SINTERING AND OXIDATION OF MB_2-SiC (M = Hf, Zr) CERAMICS WITH ADDITION OF Cr

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Transition metal borides, carbides, and nitrides are gaining increased attention as refractory compounds with superior properties at very high temperatures. Hafnium and zirconium diborides especially combined with ~20 vol% of silicon carbide display a number of unique properties such as hardness, high thermal conductivity and chemical stability. Due to a high melting points of HfB_2 and ZrB_2 (3380 and 3245°C, respectively) the fabrication of dense and durable HfB_2 or ZrB_2-based ceramics needs in the special high-temperature sintering techniques, such as hot pressing (HP) or spark plasma sintering (SPS). The typical temperature of sintering of such ceramics that gives a relative density of 98% or higher is about 2000-2200°C for HP and 1900-2000°C for SPS.

Alternative approach to compact the ceramic powders is based on the formation of transient liquid-phase (TLP) during thermal treatment of ceramic powders with some aids. It is known that silicon carbide reacts with chromium at 1600°C with the formation of liquid Cr-Si-C eutectics. One can propose that the transient liquid phase could promote the sintering of MB_2-SiC (M = Hf, Zr) ceramics at temperatures lower than 2000°C. The other benefit to use chromium as sintering additive is in the fact that the oxidation of the MB_2-SiC-Cr system at high temperatures could lead to the formation of protective layer due to the formation of the MO_2-Cr_2O_3 (M = Hf, Zr) eutectics at temperatures higher than 1900°C. Thus, the present work aims to the study of the effect of chromium additive on the densification behavior, chemical transformations and oxidation resistance of the HfB_2-SiC and ZrB_2-SiC ceramics.

It was shown that increase of Cr content from 0 to 15.5% leads to the continuous growth of its relative density of HfB_2-SiC ceramics from 64 to 90%. It was stated that the formation of transient liquid phase Cr-Si-C-B occur at 1600°C and this liquid phase promotes the intense sintering of MB_2 (M = Hf, Zr) and SiC powders. The decrease in the porosity of ceramic samples leads to increase in their oxidation resistance at 1000-1500°C due to the change of the oxidation mechanism from bulk to passive. The results obtained in this work shows that the chromium can be considered as a promising sintering additive for the HfB_2-SiC and ZrB_2-SiC systems as well as other SiC-based ceramics due to the rather low sintering temperature (1600°C).

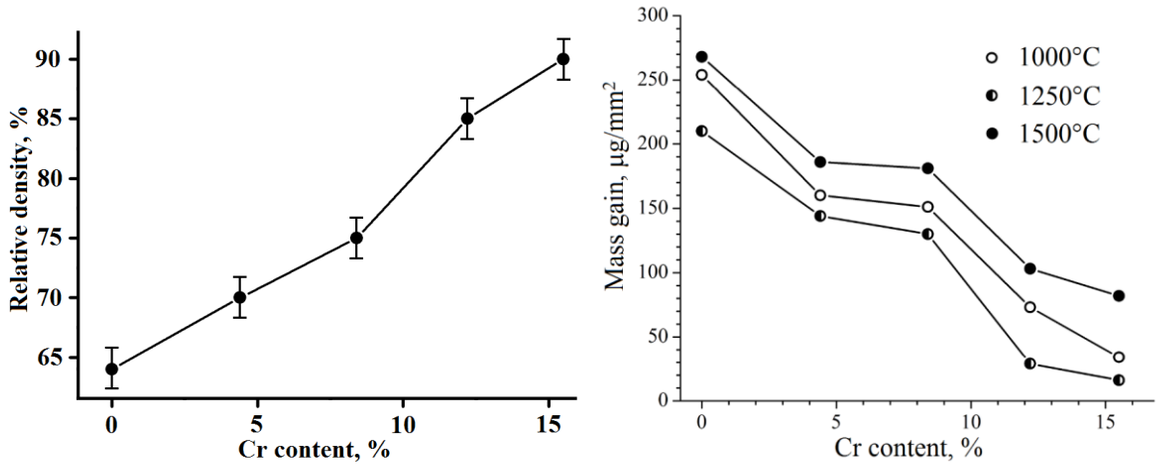

Fig. 1. Relative density of HfB2-SiC ceramics (left) and its mass gain during oxidation (right) in dependence of Cr content.