C1-P-009301

STUDY OF THE STRUCTURAL-PHASE STATE OF SIALON OBTAINED BY SYNTHESIS UNDER THE INFLUENCE OF LOW-TEMPERATURE PLASMA ENERGY

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Sialons appertain to the class of ceramic materials with excellent high-temperature properties and high mechanical properties. These properties contribute to their wide application in many areas of industry: automobile engines, gas turbine blades, high-performance bearings, etc.

About 10 types of four-component sialons with crystal structures are known. The main and widely used are α-, *β*- and O'-SiAlON [1]. Non-stoichiometric composition β–SiAlON described by the formula $Si_{6-\varepsilon}Al_{1+\varepsilon}O_{1+\delta}N_{8-\delta}$. Here δ and ε characterize deviations from stoichiometry within the limits of $1 \le \varepsilon \le 3.2$ and $1 \le \delta \le 4.2$. With a lack of nitrogen in the compound, anions N^{3-} have two possibilities: 1) create vacancies on the nitrogen sublattice; 2) anions O^{2-} infiltrate the nodes on the nitrogen sublattice. A similar situation exists metal nodes on cationic sublattices Al and Si. As a result, β-SiAlON have a wide area of homogeneity and this compound is isostructural to a two-component compound β-Si_3N_4. α-SiAlON is a compound, which already contains four formula units β-Si_3N_4, and is described by the formula $Me_{\varepsilon}Si_{12-(\varepsilon+\delta)}Al_{\varepsilon}O_{\delta}N_{16-\delta}$ (Me≡ metal ion). It is known that the phase transition between the two types of SiAlON satisfies the conditions [2]: α- SiAlON+O_2→β-SiAlON and β-SiAlON+N_2→α-SiAlON. The physical and mechanical properties of these two types of sialon differ significantly.

In [3] data on the study of mullite synthesis by means of thermal influence of plasma beam are given. Application of plasma energy is also possible for the synthesis of other high-temperature ceramics.

The aim of this work was to study the structural-phase composition of the synthesis products obtained by plasma-chemical synthesis of SiAlON.

For the experiment, mixtures were prepared from which briquettes were formed followed by heat treatment in an oven at 400 C^{o} for 30 minutes. Two reaction mixtures are used for the synthesis of SiAlON by the plasma chemical method: SiAlON-I: β-Si_3N_4+AlN+H_4N_2CO+Na_2SiO_3; SiAlON-II: β-Si_3N_4+AlN+H_4N_2CO+Na_2SiO_3+Re (Fe, Co) (where Re=Nd, Pr, La).

High-temperature exposure to the sample was carried out in a plasma jet obtained in a plasma generator of the VPR-410 NPP type. Plasma generator power P =30 kW with specific heat flow $q=2,3\times10^6$ W/m^2. The plasma gas was nitrogen.

During the interaction of a low-temperature plasma jet with a mass-average temperature T = 6100÷7300 K with sample material compounds with different crystal structures are formed in the heat-affected zone within tens of seconds. A feature of SiAlON formation is the strong dependence of solid-phase reactions on the movement of point defects in the high-temperature fields created by the plasma jet. Because the reactivity of solids depends significantly on non-stoichiometry. As a result, this property was well manifested in the reactions solid-solid, solid-gas in our experiment.

X-ray diffraction analysis showed that the main phase is the compound β- SiAlON (Si_5AlON_7 space group $P6_3$). Also found traces of the original compounds β-Si_3N_4 and AlN compounds. In addition to the crystal phases, a halo belonging to the X-ray amorphous phase is fixed on diffractogram. Introduction of metallic powder into the charge REM-Fe(Co) led to the formation of additional lines on the diffractograms, which are α-SiAlON.

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*The work was supported by the state assignment of the Ministry of Science and Higher Education of the Russian Federation (project number FEMN-2020-0004).