Developing Sustainable Glycerol-Based Monomers for Polymer Blends Using 3D Printing

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Glycerol has become an ideal candidate for bio-polymer synthesis with the growth of the biodiesel industry. Glycerol's molecular structure allows for easy modification with functional groups, enabling applications like radical polymerization. Using glycerol-derived alcohols, UV-curable liquid monomers can be synthesized that function as resins for 3D-printing. These monomers act as solvents for thermoplastics, such as polystyrene (PS) and poly(methyl methacrylate) (PMMA). These plastics contribute heavily to global plastic pollution, with PS being especially difficult to recycle. Dissolving these plastics into the monomers offers a route for upcycling traditional plastic waste. For this project, three glycerol-derived liquid monomers (DEP-MAA, DMEP-MAA, DBP-MAA) were synthesized via esterification reactions of a glycerol-derived alcohol (DEP, DMEP, DBP) and methylacrylic anhydride. Low-molecular-weight PS or PMMA was dissolved in the pure monomers at 5wt% or 10wt%. Tensile samples for each polymer blend were printed with a 50-second UV exposure (405 nm) between layers. Tensile testing followed ASTM D638 standards to characterize the Young's Modulus, tensile strength, and elongation at break of each. Comparison of the tensile properties of each polymer blend shows that the incorporation of thermoplastics into pure monomers considerably changes the mechanical properties. In particular, PS blends displayed enhanced tensile strength and greatly reduced elongation at break. Conversely, PMMA blends maintained high elongation at break with minor increases in tensile strength. These findings demonstrate plastic additives' potential for tuning the mechanical properties of glycerol-derived monomers, enabling a route for upcycling waste plastics as polymer enhancements.

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