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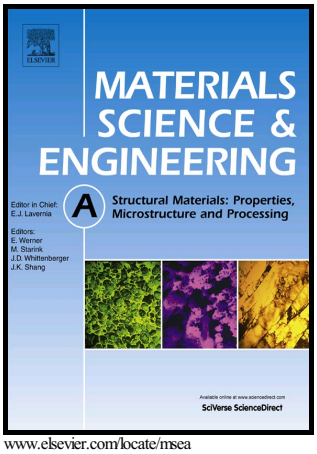

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Effects of nano-graphite content on the characteristics of spark plasma sintered ZiB_2–SiC composites

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Abstract

In this study, ZrB_2–25 vol% SiC composite containing 0, 2.5, 5, 7.5 and 10 wt% graphite nano-flakes were prepared by spark plasma sintering (SPS) process at 1900 ºC for 7 min under 40 MPa. The fabricated composite samples were compared to examine the influences of nano-graphite content on the densification, microstructure and mechanical properties of ZrB_2–SiC-based ultrahigh temperature ceramics. Fully dense composites were obtained by adding 0-5 wt% nano-graphite, but higher amounts of additive led to a small drop in the sintered density. The growth of ZrB_2 grains was moderately hindered by adding nano-graphite but independent of its content. The hardness linearly decreased from 19.5 for the graphite-free ceramic to 12.1 GPa for the sample doped with 10 wt% nano-graphite. Addition of graphite nano-flakes increased the fracture toughness of composites as a value of 8.2 MPa $m^{½}$ was achieved by adding 7.5 wt% nano-graphite, twice higher than that measured for the graphite-free sample (4.3 MPa $m^{½}$). The in-situ formation of ZrC and B_4C nano-particles as well as the presence of unreacted graphite nano-flakes led to a remarkable enhancement in fracture toughness through activating several toughening mechanisms such as crack deflection, crack bridging, crack branching and graphite pullout.

Keywords: spark plasma sintering; zirconium diboride; graphite nano-flake; nanocomposite; densification; mechanical properties.