SYNTHESIS AND INVESTIGATION OF BIO-BASED VITRIMERS DERIVED FROMRENEWABLE RESOURCES

Viltė Šereikaitė[1], Sigita Grauželienė[1], Jolita Ostrauskaitė[1]

[1] Lithuania, Kaunas University of Technology, Faculty of Chemical Technology, Department of Polymer Chemistry and Technology
vilte.sereikaite@ktu.edu

Polymers from natural sources provide ecological benefits, being renewable, accessible, relatively easy to extract, biocompatible, and non-toxic [1]. Vitrimers, a class of covalent adaptable networks with dynamic covalent bonds, allow reversible bond exchange, combining thermoset rigidity and thermal stability with stress relaxation, self-healing, reprocessability, and recyclability [2]. These features make vitrimers promising for sustainable and durable applications, including coatings, packaging, biomedical devices, and wearable systems [3].

In this study, a series of vitrimers was synthesized by photopolymerization of resins containing natural oil-based monomers and various bio-based comonomers, using ethyl-(2,4,6-trimethylbenzoyl)-phenylphosphinate as the photoinitiator. Real-time photorheometry was used to monitor the photocuring process, showing the photocuring rate and the influence of monomer content on resin properties. The chemical structure of vitrimers was confirmed by Fourier transform infrared spectroscopy and Soxhlet extraction. The thermal and mechanical properties of vitrimers were investigated by thermogravimetric analysis, dynamic thermomechanical analysis, and tensile testing.

It was determined that changes in the initial resin composition affected the photocuring rate, as well as the rheological, thermal, and mechanical properties of the vitrimers. The results of photocuring kinetics showed that monofunctional monomers exhibited a longer induction period and gelation time, although the values of these characteristics decreased in the mixed systems. In three-component formulations, increasing the amount of monofunctional monomers reduced viscosity and shrinkage, while the gelation time and induction period were extended, and the storage modulus remained almost unchanged. The presence of aromatic moieties provided rigidity to the network, while reducing intermolecular interactions, resulting in a rigid material. The self-welding experiment showed that parts of the vitrimer specimen can self-weld at elevated temperatures while maintaining the desirable mechanical properties of the original vitrimer. This phenomenon is attributed to dynamic covalent bond exchange reactions and, probably, thermal polymerization of the remaining free functional groups. This property is important for repairing materials and increasing their durability.

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