Sustainable Interpenetrating Polymer Networks for lithography-based 3D-printing

Antonella Fantoni[a,b], Jo Carlos Schoup[a,b], Thomas Koch[c], Stefan Baudis[a,b] and Robert Liska[b]

[a]Christian Doppler Laboratory for Advanced Polymers for Biomaterials and 3D Printing, Getreidemarkt 9, 1060 Vienna, Austria

[b]Institute of Applied Synthetic Chemistry, Technische Universität Wien, Vienna, Austria

[c]Institute of Materials Science and Technology, Technische Universität Wien, Vienna, Austria

In the last decades, the demand for photopolymerizable resins in additive manufacturing technologies (AMTs) has grown exponentially. However, state-of-the-art monomers comprising (meth)acrylates are derived from fossil resources and suffer from insufficient mechanical properties (e.g. low toughness) due to the formation of highly-crosslinked and irregular polymer networks. [1] Herein, interpenetrating polymer networks (IPNs), produced by the combination of two or more independent polymer networks, are reported to improve the materials' final properties.

In this work, dual-curing strategies for sustainable IPNs consisting of a soft photopolymerizable methacrylate- and rigid thermally crosslinked epoxy-derived network were investigated. At first, both networks were optimized separately and characterized regarding their (photo)reactivity and (thermo)mechanical properties by means of (photo)-DSC, photorheology, DMTA and tensile tests. A co-reactivity study proved the orthogonality of the respective polymerization modes, allowing the preparation of bio-based hybrid materials. Comparison between the independent networks and synthesized IPNs highlighted enhanced network homogeneity and increased tensile toughness, without forfeiting T_G or tensile strength as a result of strong physical interaction between both networks.

---

[1] Voet, V. S. D., Guit, J., Loos, K., Sustainable Photopolymers in 3D Printing: A Review on Biobased, Biodegradable, and Recyclable Alternatives. Macromol. Rapid Commun. 2021, 42, 2000475.