

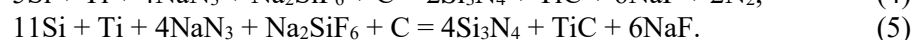
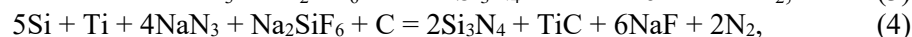
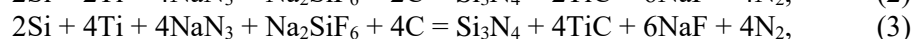
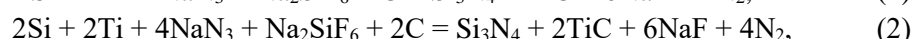
Application of combustion of Ti-Si-Na₃-Na₂SiF₆-C powder mixture for the synthesis of highly dispersed Si₃N₄-TiC ceramic composition

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Silicon nitride ceramics are capable of operating under high temperature and stress conditions due to their thermal conductivity, low coefficient of thermal expansion, and high resistance to thermal shock. However, the strength of Si₃N₄ ceramics tended to decrease due to the formation of microcracks around large grains. Many efforts have been made to improve the mechanical properties of Si₃N₄ by controlling the microstructure or creating various types of composites. Significant improvements in strength, toughness and damage resistance have been obtained in numerous ceramics such as AlN-SiC, Si₃N₄-SiC and Si₃N₄-TiC [1,2]. Titanium carbide (TiC) particles, characterized by a high elastic modulus, hardness and electrical conductivity, are introduced as a dispersion-strengthening phase into monolithic Si₃N₄ ceramics to improve not only the strength, but also the fracture toughness and electrical conductivity of composite ceramics.

A Si₃N₄-TiC nanocomposite with high mechanical properties was obtained by hot pressing by adding 10 wt.% nanosized Si₃N₄ particles and 15 wt.% TiC to a submicro-sized Si₃N₄ matrix [3]. Layered composites have the highest strength, fracture toughness and wear resistance. Thus, a Si₃N₄-TiC ceramic nanocomposite for cutting tools using a Si₃N₄ micromatrix with Si₃N₄ and TiC nanoparticles showed better wear resistance than a sialon tool. Meanwhile, the wear of Si₃N₄-TiC composite ceramic cutting tool is mainly dominated by abrasion and adhesion, while the wear of sialon ceramic cutting tool is dominated by abrasion, adhesion, thermal cracking and peeling [4]. This paper explores the application of azide SHS, in which sodium azide powder and a halide salt (Na₂SiF₆) are used as a nitriding reagent. The compositions of the initial mixtures of powders for the synthesis of single-phase Si₃N₄ and TiC are known, based on the analysis of which the following chemical reaction equations were used to synthesize the Si₃N₄-TiC composition with a molar phase ratio from 1:4 to 4:1:



Thus, despite the positive results of theoretical thermodynamic analysis, the considered experimental application of the azide SHS method did not allow us to synthesize the target composition of Si₃N₄-TiC powders in pure form, without the side titanium nitride phase (TiN) in the composition. But for the first time, the possibility of using combustion for the synthesis of compositions of highly dispersed nano-sized and submicron ceramic powders Si₃N₄-TiC and Si₃N₄-TiC-TiN with a particle size of less than 500 nm with a relatively low content of free silicon impurity (less than 1.5%) has been experimentally demonstrated, which is noticeable achievement.

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References

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