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Bio-based reversible covalent networks and their application in soft robotics

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Elastomeric and glassy thermoset networks could be made more sustainable by increasing their lifetime in applications, by making them reprocessable and/or recyclable, and by using green approaches to synthesize them from biobased, sustainable materials. Biobased reversible covalent networks are one way to approach these targets.
In our work, the thermoreversible furan-maleimide Diels-Alder reactions are used to produce reversible elastomeric and glassy thermoset networks. Elaborate studies were made of the reaction kinetics and the influence of diffusion-controlled reactions, the chemorheological changes in the materials, and the mechanical properties and their recovery after damage. Using the kinetic information, we can predict the effect of composition, processing and storage conditions, pretreatments, healing protocols,… which supported the development of ambient temperature self-healing materials, their processing, and their use in soft robotics actuators, heaters, and sensors. To further enhance the sustainability of these self-healing and reprocessable reversible thermoset networks, bio-based building blocks, e.g., derived from lignin, fatty acids, and castor oil, are used, all providing materials showing favorable self-healing and reprocessability.

Short Bio

Guy Van Assche received his PhD from the Vrije Universiteit Brussel in 1998, working the experimental study and modelling of the pultrusion of unsaturated polyesters. After one-year stay at the Kyoto Institute of Technology (Japan), he continued as a postdoctoral researcher of the Fund for Scientific Research (FWO) at the Vrije Universiteit Brussel. His work initially focused on the development and application of advanced thermal analysis techniques, applied to gain a deeper understanding of polymer-based systems, including reactive polymers, polymer blends and solutions, nanocomposites, polymer-based photovoltaic blends, and self-healing polymers. In

addition to the more common methods for material characterization, modulated temperature DSC, rapid-scanning DSC, AFM-based thermal analysis, and simultaneous rheological and calorimetric analysis are some of the techniques used to investigate these material systems.

Since 2001 he is lecturer at the Faculty of Engineering of VUB, teaching courses in thermodynamics, chemical kinetics, advanced thermal analysis, advanced materials and polymer processing at bachelor and master level.