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Development of Strain and Damage Monitoring System for Polymer Composites with embedded Nickel Alloys

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Abstract

Glass fibre reinforced polymer matrix composites are widely used in various industries as important structural components. Unlike metals, strain induced and damage states of an anisotropic composite are hard to predict under real time loading. With that focus, a piezoresistivity material based Structural Health Monitoring (SHM) system for laminated polymer composite is proposed in the study to measure the strain induced in the composite under real time loading. Nickel based alloys such as Karma and Nichrome alloys are embedded into the composites to monitor the strain and damage induced in the composites. The resistance measurement setup with embedded strain sensing nickel alloy is tested with uni-axial tension and flexural load for performance evaluation. The piezoresistivity response of the nickel alloys is used to predict the strain induced and damage state of the composites, when subject to real time loading. The piezoresistivity response of the nickel alloy is inferred in two phases such as deformation phase and failure phase, which clearly shows the various states of strain and damage induced in the composites. In repeated loading, by monitoring the shift in the piezoresistivity response curve of embedded nickel alloy during loading and unloading condition can be directly correlated with the accumulation of permanent damage in the composites.

Keywords: Piezoresistivity materials; Structural Health Monitoring System; Nickel Alloy; Polymer Composite.

1. Introduction

Today, Composite material is widely used in various industries for its lightweight and high strength particularly in the aviation industry. The composite material is an advance engineering material composed of two or more different materials or phases (matrix phase and reinforcing phase) and having bulk properties significantly different from individual constituents. Many common materials (metals, alloys, doped ceramics and polymers mixed

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