Failure Simulation of Unidirectional Fiber-Reinforced Ceramic Matrix Composites Based on Evolving Compliant Interfacial Debonding Model

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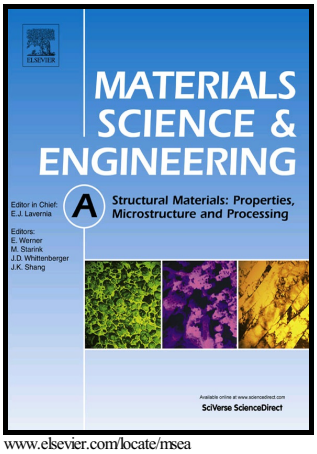

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ABSTRACT

Damage and failure process of the unidirectional fiber-reinforced ceramic matrix composites (FRCMCs) under tensile stress had been studied by many researchers in theoretical method. But because of some assumptions made in the theoretical model, it can't describe the performance of interface accurately. In this paper, evolving compliant interface (ECI) is employed to describe the properties of weak bonding interface. The ECI can respond the failure of debonding and sliding of interface efficiently. The whole damage evolution process of the material has been simulated by finite element method (FEM) and the stress-strain curve, the space of cracks at saturated state and the stress of components are discussed. The stress-strain curves of several ceramic composites were predicted by the model and compared with the experimental data. The results indicate that the tensile stress-strain curves agree well with the experimental data on consideration of evolving compliant interfacial debonding model.

Keywords: unidirectional fiber-reinforced ceramic matrix composites, matrix cracking, finite element analysis, stress-strain curve, evolving compliant interfacial (ECI) debonding model.

1. Introduction

Due to the excellent performance of high strength, high modulus, corrosion resistance and low density, continuous fiber reinforced ceramic matrix composites become an ideal material of high temperature components of aircraft [1]. Because the SiC matrix is brittler than carbon fiber, the strain-to-failure of the matrix tends to be less than that of the fibers. The first matrix crack initiates when the stress beard by matrix reaches its local strength. As the load increasing, the transverse cracks deflect along the fiber/matrix interface. When matrix cracking and interface debonding occur, interface shear stress transfers loads between fiber and matrix, which is critical for the toughness behavior of the ceramic composites. When there is no more new crack form, the cracking process is saturated. The above process has been observed by experiments [2, 3].