INTERACTION OF FERROSILICON - SHUNGITE MIXTURE WITH NITROGEN IN THE COMBUSTION MODE

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Silicon nitride and its compositions with silicon carbide are used as wear-resistant, heat-resistant, acid-resistant materials because they have valuable performance characteristics (high thermal conductivity and heat resistance, hardness, wear resistance, chemical resistance in aggressive media). There are known works on synthesis of Si3N4 - SiC in SHS mode. The authors [1] use silicon and additives of organic compounds. SHS-Az technology [2, 3] allows to obtain highly dispersed powder ceramic composition Si_3N_4 - SiC by combustion of components in the system Si-C-NaN_3 - $(NH_4)_2SiF_6$ or NH_4F. Employees of TSC SB RAS used shungite for synthesis of Si_3N_4 - SiC composite. Shungite is a natural composite, in the structure of which dispersed crystalline silicate particles are evenly distributed in a carbon matrix (SiO_2-C). Since this mineral contains a significant amount of quartz and carbon, the reactions of reduction of silica to metallic silicon $SiO_2+2C \rightarrow Si + 2CO$ and formation of silicon carbide $SiO_2 + 3C \rightarrow SiC + 2CO$ are active during heating. Under certain conditions, intensive heterogeneous reactions can be realized in SHS mode. In case ofaddition of shungite to ferrosilicon it is possible to obtain a composite of Si_3N_4, SiC, Si_2N_2O, Fe. The aim of the present work is to investigate the microstructure of synthesis products and physicochemical processes occurring during the interaction of ferrosilicon and shungite with nitrogen.

The method of differential scanning calorimetry was used for modeling the SHS - nitriding process of ferrosilicon - shungite mixture and fixation of chemical transformations accompanied by exo- or endothermic effects. A mixture of 80% ferrosilicon - 20% shungite was investigated using DSC - TG analysis. The slight endothermic broadening at 102.8ºC is due to the removal of adsorption water. In the temperature range 120 - 400ºC, the endothermic peaks are due to the removal of volatile components of shungite, which corresponds to a decrease in sample mass (TG curve). The endothermic peak at 540.5ºC corresponds to the polymorphic transition α → β quartz. The exothermic peak at 624.9ºC is associated with the burnout of shungite carbon. Gradual carbon burnout occurs up to a temperature of ~ 1070ºC. This point corresponds to a decrease in the mass of the sample. The endothermic effect with a maximum at 1215ºC refers to the melting of $FeSi_2$ - Si eutectic, and two other endothermic effects at 1334ºC and 1402ºC correspond to phase transformations in the Fe - Si system in accordance with the diagram of state. The process of active nitriding begins at temperatures above 1270ºC. The DSC curve shows a rise corresponding to the exothermic interaction of iron-silicon melt with nitrogen, and the TG curve shows an increase in the mass of absorbed nitrogen. The endothermic effect at 1434ºC is the polymorphic transformation α - quartz → α - tridymite.

According to the results of SEM studies, the main mechanism of crystal growth is crystallization from the melt. The morphology of synthesis products is represented by aggregates of small faceted crystals and crystals in the form of thin plates of irregular shape. According to the results of elemental microanalysis, the crystals are nitride, carbide and silicon oxynitride, because their chemical composition is represented by silicon, nitrogen, carbon and oxygen. Crystals in the form of thin plates - silicon carbide (silicon and carbon are determined by MRSA data).

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