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Fatigue and reliability analysis of nano-modified scarf adhesive joints in carbon fiber composites

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ABSTRACT

Enhancing the fatigue performance of scarf adhesive joints (SAJs) in carbon fiber-reinforced epoxy (CFRE) composite structures via incorporation of nanofillers into the epoxy adhesive has not yet been fully investigated and is the subject of this study. The optimum weight percentages of multi-walled carbon nanotubes (MWCNTs), SiC and Al2O3 nanofillers were ultrasonically dispersed in Epocast 50-A1/946 epoxy. The nanophased matrices were used to fabricate the SAJs with 5° scarf angle. Fatigue tests were conducted at constant-load amplitude, frequency of 10 Hz and stress ratio of 0.1. Result from fatigue tests showed that the gain/loss in the fatigue lives of the modified SAJs with MWCNTs, SiC and Al_2O_3 are respectively 19%, 52% and -22% at fatigue limit of 36 MPa. The load-displacement hysteresis loops of the nano-modified SAJs showed higher fatigue stiffness compared to neat epoxy-SAJ. The stiffness of the SAJs was increased with increasing number of cycles up to about N/Nf=0.01. As the number of cycles increases the damage level is increased and thus the slope of the hysteresis loop (stiffness) is decreased and the hysteresis loop area becomes wider. The highest penalty paid to gain safe lives was observed for Al2O3-SAJs, which has highest scatter in the fatigue lives.

KEYWORDS: A. Polymer-matrix composites (PMCs), B. Fatigue, C. Statistical properties/methods, E. Joints/joining

1. INTRODUCTION

Fiber-reinforced polymer (FRP) composite materials are characterized by their superior specific strength, light weight, chemical and corrosion resistance, and unique flexibility in design and tailoring their mechanical properties by choosing their constituent materials. These properties make FRP composites attractive not only to the military,

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