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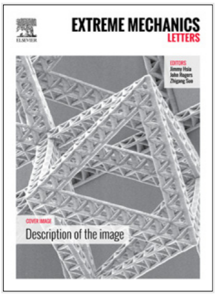

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Ni bonded TiC cermet pyramidal lattice structures

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Abstract

Ultralight pyramidal lattice structures with a relative density ($\bar{\rho}$) ranging from 1.5 to 21% have been fabricated from a Ni bonded TiC cermet and configured as sandwich panels using a mechanical snap-fit and vacuum brazing technique. The lattice structures moduli and strengths have been measured using unit cell samples during out of plane compression as a function of the lattice relative density. Two strut failure modes were observed: Euler buckling of the struts dominated the response at low density, $\bar{\rho} \leq 1.5\%$, while compressive yielding failure governed the response for $\bar{\rho} > 1.5\%$. The measurements are shown to be well predicted by micromechanics models of these strut failure modes, and excellent agreement was achieved between experimental results and finite element predictions. When compared with other cellular lattices and topologies, snap-fit Ni bonded TiC composite pyramidal lattice structures are found to exhibit superior mechanical properties, and appear to be promising candidates for high temperature applications.

1. Introduction

Sandwich panel structures are widely used as light structures for the efficient support of elastic bending loads [1,2,3]. In these applications, light, stiff face sheets are separated by a low-density (frequently cellular structure) core that preserves the face sheet separation during loading, thereby enabling minimization of the panel's elastic deflection. If the panel geometry is fixed, the elastic moduli of the core governs the panel's response under elastic loading. The compressive elastic moduli of a variety of cellular core materials are compared with other engineering materials in the Ashby chart shown in Figure 1(a). The highest specific modulus core material that could be made is limited by the Voigt bound for diamond (regions exceeding this are shown in grey). At densities below 1000 kgm^{-3}, the best cores are cellular (pyramidal, tetrahedral and honeycomb) lattice structures made from high specific stiffness materials such as aluminum [4,5,6] and titanium alloys [7,8,9] or carbon fiber reinforced polymer (CFRP) composites [10,11,12,13,14].

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