Scintillation property of BaO-Y_2O_3-B_2O_3, BaO-Y_2O_3-SiO_2, and BaO-Y_2O_3-P_2O_5 glasses

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Introduction: A scintillator is a type of phosphor that converts the energy of absorbed ionizing radiation into a large number of low-energy photons. Scintillators have been widely used in security screening, medical imaging, radiation dosimetry, and high-energy and nuclear physics [1, 2]. The scintillation process generally consists of three steps. First, ionizing radiation generates charge carriers in the scintillator, the number of which depends on the band gap of the material. Second, these carriers are transported through the conduction band to luminescence centers. Finally, the material emits light as a result of carrier recombination at these centers. Because the emission intensity is proportional to the absorbed energy of ionizing radiation, scintillators can be used for radiation detection. Most scintillators are based on inorganic materials, including glasses, ceramics, and single crystals. Among them, oxide glasses are typically composed of relatively light elements such as B_2O_3, P_2O_5, and SiO_2 [1]. Therefore, in this study, we compare the scintillation properties of Ce-doped borate, phosphate, and silicate glasses.

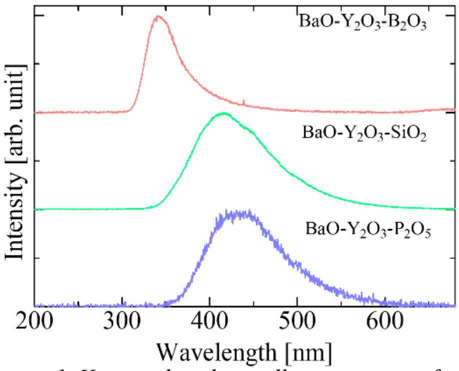

Figure 1. X-ray induced scintillation spectra of BaO-Y_2O_3-B_2O_3, BaO-Y_2O_3-SiO_2, and BaO-Y_2O_3-P_2O_5 glasses

Materials and Methods: The glass samples were prepared using the melt-quenching technique. $BaCO_3$ (4N), Y_2O_3 (4N), B_2O_3 (4N), SiO_2 (4N), $NH_4H_2PO_4$ (4N), and CeO_2 (4N) were used as starting materials. For the BaO-Y_2O_3-B_2O_3 and BaO-Y_2O_3-P_2O_5 glass compositions, the mixtures were transferred to alumina crucibles and melted at 1200 °C for 1 h in air. The molten glass was then rapidly poured onto a stainless-steel plate preheated to 300 °C and pressed to form flat specimens. For the BaO-Y_2O_3-SiO_2 composition, the mixed raw powders were shaped into rods using a hydrostatic press, followed by sintering at 1200 °C for 8 h to obtain ceramic rods. These rods were subsequently melted using an optical floating-zone (FZ) furnace. The FZ furnace was equipped with four Xe lamps, and the focused light was used to melt the ceramic rods under ambient atmosphere. The molten portion was then quenched by dropping it into an alumina crucible filled with room-temperature water.

Results and Discussion: Fig. 1 shows X-ray induced scintillation spectra of all glass samples. The BaO-Y_2O_3-B_2O_3 glass exhibited an emission band peaking at 340 nm, which is attributed to 5d-4f transitions of Ce^{3+} ions [3]. The BaO-Y_2O_3-P_2O_5 and BaO-Y_2O_3-SiO_2 glasses exhibited an emission band peaking at around 420 nm, which is attributed to 5d-4f transitions of Ce^{3+} ions [4].

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