GLASS FOR CONTINUOUS FIBER BASED ON COMPOSITIONS BASALT–MODIFIER

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Rocks of volcanic origin, such as basalts, basaltic andesites, etc., are widely used in the production of thermal insulation materials based on mineral wool. At present, the most promising material obtained from such rocks is continuous fibre. Wide prospects for application of continuous basalt fibre are attributable to the abundance of the raw materials in the nature, the environmental friendliness of the production and high level of strength, thermal resistance and chemical resistance of the materials based on it. In particular, basalt continuous fiber is an effective reinforcement material in the production of composites that are characterized by high level of strength and resistance to alternating loads [1, 2]. However, there are a number of technological problems in the production of continuous fibre due to the instability of the chemical and mineral composition of basalt, the high absorption ability of iron-containing melt and the enhanced crystallization ability [2, 3].

Basalt continuous fiber produced directly from natural basalt rarely has good technological characteristics. Consequently, there are ongoing activities aimed at modifying the composition of basalts by way of introduction of additional components [4–7].

Optimization of basaltic glass composition is a topical direction of the technological innovations in the field of continuous basalt fiber production.

Basaltic andesites from Podgornyanskoye deposit were used for basaltic glass production. According to the results of analysis of chemical composition of basalts conducted by atomic emission spectroscopy method with a laser analyzer LEA-S500, average composition of basalts includes, wt.%: SiO_2 52.90; Al_2O_3 16.18; Fe_2O_3 12.88; CaO 8.36; MgO 4.31; R_2O 4.16; TiO_2 1.21.

Basalt mineral composition includes plagioclases, which are anortite-based ($CaAl_2Si_2O_8$) and albite-based ($NaAlSi_3O_8$) solid solutions, pyroxene which is diopside-based ($CaMgSi_2O_6$) solid solution, and magnetite (Fe_3O_4). Basalt glasses were synthesized based on compositions basalt – modifier. The following materials were introduced as modifying materials: disthene-sillimanite concentrate (disthene), alumina, colemanite and boric acid.

The content of oxides in compositions varies within the following limits, wt.%: SiO_2 47.33–52.90; Al_2O_3 15.08–21.24; Fe_2O_3 11.43–13.09; CaO 8.0–10.63; MgO 3.95–4.31; R_2O 3.67–4.16.

The melting of basalts and basalt-based compositions was performed the traditional way at the maximum temperature of 1500±10 °C in a gas furnace. The temperature rise in the furnace was carried out at a rate of 250 °C/h, gaseous atmosphere is oxidative; air excess factor is 1.08–1.13.

In order to identify the peculiarities of the process of melting basalt-modifier raw material compositions positional heat treatment was performed in gas furnace at 1250 and 1350 °C. The product of heat treatment of basalt at a temperature of 1250°C is a vitrified mass containing crystalline inclusions ranging in size from 10 to 300 microns. The introduction of alumina and disthene into the composition causes an increase in the volume fraction of the crystalline phase. According to X-ray diffraction measurements using diffractometer D8 Advance with CuKα radiation source, the crystalline phase is represented by relic plagioclase (labradorite). The increased crystallization ability of the glass associated with high content of iron oxides, leads to release of magnetite Fe_3O_4. Introduction of boron-containing components into the composition causes the melt to occur at lower temperatures. B_2O_3 significantly reduces the viscosity and the surface tension of the melt, which accelerates the process of dissolution of the crystals of the mineral part of basalt.

The products of heat treatment at temperature of 1350°C are a glassy material containing gaseous inclusions. Homogeneous samples of basalt glasses were obtained at 1500 °C.

Basalt glasses crystallizability has been evaluated by means of a complex method based on