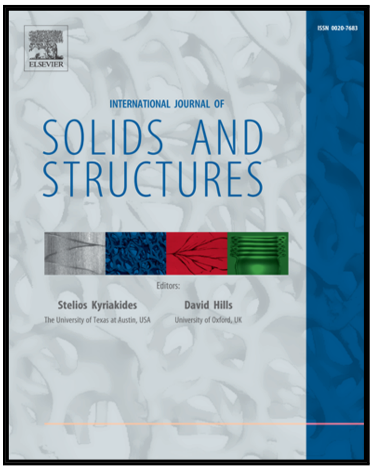

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Domain-independent I-integrals for force and couple stress intensity factor evaluations of a crack in micropolar thermoelastic medium

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Abstract

This paper establishes the domain-independent I-integrals (DII-integrals) to solve the force stress intensity factors (FSIFs) and couple stress intensity factors (CSIFs) of a crack in a two-dimensional micropolar thermoelastic solid. The DII-integrals are derived from the J-integral based on the superposition of an actual field and an auxiliary field. The auxiliary field can be designed freely, so that mixed-mode FSIFs and the in-plane CSIF can be decoupled. Analytical solutions for the near-tip asymptotic field of a crack in infinite micropolar elasticity are firstly adopted to define the auxiliary field and then, a DII-integral is established. The DII-integral is domain-dependent for thermal mismatch interfaces, which is troublesome to thermal fracture analysis of composites with complex thermal mismatch interfaces. In order to effectively solve the crack-tip field intensity factors for such composites, this paper discusses the conditions to establish a DII-integral and then, proposes a new auxiliary field which has an important feature, i.e., the mean auxiliary stress is zero. The DII-integral using this new auxiliary is proved to be domain-independent not only for interfaces with discontinuous mechanical properties, but also for interfaces with discontinuous thermal properties. Finally, these two DII-integrals are employed to investigate four micropolar plates with different thermoelastic properties. The results confirm that both DII-integrals are reliable and convenient for homogeneous, continuously nonhomogeneous micropolar materials, whereas the new DII-integral is more appropriate for micropolar materials with complex thermal mismatch interfaces.

Keywords: micropolar; thermoelastic; domain-independent I-integral (DII-integral); force stress intensity factors (FSIFs); couple stress intensity factors (CSIFs)

1. Introduction

Various composite materials are characterized by random microstructures, such as particle-reinforced, fiber-reinforced and granular composites, and masonry composed of crushed stones. They are prone to fracture failure due to interfaces that typically act as a source of defects during the manufacturing process or in service. The development of multiscale mechanics has led to increased interest in the correlation of a material

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