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In situ synthesis of CNTs in HfB_2 powders by chemical vapor deposition of methane to fabricate reinforced HfB_2 composites

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Abstract

Carbon nanotubes (CNTs) were synthesized over a $Ni/Y_2O_3/HfB_2$ catalyst by chemical vapor deposition of methane at temperatures ranging from 800 °C to 1200 °C. Results of X-ray diffraction, scanning electron microcopy, transmission electron microcopy, and Raman spectroscopy indicated that 1100 °C was the most suitable synthesis temperature for the CNT growth using the $Ni/Y_2O_3/HfB_2$ catalyst. Spark plasma sintering was then conducted on the well-synthesized composite powder at 1600 °C for 10 min under a uniaxial load of 30 MPa in vacuum to obtain fully dense bulk composite. The flexural strength and fracture toughness of the in situ synthesized CNT(Ni/Y_2O_3)–HfB_2 composite were increased to 942 ± 34 MPa and 9.2 ± 0.5 $MPa \cdot m^{1/2}$, respectively. These values were considerably higher than those of traditional HfB_2-based composites. Crack deflection, crack bridging, CNTs debonding, and pull-out were identified as the main reinforcing mechanisms for the improvement of mechanical properties.

Keywords: A. Ceramics; B. Sintering; C. Mechanical properties; C. Microstructure

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