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IN SITU STRUCTURAL HEALTH MONITORING AND ANTI-DELAMINATION OF LAMINATED COMPOSITES WITH MULTIFUNCTIONAL CARBON NANOTUBES FILMS

Abstract

Carbon fiber/epoxy (CF/E) composites has been widely used in aerospace industries, owning to their high stiffness and strength to weight ratios compared with conventional metallic materials. However, carbon fiber/epoxy(CF/E) composites have low inter-lamina strength, which can result in delamination cracks under any low-velocity impact. As the delamination is barely detectable by visual inspection, hence,in situ delamination monitoring systems are essential for composite parts. One of the solutions is the self-sensing method that uses the electrical resistance change of the structure to detect delamination.

It has been proposed in present research articles that reducing the electrical resistivity in the thickness direction can improve the sensitivity of the method for damage sensing. In this article, functionalized carbon nanotube interleaves were introduced to carbon fiber/epoxy(CF/E) composites. The incorporation of carbon nanotube interleaves into laminated composites was found to enhance inter-lamina strength, as well as significantly increase the electrical conductivity in the thickness direction with aim to realize the in situ structural health monitoring of laminated composites. As an example of application, the case of a Double Cantilever Beam (DCB) test was conducted, with the aim to demonstrate the damage sensing capacity of the electrical resistance change method. The result showed that the electrical resistance change increased almost linearly with crack increment, furthermore, the electrical resistance response become more sensitive respect to crack increment owing to the incorporation of conductive carbon nanotube films into laminated composites. For the purpose of in situ structural health monitoring for damaged composites laminates, a theoretical model was proposed to predict electrical response with delamination, and this theoretical prediction showed a satisfactory agreement with the experimental data.