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Acrylate-Based Photopolymer Resin Combined with Acrylated Epoxidized Soybean Oil for 3D-Printing

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Abstract : Stereolithography (SLA) is one of the 3D-printing technologies that has been steadily growing in popularity for both industrial and personal applications due to its versatility, high accuracy, and low cost. Its printing process consists of using a light emitter to solidify photosensitive liquid resins layer-by-layer to produce solid objects. However, the majority of the resins used in SLA are derived from petroleum and characterized by toxicity, stability, and recalcitrance to degradation in natural environments. Aiming to develop an eco-friendly resin, in this work, different combinations of a standard commercial SLA resin (Peopoly UV professional) with a vegetable-based resin were investigated. To reach this goal, different mass concentrations (varying from 10 to 50 wt%) of acrylated epoxidized soybean oil (AESO), a vegetable resin produced from soyabean oil, were mixed with a commercial acrylate-based resin. 1.0 wt% of Diphenyl(2,4,6-trimethylbenzoyl) phosphine oxide (TPO) was used as photo-initiator, and the samples were printed using a Peopoly moai 130. The machine was set to operate at standard configurations when printing commercial resins. After the print was finished, the excess resin was drained off, and the samples were washed in isopropanol and water to remove any non-reacted resin. Finally, the samples were post-cured for 30 min in a UV chamber. FT-IR analysis was used to confirm the UV polymerization of the formulated resin with different AESO/Peopoly ratios. The signals from 1643.7 to 1616, which corresponds to the C=C stretching of the AESO acrylic acids and Peopoly acrylic groups, significantly decreases after the reaction. The signal decrease indicates the consumption of the double bonds during the radical polymerization. Furthermore, the slight change of the C-O-C signal from 1186.1 to 1159.9 decrease of the signals at 809.5 and 983.1, which corresponds to unsaturated double bonds, are both proofs of the successful polymerization. Mechanical analyses showed a decrease of 50.44% on tensile strength when adding 10 wt% of AESO, but it was still in the same range as other commercial resins. The elongation of break increased by 24% with 10 wt% of AESO and swelling analysis showed that samples with a higher concentration of AESO mixed absorbed less water than their counterparts. Furthermore, high-resolution prototypes were printed using both resins, and visual analysis did not show any significant difference between both products. In conclusion, the AESO resin was successful incorporated into a commercial resin without affecting its printability. The bio-based resin showed lower tensile strength than the Peopoly resin due to network loosening, but it was still in the range of other commercial resins. The hybrid resin also showed better flexibility and water resistance than Peopoly resin without affecting its resolution. Finally, the development of new types of SLA resins is essential to provide new sustainable alternatives to the commercial petroleum-based ones.

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