HIGH-PERFORMANCE POLYMERS FOR LITHOGRAPHY-BASED ADDITIVE MANUFACTURING

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Abstract. Lithography-based additive manufacturing technology (L-AMT) is a layered manufacturing approach where liquid photopolymerizable resins, which contain a photoinitiator, are solidified with ultraviolet or visible light. The advantage of the L-AMT (e.g. stereolithography) versus other AMT is the excellent precision and the high achievable feature resolution. Therefore, this method provides a smoother surface finish and higher precision than other AMT. With the L-AMT systems used for this work, resolutions of 25 μm are achievable. The disadvantages of this printing technology are the currently insufficient mechanical properties of the final parts. In this talk, results on materials development for thermoplast-like photopolymers are presented.

Highly crosslinked photopolymers are typically quite brittle and in many cases not suitable for load-bearing applications. Further, due to the low glass transition temperature (T_g) of existing AM-materials the heat deflection temperature is not high enough in many instances. Currently there is a big gap between industrially used thermoplastics and additive manufacturing (AM) materials, which can be photopolymerized. If 3D-printed, photopolymerized parts, with their excellent surface quality and precision, are able to close this gap to thermoplastic polymers, a substantial number of new fields of applications can be targeted.

In this work high-molecular-weight (meth)acrylate-based resins are investigated regarding their mechanical properties (toughness, strength and Young‘s modulus). The goal is to mimic the thermo-mechanical properties of engineering polymers like ABS and polypropylene. The main components of the resin are mono- and difunctional methacrylate oligomers, leading to a polymer network with relatively low crosslinking density and strong intermolecular forces. These monomers or oligomers have a high T_g. By incorporating toughening agents like core-shell particles (CSP), the ductility of the resulting polymer can be improved.

Conventional L-AMT systems are not able to process of above-mentioned oligomers, since their viscosity is typically very high (>20 Pa s). The presented resins were therefore structured with the recently introduced hot-lithography process, which facilitates the use of such resins.