Title - Determining the Effect of Embedding Sensors in the Hosting Composite's Mechanical Properties

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Abstract

Composite materials are materials that are made by dispersing fillers in a matrix. These materials have advantages such as higher strength to weight ratio, ease of manufacturability, and corrosion and moisture resistance. Due to these advantages, their use in automotive, aerospace, sport goods, and defense sectors have increased recently. For example, 5% to 10% of the structural weight of present generation fighter aircrafts is made of composite materials (Heida & Platenkamp, 2012). Also 50 % of the airframe weight of Boeing 787 Dreamliner is made of composite materials. The trend of using composite materials is expected to increase in the future. However, one of the concerns in using composite materials is the inability to continuously monitor the health of the materials during service. Current methods involve costly schedule maintenance.

In the past, researchers have suggested the use of fully integrated monitoring systems such as state-of-the-art structural health monitoring (SHM) techniques as a promising solution (Chandarana et al., 2017). SHM systems involve integration of sensing elements in the composites to detect damage and failure during service. The method enables collection of large amounts of response data and analyze it to assess various health-related properties of structures in real-time. One of the materials proposed for SHM applications is carbon nanotubes (CNTs).

Carbon nanotubes possess distinctive electrical properties that change when subjected to various strains and stresses. Several research studies suggest that these properties may make CNT's and other such nanomaterials a potentially viable option for the creation of more precise strain sensors and gauges. These strain sensors can be embedded directly into composite materials, thus potentially enabling the performance of the composite to be measured during service. The embedded sensors are usually more conductive than the hosting composite and therefore it is possible to correlate the electrical signal change across these embedded sensors with the

composite's internal defects. Hence, the embedded sensors could provide meaningful information about the health of the composite material. However, due to the heterogeneity of the material composition, the embedded sensors may act as defects in the composite and could degrade its mechanical properties. The objective of this project is to determine the effects of embedding sensors in a composite's mechanical property through fabricating sensor-embedded composite test samples and performing mechanical tests and measurements.

Keywords: Structural health monitoring, embedded sensors, internal strain