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INTERACTION OF THE "FERROSILICON-ZIRCON-ALUMINIUM" MIXTURE WITH NITROGEN DURING SHS

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Si_3N_4 due to its properties (high hardness, heat resistance, mechanical strength) and composite materials based on it (Si_3N_4-SiC, Si_3N_4-TiN, Si_3N_4-BN, Si_3N_4-$MoSi_2$ etc.) are widely used in tool industry, mechanical engineering, chemistry, electrical and radio engineering [1-3]. Due to the covalent bonds, Si_3N_4 is a high-sintering material. Activating oxygen-containing additives (Al, Mg, REM oxides) are used to obtain high-density Si_3N_4 - based ceramics. Sintering activators also include ZrO_2. In this work, a new approach to the synthesis of Si_3N_4-based composite powders was proposed. It was proposed to nitride ferrosilicon (iron-silicon alloy) with natural oxides (zircon) by self-propagating high-temperature synthesis (SHS). The heat of the nitride formation reaction contributes to an endothermic process of zircon dissociation and the powder Si_3N_4-ZrO_2-Si_2N_2O-Fe is obtained without additional energy costs.

In [4] the effect of aluminum additives (1-10 wt%) on the phase composition of composite powders was reported using the "40 % ferrosilicon - 30 % nitrided ferrosilicon - 30 % zircon" mixture that was nitrided by SHS. It was found that the addition of 1% Al leads sharply decreases the Si_2N_2O phase content in the synthesized products, and a further increase in Al leads to the disappearance of Si_2N_2O. Addition of 6 % and more leads to the formation of ZrN phase in the burned samples, which is visually observed as separate areas of golden color. The addition of Al additives to the mixture leads to the formation of a solid solution based on Si_3N_4 in the final products. However, the mechanism of interaction of the mixture with nitrogen in the presence of aluminum during combustion remains unclear. This work is an ongoing research and devoted to the study of chemical transformations during nitriding of the mixture with aluminum additives (1 - 10 %) using the methods of isothermal synthesis and differential scanning calorimetry.

To study physicochemical processes occurring during nitriding of the mixture with Al, sample 1 (mixture + 6 % Al) and sample 2 (mixture + 10 % Al) were used. Nitriding of sample 1 under isothermal conditions showed a small amount of nitrogen in the products in the temperature range of 800 - 1000ºC with increasing the nitriding time (30 - 180 min). At temperatures above 1000ºC, the amount of nitrogen in the products increases. According to XRD data, AlN is formed in the products at 800ºC. At 900ºC, Si_3N_4 reflexes are observed in X-ray diffraction patterns, and ZrO_2 at 1000ºC. In the temperature range of 1000 - 1250ºC, the phase composition of the products is represented by β- Si_3N_4, ZrO_2. With increasing the nitriding time, the intensity of reflexes of these phases slightly increases. The synthesized products contain unreacted components of the mixture ($FeSi_2$, Si, Fe_xSi_y, $ZrSiO_4$). A similar pattern is observed during nitriding of sample 2 under isothermal conditions.

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