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APPLICATION OF Ti-NaN_3-NH_4Cl-C POWDER MIXTURE COMBUSTION FOR SYNTHESIS OF HIGHLY DISPERSED TiN-TiC CERAMIC COMPOSITION*

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Due to the development of the aerospace, energy, chemical and automotive industries, the need for hard-to-process materials such as superalloys, hardened steel and ultra-high-strength steel is growing. There is also a growing demand for cutting tool materials with high performance characteristics. Due to its high hardness, excellent wear resistance, ceramic cutting tools are an ideal choice for high-speed cutting of hard-to-process materials.

Due to the high strength and poor thermal properties of ultrahigh-strength steels, high cutting temperatures, high-speed steel processing results in a strong hardening. Therefore, the desired ceramic tool materials must have exceptionally high hardness and significant wear resistance. Al_2O_3 and *TiN* microparticles and *TiC* nanoparticles have high hardness and good wear resistance, and *TiN* particles can inhibit the growth of Al_2O_3 micrograins. Meanwhile, *TiC* nanoparticles can reduce Al_2O_3 grains in size, which leads to an increase in the fracture toughness of ceramics [1].

A study of the effect of *TiN* additives on sintering, mechanical properties and microstructure of *TiC*-based materials showed that the introduction of *TiN* increased the relative density of *TiC* by about 1.5%, amounting to about 97%, Vickers hardness - 2750 HV, bending strength - 450 MPa [2]. However, such composites have a high cost and are difficult to manufacture, which is due to the high cost of ceramic nanopowders and the practical impossibility of their homogeneous mechanical mixing [3]. Therefore, chemical methods of direct synthesis of ceramic powders inside the desired composition from inexpensive starting reagents are preferred. Among chemical methods, a simple energy-saving method of self-propagating high-temperature synthesis (SHS) attracts much attention. In this paper, the use of azide SHS is investigated, in which sodium azide powder as a nitriding reagent and halide salts are used. The compositions of the initial powder mixtures for the synthesis of single-phase *TiN* and *TiC* are known, based on the analysis of which the following chemical reaction equations were used for the synthesis of a *TiN-TiC* composition with a molar phase ratio from 1:4 to 4:1:

$$2Ti + C + NaN_3 + NH_4Cl = TiN + TiC + NaCl + 1{,}5N_2 + 2H_2, \quad (1)$$
$$3Ti + 2C + NaN_3 + NH_4Cl = TiN + 2TiC + NaCl + 1{,}5N_2 + 2H_2, \quad (2)$$
$$5Ti + 4C + NaN_3 + NH_4Cl = TiN + 4TiC + NaCl + 1{,}5N_2 + 2H_2, \quad (3)$$
$$3Ti + C + NaN_3 + NH_4Cl = 2TiN + TiC + NaCl + N_2 + 2H_2, \quad (4)$$
$$5Ti + C + NaN_3 + NH_4Cl = 4TiN + TiC + NaCl + 2H_2. \quad (5)$$

The results of thermodynamic calculations of these reactions are obtained, according to which the adiabatic temperatures are high enough to realize a self-sustaining combustion regime, and the reaction products correspond to the right-hand sides of equations (1)-(5). The combustion temperatures and velocities, structure and phase composition of the combustion products were determined during the experimental study. The study of the microstructure showed that the synthesized composition consists of equiaxed *TiN* and *TiC* particles ranging in size from 100 to 350 nm.

Thus, the azide SHS method made it possible to prepare a promising *TiN-TiC* ceramic composition in one stage, and with a different ratio of target phases.

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