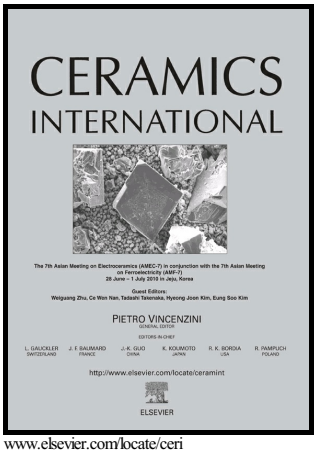

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PII: S0272-8842(17)30320-6
DOI: http://dx.doi.org/10.1016/j.ceramint.2017.02.117
Reference: CERI14733

To appear in: *Ceramics International*

Received date: 24 October 2016
Revised date: 13 February 2017
Accepted date: 22 February 2017

Cite this article as: Eric W. Neuman, Gregory E. Hilmas and William G Fahrenholtz, Processing, Microstructure, and Mechanical Properties of Zirconiur Diboride-Boron Carbide Ceramics, *Ceramics Internationa* http://dx.doi.org/10.1016/j.ceramint.2017.02.117

Processing, Microstructure, and Mechanical Properties of Zirconium Diboride-Boron Carbide Ceramics

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Abstract

The processing, microstructure, and mechanical properties of zirconium diboride-boron carbide (ZrB_2-B_4C) ceramics were characterized. Ceramics containing nominally 5, 10, 20, 30, and 40 vol% B_4C were hot-pressed to full density at 1900°C. The ZrB_2 grain size decreased from 4 to 2 μm and B_4C inclusion size increased from 3 to 5 μm for B_4C additions of 5 and 40 vol% B_4C, respectively. Elastic modulus decreased from 525 to 515 GPa and Vickers hardness increased from 15 to 21 GPa as the B_4C content increased from 5 to 40 vol%, respectively, following trends predicted using linear rules of mixtures. Flexure strength and fracture toughness both increased with increasing B_4C content. Fracture toughness increased from 4.1 MPa·$m^{½}$ at 5 vol% B_4C to 5.3 MPa·$m^{½}$ at 40 vol% B_4C additions. Flexure strength was 450 MPa with a 5 vol% B_4C addition, increasing to 590 MPa for a 40 vol% addition. The critical flaw size was calculated to be ~30 μm for all compositions, and analysis of the fracture surfaces indicated that strength was controlled by edge flaws generated by machining induced sub-surface damage. Increasing amounts of B_4C added to ZrB_2 led to increasing hardness due to the higher hardness

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