High Throughput, Laser-based Additive Manufacturing of High-Performance Photopolymers

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Laser based additive manufacturing via photopolymerization has gained relevance for high-mix, low-volume production. Toolless fabrication of freely shaped polymer parts offers increased agility in manufacturing compared to traditional methods. Recent advances in photopolymer chemistry have significantly narrowed the gap between 3D printed polymer parts and their injection molded counterparts. However, for mass production with feature resolution < 50 µm, the lack of throughput of high accuracy systems is holding back a broader adoption of additive manufacturing. Fast curing of high-performance resins combined with excellent resolution needs to be realized.

For additive manufacturing, scanning systems based on diode lasers offer unique advantages over conventionally used solid state lasers. Their fast modulation and high beam quality, in the relevant power range typically required for stereolithography (SLA), allow the production of precise polymer parts. However, the material portfolio which conventionally can be used on such SLA systems is limited to resins which can be processed at room temperature. By introducing Hot Lithography[1], laser-based additive manufacturing through controlled heating of a thinly coated material film, a dramatically expanded process window is provided. This expanded window of opportunity for material development represents a unique pathway for innovative photopolymer concepts and gives critical control over the polymerization kinetics, thus influencing network formation and final material properties. Approaching this opportunity by simultaneously satisfying optical as well as chemical limitations opens the gate toward high performance materials with optimized molecular weight, high melting temperatures, strong intermolecular forces, new reactive groups or high contents of functional fillers (e.g., ceramic, metal or polymer)[2,3].

References

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