CONTROLLED CONVERSION APPROACHES TO SELECTIVE LASER SINTERING (SLS) PRINTING OF HIGH TG THERMOSETS

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Thermoset materials display superior physical and mechanical properties as compared to commonly printed semi-crystalline thermoplastics, yet they typically are not printed by selective laser sintering (SLS). This is because these materials require a post-print thermal cure above T_g to achieve maximal properties. However, such thermal treatment typically results in re-melting of the printed part. Current approaches to printing thermoset materials by this technique have largely relied on infiltrating a porous thermoplastic printed object with a low viscosity reactive resin which is then cured. More recently, direct printing of thermoset materials was also demonstrated, but these approaches require very rapid curing which is often also associated with reduced shelf-life and/or high filler content which may not be desired. Other higher temperature thermoplastics with superior properties (PPS and PEEK) have also been printed using this technique, but the printing of these requires specially designed high-temperature (200-300°C) printing chambers.

We will discuss a "controlled conversion" approach to enable the direct SLS printing of thermosetting materials using a standard low-cost SLS printer. By advancing the cure state of a thermosetting resin system to a point near gelation prior to milling, a SLS printable reactive resin powder is produced. The printed part is then slowly cured using a thermal ramp maintained below the increasing T_g of the material allowing gelation to occur while preventing inadvertent shape changes in the printed object. For the first time, we have demonstrated that a high T_g (>200°C) un-filled thermoset material can be successfully printed with this approach. Through a framework based on the relationship between cure chemistry-and printability, the broader properties inherent to thermoset materials are now accessible to SLS printing. This enables the manufacture of components with superior physical/mechanical properties and tunability on standard SLS printing platforms.

3D Printable High T_g Thermoset