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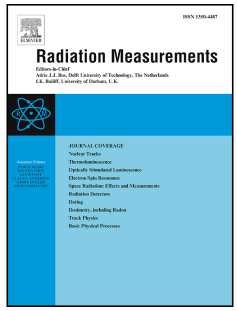

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Emission properties of cerium-doped barium borate glasses for scintillator applications

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H I G H L I G H T S

- We prepared Ce-doped $BaO-B_2O_3$ glasses by the melt-quenching method.
- Photoluminescence and X-ray-induced luminescence of the glasses were investigated.
- The optimal concentration of Ce was 0.l mol% in all emission property measurements.

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Photoluminescence (PL) and X-ray-induced luminescence properties of Ce^{3+}-doped barium borate glasses with different cerium concentrations (from 0 to 1.0 mol%) were investigated. Emission intensities in PL and storage luminescence and quantum yields showed the maximum values at 0.1 mol% concentration of Ce. In contrast, the emission intensity in X-ray-induced scintillation increased, although an inflection point of the intensity growth curve was observed at 0.1 mol%. It was therefore confirmed that a Ce concentration of 0.1 mol% is the most preferable for better PL, scintillation, and storage luminescence properties.

1. Introduction

Radiation detectors, scintillators and dosimeters, have been widely used for many years. Scintillators are devices that promptly convert radiation into visible light and can detect (1) γ-rays and X-rays and (2) neutrons. The former allows to detect heavy atoms, while the latter allows to detect lithium or boron atom. Dosimeters are devices that emit light by stimulation after absorbing radiation energy. Individual exposure dosimeter and imaging plate are the main applications of dosimeters. From the industrial viewpoint, a large-scale production of solid-state matter possessing high sensitivity is required to decrease the fabrication cost. Glass is one of the most promising materials because of its low production costs and relatively good formability (Liu et al., 2016).

Ce^{3+} center is one of the most promising emission centers for the application of radiation detectors because of its following characteristic features (Bei et al., 2007; Murata et al., 2005). (1) Emission intensity due to allowed transition (5d → 4f transition) is strong. (2) Decay time is very short, i.e., 20–50 ns; therefore, its emission intensity per unit time becomes stronger. (3) Because 5d orbitals are strongly affected by the surrounding environment of Ce^{3+}, it can be considered that the emission properties of the Ce^{3+} center reflect the local structure of Ce^{3+}. A controlled redox reaction of Ce^{3+} to Ce^{4+} in oxide glass is the most important reaction in oxide glass systems (Dar et al., 1998; Murata et al., 2005; Smythe et al., 2013). It is known that the ratio of Ce^{3+} to Ce^{4+} depends on several factors such as the composition of the glass, the melting atmosphere, and

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