Synthesizing 3D Printable Self-Healing Materials

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Flowable light curable acrylic resins with adequate initiator have been used in DLP or SLA based 3D printer to print 3D objects. Light curable acrylic resins with a bulky urea group will undergo a reversible bonding formation that will allow a self-healing process in cured materials. Adding low viscosity, light curable materials that contain (meth)acrylate groups and an initiator to the resin can create 3D printable materials that can be printed from a digital light processing (DLP) or stereolithography (SLA) based 3D printer to form self-healing polymeric objects This investigation synthesized several new monomers and oligomers containing bulky functional groups which undergo reversible covalent bonding process to form urea from isocyanate and amine groups along with an initiator to allow light curing. The synthesized oligomers were characterized by using 1H NMR and 13C NMR spectra. After UV light curing, several cured compositions that were formulated from these newly synthesized compounds demonstrated self-healing abilities at ambient and elevated temperatures. These relatively low viscous self-healing polymerizable resins can be used in 3D printing via DLP or SLA processes. The strength of these self-healing polymers after repair ranged from 22% to 44% of the undamaged polymer strength. A self-healing efficiency test showed that the cured polymers had improved self-healing strength when the temperature increased which is attributed to the increased molecular mobility and increased reversible urea bond formation, except for the PDIBBAMA based material with bulkier urea bonds. Self-healing strength at ambient temperature also improved when there was an increase in bulkiness around the urea groups which resulted in an accelerated reversible bonding process.

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