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High-temperature strength of directionally solidified B_4C-ZrB_2 composite

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Abstract

Directionally solidified eutectic B_4C-ZrB_2 composite was prepared by a floating zone method based on crucibleless zone melting of compacted powders. The ZrB_2 and B_4C powders were used as initial materials. In the final product, the fibers of zirconium diboride were uniformly distributed in the B_4C matrix thereby reducing its brittleness. The bending strength of the melted eutectic B_4C-ZrB_2 composite was evaluated in the temperature range 25-1600°C. With increasing temperature, its value decreases to 120 MPa at 800°C and than increased to 240 MPa at 1600°C. We speculate that the bending strength of directionally reinforced B_4C-ZrB_2 composite at high temperatures mainly depends on the temperature dependence of the thermal expansion coefficient and on the plasticity of ZrB_2 fibers and B_4C matrix.

Key words: *Ceramic composites, Boron carbide, Zirconium diboride, Directional crystallization, Bending strength.*

1. Introduction

It is well known that boride ceramics have high melting temperature, hardness, onset temperature of creep, and chemical stability at high temperatures (Martienssen and Warlimont, 2005; Matkovich, 1977). Therefore, they might be used in cutting tools, wear resistant parts, armor materials and functional elements of cathode assemblies, working in conditions of high-rate heating or cooling and heterogeneous thermal tension, at temperatures ranging between 1200 and 1700 °C (Mroz, 2000; Ashbrook, 1977; Ni *et al.*, 2009). However, boride ceramics are rather brittle, especially in comparison with traditional refractory metals, such as W, Mo, Ta or Nb (Skorokhod and Krstic, 2000; Skorokhod and Krstic, 2000). Metallic bonds (cermets), shattering of grains, intentional generation of internal stresses and reinforcement by fibers or inclusions are usually used for strengthening ceramic materials [(Skorokhod and Krstic, 2000; Raj, 1993; Claussen *et al.*, 1996; Hasselman *et al.*, 1991; Zhang and Chen, 2007). The eutectic LaB_6-MeB_2 and B_4C-MeB_2 alloys (Me = Ti, Zr, Hf), produced by the floating zone method, are examples of materials directionally reinforced by the metal

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