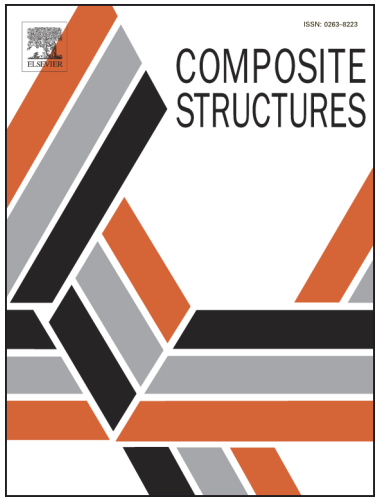

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Mio Sato, Jun Koyanagi, Xin Lu, Yuki Kubota, Yuichi Ishida, T.E. Tay

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Temperature Dependence of Interfacial Strength of Carbon-Fiber-Reinforced Temperature-Resistant Polymer Composites

Mio SATO[(a)], Jun KOYANAGI[(b)], Xin LU[(c)], Yuki KUBOTA[(d)], Yuichi ISHIDA[(d)], T.E. TAY[(c)]

(a) Graduate School of Tokyo University of Science

(b) Tokyo University of Science

(c) National University of Singapore

(d) Japan Aerospace Exploration Agency

Abstract

In the present study, the temperature-dependence of fiber/matrix interfacial strength is discussed through temperature-controlled microbond testing and its numerical simulation. The tests are carried out from room temperature to 100°C. The micromechanical testing machine debonds the interface and the load at which debonding occurs is measured. In the numerical simulation, thermal residual stress is calculated by considering the relaxation modulus and the time–temperature superposition principle for the resin, i.e. thermo-viscoelasticity, in order to obtain an accurate thermal residual stress. In order to reproduce the damage of resin unique to the microbond test, continuum damage mechanics and Christensen's failure criterion for multi-axial stress states are applied from ambient temperature to 100°C. Interfacial debonding is simulated using a cohesive zone model. The interfacial strength is determined by comparing the analysis results with the experimental results. Results show that there is no obvious temperature dependence on interfacial strength; similar interface strengths are obtained over the range of temperatures studied.

1. Introduction

In recent years, heat-resistant carbon fiber reinforced plastics (CFRP) composed of TriA-X polyimide [1,2], having high mechanical property even over 300°C, have been considered for application to titanium materials, such as the inner frame structure of turbofan engines in order to reduce weight and increase production. Therefore, it is imperative to characterize the various properties of heat-resistant CFRP under high temperature environment. Many studies related to high-temperature durability such as tensile strength, compressive strength, fracture energy, and fatigue strength have been conducted at the macro-scale [3-12]. On the other hand, in order to discuss high-temperature durability from the micro-point of view, it is necessary to grasp the interfacial mechanical property between the fiber and the resin, in addition to the time and temperature dependence mechanical property of those constituent materials of CFRP [13-16].