ULTRAHIGH PRESSURE SPARK PLASMA SINTERING OF ZrC-TiC-$MoSi_2$ AND ZrC-TiC-Si_3N_4 COMPOSITES

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Zirconium carbide (ZrC) is a potential candidate for cutting tools, engines, hypersonic vehicles, plasma arc electrodes, cutting tools and nuclear reactors by virtue of numerous promising properties, such as high melting temperature, good thermomechanical and thermoelectrical properties, chemical stability and neutron transparency. However, the current imperative demand is to develop ZrC as a matrix for ceramic-matrix composites with chemically compatible constituents to enhance their densification behavior, high temperature hardness, sinterability and fracture toughness [1].

ZrC with introduced secondary phases was consolidated using HPHT SPS (high pressure, high temperature spark plasma sintering) technique directed at developing the potential of HPHT SPS technique for the absolute densification of zirconium carbide based composites [2]. Spark plasma sintering of these composites was also performed to compare the effect of high pressure on the sintering behavior of target composites. In the present research the comparative study of the following systems (ZrC-20wt.%TiC)-10wt.%$MoSi_2$, (ZrC-20wt.%TiC)-5/10wt.%Si_3N_4 was performed.

Preliminary, commercially available ZrC-TiC-Si_3N_4 and ZrC-TiC-$MoSi_2$ powders were subjected to ball milling for 1 hour (200rev/min), using ZrO_2 as a milling media with a ball powder ratio of 4:1. The compaction process was performed using the Bridgman-type toroidal apparatus - HPHT SPS technique. Under the influence of a simultaneous action of pressure (6-7.7 GPa) and temperature (1800-1950^{o}C) the sintering process occurred much faster (40s) than in the case of conventional spark plasma sintering, where set of a parameters, such as 1800-1900^{o}C of temperature, 50MPa of pressure and 5-10 of dwelling times were utilized. The complete densification of HPHT SPS samples with improved physicomechanical characteristics was achieved.

References

1. Ch. Nachiappan, et al., 2010, J. Amer. Cer. Soc., 1341-1346.

2. Yung, Der-Liang, et al., 2016, Int. J. Ref. Met. and Hard Mater., 201-206.

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