Functionally graded carbon fiber-reinforced ceramics for extreme environments: characterization and numerical assessment

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Abstract

ZrB_2 is an ultra-high temperature ceramic (UHTC) possessing a melting point exceeding 3000°C and a combination of exceptional engineering and physical properties.[1,2] As such, ZrB_2 ceramics are potential candidates for space and hypersonic components. The main drawbacks that restrict the employment of ZrB_2 ceramics for a wider spectrum of applications are related to the low damage tolerance, poor oxidation resistance and relatively high density. However, the introduction of discontinuous C fibers can increase both ZrB_2 robustness and notably decrease the total weight.[3] Moreover, the addition of secondary phases, such as $MoSi_2$, can further improve the high-temperature strength and, most importantly, the oxidation performance of the boride matrix owing to an in-situ development of a complex multilayer oxide structure.[4] However, detrimental chemical reactions between Mo-compounds and C fibers occur during sintering at high temperature thus leading to degradation of the fibers and loss of their toughening function. Therefore, an accurate choice of the sintering additive is paramount to preserve the fiber structural function.

Here we present a functionally graded (FG) composite made up of a ZrB_2-$MoSi_2$ outer scale, to provide oxidation and ablation resistance, and a progressively C fiber-rich body, to guarantee failure tolerance and lighten the whole structure. To define the best FG architecture and exploit residual stress toughening upon layering,[5] thermo-elastic simulation by finite element modeling is adopted.

Biography:

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