INCREASING BIO-BASED AND CIRCULAR CONTENT OF THERMOSETTING POLYURETHANES FOR ENCAPSULATION OF OPTOELECTRONIC COMPONENTS: A DESIGN OF EXPERIMENT APPROACH

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Introduction

In recent years, the use of polyurethanes (PUs) has enormously increased in the industrial context thanks to their versatile synthesis and tunable physicochemical properties. Nowadays, PU-based materials are massively used in many fields; however, they present some critical environmental concerns, like the massive use of fossil-based components and mercury-based catalysts (now significantly restricted by European legislation). It is, therefore, essential to implement alternative reagents and catalysts, aiming to improve the sustainability of polyurethanes while reducing resource consumption and carbon footprint. Bio-based and recycled precursors can be valid candidates for an industrial symbiosis toward more sustainable and circular PUs.

Material and Methods

In this contribution, a commercial polyurethane resin formulation for LED encapsulation has been investigated to implement bio-based and recycled components and remove the toxic catalyst while maintaining optimal characteristics in terms of optical transparency, UV light and thermal stability. Specifically, a facile and solvent-free procedure will be presented for a new and eco-friendly PU formulation in the optoelectronic field.

An Experimental Design (DoE) approach was successfully applied. The DoE is a multivariate statistical method that simultaneously evaluates the influence of different factors on the selected responses, giving information on the whole experimental domain.

Results and Discussion

Fossil-based components have been substituted with bio-based and recycled ones. Bis(2-hydroxyethyl) terephthalate (BHET) was directly implemented in the formulation as an example of waste-derived material.

Market-level optical transparency ($\%T_{555nm} = 88\%$) and thermal and UV light stability values have been maintained throughout this optimization process. DoE allows us to face all the formulation and process variables involved, understand the most influential factors on the formulation process, and ensure the most economical and efficient analysis.