EFFECT OF ALUMINIUM OXIDE AND ASH MICROSPHERES ON NITRIDING OF ALUMINIUM FERROSILICON IN THE COMBUSTION MODE[1]

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β-Sialons are solid solutions with a variable composition $Si_{6-z}Al_zO_zN_{8-z}$ formed on the basis of β- Si_3N_4 by substitution of Si → Al and N → O (z is the number of substituted silicon and nitrogen atoms in the formula of silicon nitride and is changed in the range from 0 to 4.2). These compounds are stable at high temperatures (1500-1800 °C), demonstrate high corrosion, heat and wear resistance, significant hardness and strength [1] and are currently considered to be technologically and commercially promising materials. As a rule, the synthesis of sialons is combined with the hot pressing of mixtures from preformed powders of Si_3N_4, AlN and Al_2O_3, which results in high costs of ceramic materials. The process of production becomes much simpler and the costs of sialon ceramics are reduced if green mixtures used for the production of ceramics are not subjected to deep chemical cleaning, for example, aluminosilicate minerals or iron-containing alloys. As shown in [2], even if sialon ceramics contains iron in significant amount (about 10%), such ceramics has high performance characteristics. Ferroalloys that contain both nitride-forming elements in the composition of sialon (aluminum and silicon) are of particular interest.

Aluminium ferrosilicon (grade FS65F15), aluminium oxide and ash microspheres were used as green mixtures. Samples were burned in a constant-pressure device according to the procedure in [3]. The nitriding of aluminium ferrosilicon in the presence of ash microspheres in the amount of more than 10 wt.% allows the nonstationary combustion to be changed to the stationary one. The combustion product is a sintered porous homogeneous material. As studies have shown, the pore size of the sample is usually determined by the particle size of ash microspheres. When the amount of an added green mixture was more than 25 wt.%, the combustion of aluminium ferrosilicon was not observed.

Aluminium oxide (α-Al_2O_3) was added to the green mixture in the amount of 5-22% to achieve the maximum possible nitriding degree of synthesis products and obtain β-sialon with a composition of $Si_3Al_3O_3N_5$. When the amount of Al_2O_3 was more than 22%, the combustion of aluminium ferrosilicon was not observed. A detailed study of a diffraction profile for the combustion products of aluminium ferrosilicon in the presence of Al_2O_3 showed that all diffraction maxima shifted toward smaller angles (2θ). It is seen that an increase in the amount of aluminium oxide leads to the fact that the crystal lattice parameters approach the reference values for β-Si3Al3O3N5 and reach the maximum matching for 22% of Al_2O_3. In this case, a two-phase combustion product consisting of β - $Si_3Al_3O_3N_5$ and α-Fe is formed.

In general, ash microspheres can be used to change a surface combustion mode to a layered one, which allows us to obtain a sample with a homogeneous macrostructure, and a sintered porous material as well. The study has shown that the final product of aluminium ferrosilicon nitriding in the combustion mode is a two-phase material consisting of β – $Si_3Al_3O_3N_5$ and α-Fe, for the case when the amount of Al_2O_3 added to the initial ferroalloy was 22 wt.%.

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