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PROCEEDINGS

Static and Dynamic Fracture Toughness of Graphite Materials with Varying Grain Sizes

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ABSTRACT

Graphite materials serve critical roles as moderators, reflectors and core structural components in high-temperature gas-cooled nuclear reactors. These materials may experience a variety of loads during the reactor operation, including thermal, radiation, fatigue and dynamic loads, potentially leading to crack initiation and propagation. Consequently, it is imperative to investigate the fracture properties of graphite materials. Currently, there exists a dearth of comprehensive studies on the fracture toughness of graphite materials with varying grain sizes, especially regarding dynamic fracture toughness. This study introduces a novel approach utilizing a digital-image-correlation-based virtual extensometer to analyze crack propagation in graphite materials of varying grain sizes. This methodology allows for precise measurement of crack propagation lengths and accurate determination of fracture toughness. Results indicate that static fracture toughness demonstrates an upward trend with increasing grain size of graphite materials. In contrast, under equivalent impact velocities, larger-grain graphite materials exhibit reduced dynamic fracture toughness. Notably, dynamic fracture toughness of the three graphite material types studied shows an increment as the impact velocity increases. The ex-amination of fractured specimen surfaces through scanning electron microscopy provides in-sights into the mechanisms underlying the substantial difference between dynamic and static fracture toughness. The results suggest that heightened impact velocity triggers a transition in fracture mode from intergranular to transgranular fracture, allowing specimens to absorb more energy. This phenomenon significantly enhances dynamic fracture toughness relative to static fracture toughness.

KEYWORDS

Graphite; fracture toughness; digital image correlation; grain size; scanning electron mi-croscopy

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