β-SiAlON-BASED CERAMIC COMPOSITES BY COMBUSTION SYNTHESIS AND SPARK PLASMA SINTERING

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Spark-plasma sintering (SPS) of composite ceramics in the β-Si₅AlON₇ system (SiC, TiN, BN) was studied. An effective mechanism of intensification of sintering processes was revealed due to the introduction of h-BN, having a scaly structure and playing the role of a solid lubricant, which improves the compressibility of the sintered powder mixtures under load. For composites containing 0–30 wt. % h-BN, 0–40 wt.% β-SiC, and 0–40 wt. % TiN, with different character distribution of components by volume (homogeneous, layered and gradient), the optimal parameters of the PCA were established, ensuring the achievement of a high level of relative density (not less than 95%) and functional characteristics. According to XRD results, the raw powders of β-Si₅AlON₇, h-BN, and TiN did not contain impurity phases while β-SiC had trace amounts of Si₃N₄. According to SEM results, all as-synthesized powders appeared largely as agglomerates. Their specific surface was about 1.3 m²/g for β-Si₅AlON₇ powders, and from 9.8 to 22.8 m²/g for h-BN, β-SiC, and TiN fine powders. After ball milling, the specific surface increased by a factor of 4–6.

The addition of h-BN improves the compactibility of sintered powder mixtures. Under a compressive stress of 50 MPa at 600°C, the initial value of ρrel exceeds 80% for the compact containing 30 wt. % BN and 60% for that of pure β-Si₅AlON₇ (Figure 1). In parallel, an increase in h-BN content suppresses the consolidation processes due to formation of liquid eutectics. At 30 wt. % BN, the temperature dependence of ρrel becomes much more aligned.

![Figure 1. Relative density ρrel as a function of temperature T for: β-Si₅AlON₇ (1), β-Si₅AlON₇–BN (10 wt. %) (2), β-Si₅AlON₇–BN (20 wt. %) (3), and β-Si₅AlON₇–BN (30 wt. %) (4); Tmax = 1650°C.](image)

The main structural characteristics (relative density, phase composition, microstructure) and physics-mechanical properties and functional characteristics of the obtained samples of composite ceramics (flexural strength, electrical conductivity, linear thermal expansion coefficient, thermal shock and wear resistance, etc.) and dependencies between them were researched. The achieved level of physics-mechanical properties and functional characteristics confirms that productive and energy efficient methods of SHS and SPS can be successfully applied in the development of promising ceramic materials and products based on sialons for use in extreme conditions.