



NOVEL RECYCLABLE AND RESHAPABLE COMPOSITES THROUGH PHOTO-INDUCED FRONTAL POLYMERIZATION

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Efficient strategies for reusing thermoset materials hold significant potential to reduce material waste and promote sustainability. Developing novel thermoset polymers and composites through energy-efficient and environmentally friendly polymerization methods is a critical step in this direction. Key to this effort are advancements in the reprocessability, reshaping capability, and recyclability of these materials. This study focuses on the development of innovative photo-curable composites with controllable compliance and shape. The resin system is based on a reactive acrylate vitrimer system, capable of initiating a self-sustaining reaction triggered by light—known as photo-frontal polymerization [1]. This approach allows for the curing of thicker and larger composite samples using minimal energy input. In addition to energy efficiency, the material offers the ability to be reprocessed, reshaped and recycled. These properties stem from the reversible nature of covalently exchangeable ester bonds [2], categorizing the material as part of the vitrimer family. To integrate the reactive precursors effectively into the reinforcement phase, a vacuum-assisted liquid impregnation process is employed, resulting in the production of a vitrimer composite [3].

To conclude, this research will evaluate the possibility to produce high quality composites with a photo-frontally polymerizable system. It will assess the mechanical properties of the composites and evaluate their potential for reprocessability. A key focus will be understanding how the presence of the reinforcement and the matrix/reinforcement interface affect the curing process and the dynamics of disulfide bond rearrangement.

Papers related to the research:

- [1] C. Schmidleitner, M. U. Kriehuber, S. Schlögl, and E. Rossegger, "Frontal Polymerization of Covalent Adaptable Networks," Sep. 10, 2024, *ChemRxiv*. doi: 10.26434/chemrxiv-2024-k4vjd.
- [2] W. Alabiso *et al.*, "On-Demand Activation of Transesterification by Chemical Amplification in Dynamic Thiol-Ene Photopolymers," *Angew. Chem. Int. Ed.*, vol. 62, no. 45, p. e202311341, 2023, doi: 10.1002/anie.202311341.
- [3] J. Staal, E. Smit, B. Caglar, and V. Michaud, "Thermal management in radical induced cationic frontal polymerisation for optimised processing of fibre reinforced polymers," *Compos. Sci. Technol.*, vol. 237, p. 110009, May 2023, doi: 10.1016/j.compscitech.2023.110009.

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