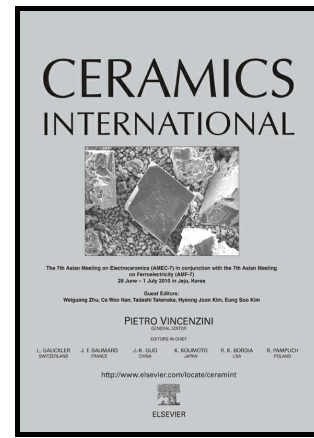


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Establishing Microstructure-Mechanical Property Correlation in ZrB₂-based Ultra-High Temperature Ceramic Composites

Ambreen Nisar, S. Ariharan, and Kantesh Balani*

High Temperature Ceramic Laboratory, Department of Materials Science and Engineering,
Indian Institute of Technology Kanpur, Kanpur-208016, India

*Corresponding author. Tel.: +91-5122596194. kbalani@iitk.ac.in (K. Balani)

Abstract

The current work focuses on enhancing the flexural strength and fracture toughness of zirconium diboride (ZrB₂) reinforced with silicon carbide (SiC) and carbon nanotubes (CNT). The flexural strength has shown to increase by ~1.2 times from 322.8 MPa (for ZrB₂) to 390.7 MPa and fracture toughness up to 3 times from 3.2 MPam^{0.5} (for ZrB₂) to 9.5 MPam^{0.5} with the synergistic addition of both SiC and CNT in ZrB₂ matrix through energy dissipating mechanisms such as deflection, branching and strong interfacial bonding evidenced from the transmission electron microscopy (TEM). A modified fractal model is used to evaluate the fracture toughness and delineate the contribution of residual stresses, and reinforcements (SiC and CNT) in enhancing the fracture toughness. Interfacial bonding in terms of a debonding factor was also evaluated by theoretically predicting the elastic modulus and then correlated microstructurally along with the mechanical properties of ZrB₂-SiC-CNT composites.

Keywords: Ultra-high temperature ceramic (UHTC); electron microscopy; four-point bending; fracture toughness; interfaces.

1. Introduction:

The insatiable demand for the development of hypersonic re-entry vehicle-structure thermal protection system mandate the usage of ultra-high temperature ceramic (UHTC) [1, 2] for hostile environmental conditions [3-6]. Zirconium diboride (ZrB₂), a potential UHTC has a

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