

Understanding Multi-Scale Fracture Toughness in CeO₂-Stabilized Zirconia Ceramics

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Abstract (150 words)

Assessing the transferability of micromechanical fracture metrics to structural-scale behavior is crucial for CeO₂-stabilized zirconia, a promising alternative to YSZ due to its enhanced resistance to low-temperature degradation. This study investigates the fracture behavior of CeO₂-stabilized zirconia with varying ceria mol% by combining micromechanical testing with three-point ASTM beams.

Micropillar splitting and micro-cantilever bending consistently demonstrate an increase in fracture toughness with higher ceria content. An energetic analysis based on indentation work quantifies the relationship between crack resistance and plastic dissipation. Fractographic analysis reveals intergranular fracture mechanisms across all scales, indicating that the interfaces primarily govern these mechanisms. High-Resolution Transmission Electron Microscopy (HR-TEM) and Energy Dispersive X-ray Spectroscopy (EDX) exclude ceria segregation at grain boundaries, suggesting alternative interpretations based on boundary energy or stress redistribution.

Ultimately, this research clarifies the toughening mechanisms in CeO₂ ceramics employing consistent processing methods across scales, which enables direct comparison between microstructure and crack propagation.