

Formation of high temperature compounds in Ti-B-N-C, W-C-B systems by using reactive spark plasma sintering

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Boron carbide and titanium or tungsten boride due to high melting point and hardness are attractive compounds for high-temperature wear-resistant materials. However sintering of boron carbide or borides demands very high temperature or the use of different additives.

From literature data follows that sinterability of these powders could be improved by using nanosize powders and fast plasma sintering technique which find wide application for producing nanostructural materials including boron carbide, titanium and tungsten diboride.

In the present work the formation of high temperature composites in Ti-B-C-N, W-C-B systems from fine-grained powders in dependence on the ratio of components by using reactive spark plasma sintering was studied.

As precursors the mixtures of TiN, TiNC, W₂C, and C nanoparticles were used because they were more stable in air with respect to metal nanoparticles. The W₂C and carbon mixture with different ratio of components was prepared by reduction of WO₃ in presence of CH₄ in nitrogen inductively coupled plasma. The TiN and TiNC nanoparticles were prepared by evaporation of Ti in nitrogen inductively coupled plasma. Specific surface area of the mixture was in the range of 36 – 42 m²/g in dependence on the content of carbon.

The TiN, TiNC, W₂C and carbon particles were mixed mechanically with amorphous boron and densified using spark plasma sintering technique at 1500–1700 °C and pressure of 30 MPa for 5–10 minutes.

The sintered bodies contained TiN_{0.1}C_{0.9}-TiB₂, TiB₂-B₄C or WB₂-B₄C phases. The ratio of phases depends on the content of the components in the raw mixture.

The density of bulk materials was in the range of 91.0–98.6% in the dependence on the content of borides and B₄C and sintering temperature. The obtained materials had fine-grained microstructure.