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ELECTRICAL-BASED DELAMINATION CRACK MONITORING IN COMPOSITES USING Z-PINS

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ABSTRACT

The in-situ, real-time detection of delamination cracks in composite materials using z-pins is reported. Carbon fibre-epoxy composites were reinforced in the through-thickness direction with different volume content (up to 4%) or material type (composite, metal) of z-pins. Z-pins can reduce the through-thickness electrical resistivity of composites by several orders of magnitude (up to ~10^6), depending on their volume content and electrical properties. Z-pins create an electrically conductive pathway through-the-thickness of the otherwise resistive composite material (with an electrical resistivity of about 1.25 Ω.m). Mode I interlaminar tests performed under static fracture and cyclic fatigue load conditions reveal that z-pins can be used to detect delamination cracking via changes to the electrical resistivity. The sensitivity of z-pins to changes in the resistivity caused by crack growth is influenced by their volume content, electrical conductivity and interfacial bonding with the composite material.

KEYWORDS: A. Polymer-matrix composites (PMCs); B. Delamination; B. Electrical properties; D. Non-destructive testing

1 INTRODUCTION

The reliable detection and monitoring of delamination damage in composite materials is a critical maintenance issue when used in safety-critical applications, such as aircraft, ships and civil infrastructure. Delamination cracks can be detected using a variety of non-destructive evaluation (NDE) techniques, including ultrasonics, thermography, X-ray computed tomography and laser shearography. However, these techniques usually require the composite asset (e.g. aircraft) to be taken out-of-service to perform the NDE. Several structural health monitoring