Sustainable UV-Curable Monomers Derived From Glycerol for 3D Printing Applications

Guo, Sophia (School: Alabama School of Fine Arts)

The surplus of glycerol waste produced during the process of biodiesel production in the United States has posed a new challenge to the sustainability of the biofuel industry. Crude glycerol is expensive to refine and cannot be used for human consumption according to FDA standards, making it crucial to repurpose this byproduct for other applications. This research aims to explore a method to repurpose excess glycerol for the synthesis of liquid monomers for photopolymerization 3D printing. Four UV-curable monomers were synthesized via esterification of methacrylic anhydride (MAA) and a glycerol-derived alcohol, each with a different functional group (ethyl, butyl, dimethoxyethane, and methyl). To prepare for 3D printing, each monomer was mixed with a photoinitiator (BAPO) at 2.5wt% and poured into the resin tank of the 3D printer. UV-light (405 nm) was applied to facilitate polymerization during printing to produce tensile samples according to ASTM D638 standards (82mm x 12mm x 2mm). The tensile properties of obtained polymer samples were characterized using an electromechanical-driven universal testing machine in a controlled environment. By monitoring the printing process, it was determined that proper UV exposure time is crucial to the successful polymerization of liquid monomers. Comparison of tensile properties shows that the functional group of each monomer considerably influences the polymer's tensile properties after polymerization. This finding suggests that the mechanical properties of polymers can be tuned by changing monomer functional groups. Overall, this research explores a method to upcycle waste into a useful product, helping to reduce waste and improve the sustainability of various industries.

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