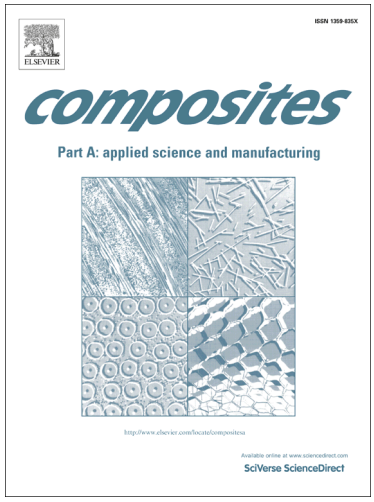

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The Stiffness Tensor for Composites with Curved Discontinuous Fibers

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Abstract

In this paper, we propose a new method for calculating the stiffness tensor for a composite material containing curved discontinuous fibers. We introduce a new concept of configuration for a single curved fiber defined by five dimensionless parameters. An ensemble of curved fibers within a composite material is then described by a configuration probability density function. The proposed stiffness tensor requires three tensors of fourth-order describing the material microstructure and a set of elastic constants. We introduce the concept of configuration averaging and present an analytical method for estimating elastic constants for materials containing curved fibers. We demonstrate that for materials containing only straight fibers, fiber configuration and configuration averaging reduces to standard fiber orientation and orientation averaging. Comparison of stiffness measurements using x-ray digital image correlation against the stiffness calculated with fiber geometry obtained by x-ray tomography shows that accounting for fiber curvature provides better estimate of stiffness.

Keywords

B. Mechanical Properties C. Anisotropy, B. Modeling, Micro-mechanics

Introduction

Discontinuous fiber reinforced composites (DFCs) are materials in which the fibers act as structural reinforcements and their aspect ratios, defined as fiber length divided by fiber diameter, influence the resulting material properties.