Mechanical Properties Improvement of Polymeric Nanocomposites Reinforced with Chemically Functionalized Helical Carbon Nanotubes: Influence of Processing Time and Molarities of Acids

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Polymer-based composites are widely used for structural applications in the aerospace and renewable energy industries. One of the main disadvantages is their failure/delamination due to interlaminar strength, which is mainly initiated from the lack of reinforcement in transverse or thickness direction. One of the recent solutions that can effectively address this problem is the use of nanomaterials, such as Carbon Nanotubes (CNTs) in the resin system. Most previous studies have used straight CNTs in as-is or functionalized forms. Because CNTs are inert in nature, it is desired to covalently functionalize them to improve their interactions with polymer molecules and enhance their dispersion homogeneity. In addition to functionalization, we believe that geometrical configuration of CNTs do also play an important role in their effectiveness, when they are used as nanoscale reinforcement in polymer resins. Overall, there are several factors that can effectively influence the properties of CNTs reinforced nanocomposites, e.g., CNTs geometry, weight percent inclusion, functionalization method, and processing parameters. In this research, helical carbon nanotubes (HCNTs) were functionalized using a mixture of nitric, sulfuric, and hydrochloric acids following 16 different procedures (i.e., sonicating with acid molarities of 3, 8 and 16 M for 1.5hr, 3hr, 4.5hr, and 6hr). Next, the functionalized HCNTs (FHCNTs) were incorporated into epoxy resin using 3 different weight percentages (i.e., 0.02, 0.04, and 0.06 wt%) and then used to fabricate nanocomposite panels for mechanical testing. The main objective of this research was to investigate the effects of chemical functionalization processes and weight percentages of HCNTs on tensile strength, fracture toughness, Young's modulus, and strain-to-failure of the polymeric nanocomposites. Based on the test results obtained in this study, the most effective chemical functionalization processes were identified and recommended for structural nanocomposite applications.