Formulation of aliphatic thermosetting polyurethane resins with characteristics of innovation and sustainability

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In recent years, the use of polyurethanes (PUs) has enormously increased in the industrial context for their versatile synthesis and tunable physicochemical properties. Nowadays PU-based materials are massively exploited in a plethora of applications, from adhesives to foams, from building insulations to athletic tracks.[1] Unfortunately, the conventional synthetic pathway of PUs still presents several sustainability-related criticisms. Just to mention, reagents and precursors derived mainly from virgin and petroleum-based sources and toxic catalysts are still widely exploited in PU formulation to obtain fast and reliable polymerization.
Recently, the EU-promoted shift towards circular economy approaches and the quest for sustainable plastics is pushing both industries and academic research to utterly innovate the whole PUs life-cycle, from raw materials selection to end-of-life polymers disposal.[2] In this perspective, the use of bio-based and/or waste-derived precursors in innovative PU formulations is a promising approach toward eco-sustainable polymers, preventing the fossil-dependency and reducing the impacts of the whole PUs value chain on both climate and the environment.[3] In this context, the synthesis of bio-polyols from triglycerides of fatty acids[4] as well as the replacement of toxic catalysts are valuable example of promising route in the winding path to sustainable PUs.[5] However, to truly improve the sustainability of the whole production, the process variables have also to be reconsidered. Aiming at coupling precursors sustainability and all the different formulative parameters, a chemometric approach as the Design of Experiments (DoE) would represent a key-enabling optimization approach compared to traditional one-factor-at-a-time (OFAT) method.[6] A thoughtfully designed multivariate analysis would allow energy, materials and time saving leading to reduced costs and minimized waste production, paving the way to truly sustainable PU formulations.

Keywords: Polyurethanes, Sustainability, Design of Experiment.

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