FUNCTIONAL BORATE GLASS-CERAMICS DOPED WITH CR3+ IONS: SYNTHESIS AND CHARACTERIZATIONS*

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Glass-ceramics (GCs) is perspective candidate for functional applications due to the better technological capabilities of transparent GCs compared to single crystals or transparent glasses. The main benefits of such materials are wider possible ranges of operating temperatures, concentrations of dopants, and the possibility of combined use of various transition metal ions (TM); flexibility of varying technological regimes; the best elastic-plastic properties and efficiency of the technology. In the structure of the GC with a certain phase composition, a higher uniformity of the distribution of the activator is provided, the best characteristics of the conversion of UV radiation into visible and IR radiation are achieved [1-4].

Nowadays there is a lack information about systematic comprehensive study of the relationship between the kinetics of crystallization and sintering of oxide matrices of borate composition on the properties of the activation additives, including spectral-kinetic ones. There are unresolved issues also related to the possibility of obtaining and controlling the luminescence characteristics of optical glass-ceramics, such as quantum yield, emission spectrum, and kinetic attenuation parameters of luminescence. These characteristics depend on many factors: methods and modes of synthesis, features of the microstructure of glass ceramics; type, number and distribution of defects (luminescence centers) and dopants.

This work shows the results of the synthesis and study of structural and optical properties of alkali alumina-borate glass-ceramics doped with chromium ions, which possesses high quantum efficiency.

Alkali-alumina-borate GCs doped with Cr^{3+} ions were successfully synthesized by the melt quenching technique. $LiAl_7B_4O_{17}:Cr^{3+}$ nanocrystals were formed in the glass host during the subsequent one- and two-stage isothermal treatments above the crystallization temperature of the nanophase. There are structural, microscopic and optical-luminescent properties of prepared glass-ceramics were characterized.

The differential scanning calorimetry studies exhibited glass transition temperatures to be 411–422 °C and glass crystallization temperatures to locate in the 600–650 °C range. After two-stage heat treatment of glass samples at temperatures 450 °C and 600 °C the chromium-doped borate glass-ceramics was obtained. The two bands of the glass absorption spectra shifted towards small wavelength region after the heat treatment with changing the glass color. The XRD studies revealed the $LiAl_7B_4O_{17}$ nanocrystals nucleation with the mean size of 20–23 nm. The glass-ceramics emission spectra possessed three intense bands in the 685–715 nm spectral region indicating high symmetrical environment around the chromium ions under electron irradiation. The maximum value of the quantum yield corresponding to a chromium concentration of 0.05 wt.% was 30% under excitation of a wavelength of 532.8 nm. The issues of radiation-induced process of prepared borate glass-ceramics are discussed in detail.

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