Material Properties Improvement of Laminated Composites Using Nanoscale Reinforcements

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Fiber-reinforced composite materials are widely used in many industries. They are predominantly used in the aerospace industry to make aircraft structural components and renewable energy industry to make wind turbine blades. Composite materials have several advantages compared to conventional materials which give composite materials the upper hand. Composites are light in weight, and have high specific stiffness, high strength, and high damage tolerance. Since composites are fabricated layer by layer, the poor adhesion of fabrics can lead to delamination, and it is one of the main disadvantages of using composite materials. Delamination is primarily due to poor interlaminar strength and lack of reinforcement between the fabric layers. One of the effective methods to solve this problem is the use of nanoscaled reinforcement between the fabric layers and within the fiber filaments. There are different types of nanomaterials available, of which carbon nanotube has been extensively studied as a nanoscaled reinforcement in laminated composites. Carbon nanotubes (CNTs) are a rolled-over form of graphene. It has very high strength and a high aspect ratio. Straight and helical CNTs are two geometrical forms of CNTs that have higher aspect ratios, as compared to other carbon nanostructures. From our previous study, it has been found that helical carbon nanotubes (HCNTs) perform better than straight carbon nanotubes. In this research, HCNTs were used to improve the material properties of the laminated composite per ASTM standards. Three laminates were made using plain weave glass fabric, one without HCNTs and two laminates with two different weight percentages of HCNTs. The fabrication of test samples and mechanical testing processes were performed per ASTM standards. The test results showed significant improvement in the material properties of the laminate composites reinforced with HCNTs.