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Fracture Toughness Assessment of γ -TiAl Alloys: Challenges in Applying ASTM Standards

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Lightweight titanium aluminide intermetallic alloys have become increasingly important to improve structural efficiency and reduce fuel consumption and carbon emissions in newly developed gas turbine engines. To enable reliable component design, consistent mechanical properties meeting stringent requirements are essential. In recent years, additive manufacturing has been successfully applied to produce γ -TiAl alloys for structural applications. However, their partially brittle fracture behavior complicates fracture toughness assessment under strict compliance with ASTM E399 and E1820 standards.

This work experimentally evaluates the fracture toughness of additively manufactured Ti 48Al-2Cr-2Nb γ -TiAl alloy at room and elevated temperature. Compact tension C(T) specimens were designed in accordance with ASTM E399 and E1820 recommendations.

For the investigated alloy, ASTM validity requirements are often only partially satisfied, and conventional post-processing procedures may lead to misleading results. To overcome these limitations, a dedicated critical load selection algorithm was developed, enabling the identification of meaningful fracture toughness values even in the presence of plateau-like load-displacement responses associated with progressive lamellar colony decohesion in predominantly lamellar microstructures. For high-temperature tests conducted according to ASTM E1820, a customized post-processing workflow was implemented to ensure consistency between calculated toughness values and experimental observations. Based on the obtained results, practical recommendations are proposed to support future fracture toughness testing campaigns on γ -TiAl alloys.

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