

SL 9.12

Toughening of UP Resin Using Aliphatic Diols and their Maleic Anhydride Terminated Derivatives

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Thermoset resins including unsaturated polyester (UP) resins are amorphous and highly cross-linked polymers. This microstructure results in many useful properties for engineering application, such as high modulus and failure strength, low creep and good performance at elevated temperature. However, these materials are relatively brittle and have a very poor resistance to crack initiation and growth. Low toughness of UP resins makes them relatively brittle for most engineering applications.

In this research effect of aliphatic diols including Polyethylene Glycol (PEG), Polypropylene Glycol (PPG) and the synthesized Maleic Anhydride Terminated Polyethylene Glycol (MATPEG) on the mechanical and morphological properties of UP resin are investigated. The materials were used at 5, 10, 15, 20 and 30phr. An increase in toughness, elongation at break and impact strength of UP resin was observed with all agents used. However, tensile strength and modulus were reduced. Maximum toughness was achieved with MATPEG showing a six fold increase in toughness at 15phr as compared to the base resin, while PEG and PPG are placed next in a descending order. With PEG as toughening agent, the increase in toughness was steady as PEG content was increased but for MATPEG and PPG a maximum was observed at 15phr and 10phr, respectively, beyond which toughness was reduced. Effect of PEG molecular weight (MW) on toughening and other mechanical properties of UP resin was also studied. Scanning Electron Microscopy (SEM) studies of the blends proved a single-phase morphology for PEG and MATPEG blends and double-phase morphology for PPG blend.