SUSTAINABLE EPOXY-METHACRYLATE INTERPENETRATING POLYMER NETWORKS: broadening the scope of high-performance materials for stereolithography

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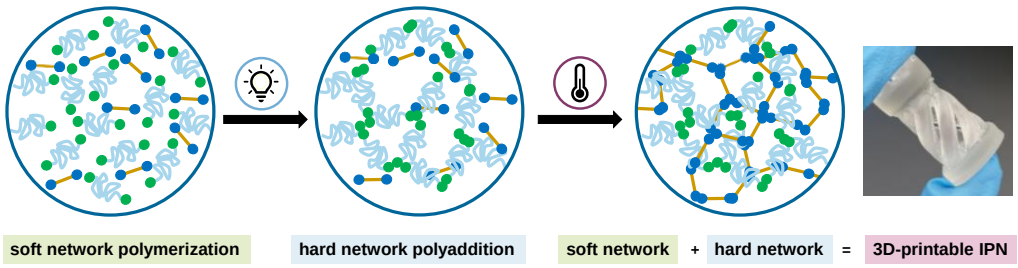
In the last decade, the global market for photopolymerizable resins in lithography-based 3D printing technologies has grown exponentially. Commercially available resins, however, are based on epoxides and (meth)acrylates, generally derived from fossil resources. Next to the predicted scarcity of fossil resources, evermore social emphasis is shifted towards the environmental impact of such materials, as crosslinked petroleum-based polymers bear a large carbon footprint and are inherently non-recyclable or (bio)degradable. Furthermore, the highly crosslinked and inhomogeneous nature of these materials leads to insufficient mechanical properties (e.g. brittleness) and thus, limits their application as high-performance materials. In this study, interpenetrating polymer networks (IPNs) with a high content of renewable carbon were utilized to tackle the abovementioned problems. IPNs were produced using an orthogonal, dual-curing strategy, combining a photopolymerizable high-molecular weight dimethacrylate with epoxy-alcohol polyaddition. While the dimethacrylate delivered an elastic and wide-meshed network, the epoxy-alcohol matrix delivered stiffness and mechanical strength.



Herein, both networks were optimized individually and their (photo-)reactivity and (thermo)mechanical properties were assessed. Combining both networks ultimately led to materials of high T_G (50-54 °C), excellent tensile toughness (13 MJ m^{-3}) and while simultaneously achieving high monomer conversions (over 90%). An in-depth phase analysis *via* AFM was conducted to explore the phase distribution and compatibility of bio-based IPNs. Finally, we could demonstrate the first successful application of bio-based epoxy-alcohol and methacrylate IPNs in lithography-based 3D printing by the fabrication of complex, free-standing and hollow objects. [1]

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References

[1] Fantoni, A.; Ecker, J.; Ahmadi, M.; Koch, T.; Stampfl, J.; Liska, R.; Baudis, S., *Green Monomers for 3D Printing: Epoxy-Methacrylate Interpenetrating Polymer Networks as a Versatile Alternative for Toughness Enhancement in Additive Manufacturing.* ACS Sustainable Chemistry & Engineering 2023, 11 (32), 12004-12013.