Effect of CNT-based resin modification on the mechanical properties of polymer composites

ABSTRACT

In this study an attempt was made to explore the possibility of substituting 3D E-glass fabric with eco-friendly basalt fabric along with the modification of resin using MWCNTs, a material system about which very limited information exists. The study involved comparing the mechanical properties of two sets of composites. The first set was comprised of 3D orthogonally woven E-glass-reinforced epoxy composites, basalt-reinforced epoxy composites, and hybrid 3D E-glass orthogonally woven/basalt-reinforced epoxy composites while the second set of composites was the same as the first but prepared with resin modified with Multi Walled Carbon Nanotubes (MWCNTs). All the composites were fabricated by hand lay-up and compression molding techniques. To modify the resin for the second set of composites, MWCNTs were dispersed into the epoxy resin with acetone as a surfactant by magnetic stirring and ultra-sonification. Mechanical tests included tensile, flexural, and low velocity impact strength which were evaluated as per standards. Scanning electron microscopy (SEM) was employed to study the fractured surfaces. Results showed that resin modification did not yield any positive results on the mechanical properties of the composites. The highest tensile (364.4 MPa) and flexural strength (345.3 MPa) was obtained for 3D E-glass composites followed by basalt composites and hybrid 3D E-glass/basalt composites while the highest impact strength of 198.42 kJ/m2 was exhibited by the hybrid 3D E-glass/basalt composites. SEM micrographs showed de-bonding between the modified matrix and fiber which was seen as one of the primary causes for relatively poor performance of the composites prepared with modified resin. Fiber breakage, matrix cracking, fiber pull-out, and delamination were the other modes of failure. Results suggest that hybridization with basalt fibers is a much safer, more cost effective, and eco-friendly option over resin modification.

Keyword: 3D E-glass composite; Basalt epoxy composites; Hybrid composites; CNT fillers; Sonication; Mechanical properties; Scanning electron microscopy