Graphene based Strain and Damage Prediction System for Polymer Composites

R. Balaji, M. Sasikumar

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Graphene based Strain and Damage Prediction System for Polymer Composites

Balaji.R*, M.Sasikumar[#]

School of Mechanical and Building Science, VIT University, Chennai Campus, India
([#]msasikumar@msn.com, [*]baluji.r@gmail.com)

Abstract

Glass fibre reinforced polymer composites are extensively used as an advanced engineering material, particularly in aviation industries because of its superior properties. Unlike metals, damage and failure of the composites are complicated to predict under real-time loading due to its anisotropic nature. With that focus, reduced Graphene Oxide (rGO) based Structural Health Monitoring for polymer composite is proposed in this work. The prioritised aim of this study is to measure the strain induced and the degree of damage accumulated in the composites. To achieve this, the rGO coated glass fibres are embedded into polymer composite to evaluate the strain and damage induced in the composites by measuring the fractional change in the piezoresistance of the coated fibre. The piezoresistive response of the coated fibres showed linear variation under low (elastic) deformation. However, under high (plastic) deformation, the piezoresistance varied nonlinearly with an irregular stepped increment. This nonlinear stepped increment is marked due to the initiation and propagation microcracks in the polymer composites. The damage accumulation in the composite is predicted by measuring the deviation of piezoresistance from the elastic response line using statistical analysis. A statistical correlation is established between the damage accumulation and the experimentally calculated residual strength. The electromechanical study on the rGO coated glass fibres suggested as potential applications for the strain and damage monitoring of composite materials.

Keywords: Structural Health Monitoring (SHM) System; Polymer Composites; Residual Strength; Reduced Graphene Oxide (rGO);

1. Introduction

Today, composite materials are being extensively used in various industries such as aviation, automobile, marine etc. The composite material is an advanced engineering material consisting of two or more different materials combined together, which shows improved or