials in polymer industry is not always obvious and straightforward due to many formulation and process variables involved. To face all of them, a multivariate statistical approach (Design of Experiments) was successfully applied. Such innovative method allowed the understanding of the most influential factors on the formulation process, ensuring the most economical and efficient way of analysis [4].

Optimized formulation allows the partial replacement of the fossil-based raw materials, obtaining a PU with a 24.4% of green inputs and comparable to the commercial counterpart in terms of transmittance, thermal stability, and with outstanding long-term stability.

References

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