EFFECT OF SHUNGITE ADDITIVES ON THE NITRIDING OF SILICON IN THE COMBUSTION MODE

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At present, ceramic materials, modified with silicon carbide, are of special interest due to the capability of silicon carbide to successfully act as a catalyst carrier [1]. One of the promising methods for the obtaining of nitrides and carbides is the self-separating high-temperature synthesis (SHS) method that is characterized by high productivity and low energy consumption, which is very important for industrial production. The purpose of this work is to investigate the effect of shungite additives on the phase composition of products obtained by the combustion of silicon in nitrogen. Silicon (grade kr-0) and shungite (Zazhoginskoe field) were used as green mixtures. Samples were burned in a constant-pressure furnace by the method described in [2]. The experiments have shown that the combustion of silicon in nitrogen occurs in a nonstationary mode, and the final product contains a sufficient amount of unreacted silicon in addition to α- and β-Si_3N_4. To increase the efficiency of silicon nitride based materials, it is of interest to add carbon-containing compounds. For this purpose, shungite was added to a green mixture consisting of silicon. The amount of shungite in the green mixture was varied in the range of 0-40%. A significant amount of carbon in shungite can lead to the formation of carbides. The samples were synthesized according to the procedure described in [3].

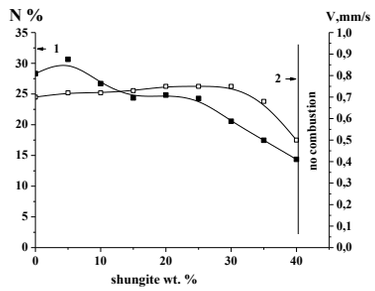

Fig. - Nitrogen content in products (1) and combustion rate (2) versus the amount of shungite (nitrogen pressure is 4 MPa)

As studies have shown, the increase in the amount of shungite by more than 10 wt.% during the nitriding of silicon results in the change of the nonstationary combustion mode to the stationary one, and the combustion product is a homogeneous material. In the case, when the amount of added shungite was more than 40 wt.%, the combustion of silicon was not observed. Increasing the amount of shungite, the propagation velocity of combustion wave initially increases insignificantly and then drops sharply. In addition, the amount of nitrogen absorbed decreases noticeably with an increase in the amount of shungite in the range of 20-40% (Fig.). On the one hand, an increase in the amount of an inert additive reduces the combustion temperature, as evidenced by the thermograms of the process. The decrease in the combustion temperature is due to the fact that during the nitriding the total reacting mass increases, and the inert additive does not contribute to the heat release. On the other hand, the adding of schungite influences on the filtration of nitrogen in the green mixture. The increase in the amount of shungite slows the sintering of material, which increases the gas permeability of the sample. Thus, the studies conducted have demonstrated the nitriding of silicon with shungite in the combustion mode. When the amount of shungite added to the green mixture was 20%, we obtained a densely sintered doping nitrogen-containing material with a maximum nitrogen content of 24.8%. When the amount of shungite was 40%, we obtained a loose unsintered powder material that can be used to obtain ceramic materials by known compaction methods. The nitriding process was investigated, and the stable conditions were found for initiating the process. The phase composition of combustion products was determined.

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