STRUCTURE AND PROPERTIES OF CASTABLE BADDELEYITE–CORUNDUM REFRACTORIES WITH 40-42% ZrO₂

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The basic operational properties of castable baddeleyite–corundum refractories with a 40-42% concentration of ZrO₂ manufactured in our country and abroad were compared. Their structural features and behavior in the region of contact with a sheet glass melt were determined. Recommendations were given for increasing the operational stability of domestic refractories.

Refractory materials containing 40-42% ZrO₂ (Zircosite Y, ER 1711, and Bakor-41) and used in the most critical lining elements of glass-melting furnaces were investigated in the present study.

Samples from the dense regions of industrial blocks were selected for the analysis. With respect to external appearance, the material in the samples was very dense, the samples of Zircosite Y and ER 1711 refractory were visually characterized by the lowest porosity, and Bakor-41 had slightly higher porosity. The color of the samples was: Zircosite Y: light, almost white; ER 1711 refractory: light yellow; Bakor-41: light grey.

A detailed description of the methods of investigation and processing of the experimental data obtained was reported previously.* The results of the studies of the physical properties, chemical composition, melting temperature of the glass phase, and corrosion resistance of the materials, as well as the tendency of the refractories toward liberation of gaseous inclusions into the glass melt are reported in Table 1. The phase composition of ER 1711 refractory, Zircosite Y, and Bakor-41 corresponds to the usual composition for this series.

ER 1711 refractory stands out because of its structural properties: crystals of combined penetration of corundum and baddeleyite predominate over the other phases (Fig. 1a). The amount of phenocrysts of baddeleyite in the corundum matrix is very insignificant.

The concentration of baddeleyite in crystals of combined penetration, especially in the peripheral parts, is low in Zircosite Y. A eutectic mixture of Al₂O₃ and ZrO₂ frequently forms dense intergrowths with free corundum crystals (Fig. 1b).

An elongated shape of the crystals of combined penetration with the layers of the glass phase between them is characteristic of Bakor-41 (Fig. 1c).

The free baddeleyite in this group of materials is distinguished by important morphological variety. In the sample of ER 1711, it is primarily represented by chain-like aggregates. Individual grains uniformly distributed in the structure are primarily characteristic of Zircosite Y. Both aggregates and separate crystalline individuals of baddeleyite are observed in Bakor-41.

Free corundum is present in ER 1711 in the form of small isometric grains. In addition to individual grains, corundum forms dense intergrowths with the Al₂O₃–ZrO₂ eutectic in Zircosite Y. Larger, well delimited, elongated skeleton crystals containing inclusions of the glass phase are characteristic of Bakor-41.

The glass phase in the refractories fills small spaces between the basic crystalline phases, although sections of the structure are observed in which the amount of glass phase is significantly higher than average. A heterogeneous structure due

to the presence of second (later) generation ZrO₂ and corundum microlites was revealed in studying the glass phase in Zircosite Y and ER 1711 with high magnification of the optical microscope. Although these are predominantly very thin skeleton crystals of corundum and embryonic crystallization of ZrO₂ in ER 1711, the later-generation crystals in Zircosite Y are well formed and their volume fraction in individual sections attains 15–20%. The presence of microlites in the glass phase of ER 1711 refractory and Zircosite Y allows predicting its refractoriness and sufficient stability in the contact zone with the glass melt.

No late-generation corundum and baddeleyite were found in the glass phase of Bakor-41 with the resolution of the microscope.

The x-ray phase analysis showed the presence of tetragonal zirconium dioxide as impurity phase in all samples, and the amount did not exceed 1-3 wt. %.

The basic structural differences in ER 1711 refractory, Zircosite Y, and Bakor-41 are thus manifested by the character of crystallization of baddeleyite and the presence of crystalline inclusions in the glass phase. These characteristics will probably also determine the mechanism of corrosion and in the final analysis, the stability of the materials in the glass melt.

The petrographic study of the reaction of the refractory materials with the glass melt was conducted on polished sections covering sections of the "neck" of the samples formed during the experiment on the surface of the melt.

ER 1711, Zircosite Y, and Bakor-41 react with the glass melt according to the scheme typical of baddeleyite—corundum refractories with formation of zonality due to the subsequent dissolution of crystalline phases, an increase in the amount of glass phase, and an increase in the porosity.

We will discuss the structure of the contact zone of refractories directly bordering the melt in more detail. Total dissolution of corundum is a common characteristic — both of independent individuals and of corundum substance from crystals of combined penetration. Baddeleyite is encountered in the glass phase in the form of relatively large, round grains with slight