LUMINESCENT GLASSES CO-DOPED BY IONS OF TRANSITION AND RARE EARTH METALS

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Nowadays there has arose the interest in manufacturing of luminescence material and devices, which should function reliably during operations and keep the optical features and optical quality. Obtaining luminescent materials in the form of single crystals has a number of disadvantages: the high cost of obtaining single crystals of sufficient optical quality and the difficulty of their subsequent mechanical processing, as well as limitations – anisotropy, which makes it impossible to obtain some materials in the form of large single crystals. In contrast to single crystals, luminescent glasses can be obtained in a wide range of compositions, which in their turn can correspond to stoichiometric crystalline compounds by their composition. The main advantages of glasses in comparison with transparent ceramics and single crystals include environmental compatibility, low cost of production, mechanical and chemical resistance, relative easiness of large volumes sample acquisition, as well as processing of final products. Typical pairs of activator ions for which luminescence is intensively studied and promising application offers have been developed are cerium – europium; cerium – terbium; cerium – manganese; cerium – samarium etc. pairs. Silicate glasses are widely usable materials properties of which are easily manageable by tuning the composition of glass matrices and co-doping with metal oxides, semiconductor and metal nanoparticles. Transition and rare earth elements introduced into silicate glass can be in the form of ions and chromophoric centers with different composition or they can form small clusters of atoms and nanocrystalline phases (oxides, chalcogenides (provided chalcogens are introduced), and others). The present work is devoted to the synthesis and investigation of the properties of silicate glasses when the additions are in the form of combinations of transition and rare earth metals ions in a wide range of molar ratios in order to determine the states of these elements in the glasses and to clarify the nature of luminescence properties are formed. The glasses under study were fabricated based on barium-alumina-silicate glass matrix and co-doped by transition and rare earth metals ions. $BaCO_3$, $ScCO_3$, CeO_2, LnO_2, MnO_2, BaF_2, AlF_3, EuF_3 and SiO_2 were used as starting materials. All reactants were analytical grade. The glasses were synthesized by using traditional melt-quenching technique. All component were mixed in required ratios and homogenized by milling in mortar. Glasses were melted in corundum crucibles for 1 h at 1500 °C in gas furnace with CO-rich atmosphere. The molten glass was casted on steel surface, and the obtained samples were annealed at 600 °C for 5 h in air for reducing the stresses before mechanical processing. Transparent and homogeneous glasses were cut and polished to obtain plates of 2 mm thickness. This gave uniformly glasses, whose physical-technical properties (density is 3105– 4027 kg/m^3; refractive index is 1.621–1.629; thermal expansion coefficient is (81.2–99.5)$\cdot 10^{-7}$ K^{-1}) correspond to the glasses used in optoelectronic manufacturing.

The optical light transmission was measured on an MS 122 spectrophotometer in the wavelength range 330–1100 nm and the photoluminescence spectra were measured on a Fluoromax fluorimeter. The influence of pairs of activator ions at their different concentrations on the spectral-luminescent properties of glasses has been established. The presence of luminescence in the blue part of the spectrum with a combination of cerium and manganese ions and red luminescence in the presence of europium /samarium ions in the glass when excited by UV light should be noted. Knowledge on valent and structure state of transition and rare earth metals ions was extended.

The optimal ratio of the transition and rare earth metals oxides was determined for the glasses with specified luminescence features and physico-technical properties. The research was supported by the BRFFR–RFBR M grant № T21PM-156.