Accepted Manuscript

Optical and luminescence characteristics of Eu3+-doped B2O3:SiO2:Y2O3:CaO glasses for visible red laser and scintillation material applications

Pabitra Aryal, C.R. Kesavulu, H.J. Kim, S.W. Lee, Sang Jun Kang, J. Kaewkhao, N. Chanthima, B. Damdee

PII: S1002-0721(17)30139-4

DOI: 10.1016/j.jre.2017.09.017

Reference: JRE 94

To appear in: *Journal of Rare Earths*

Received Date: 17 July 2017

Revised Date: 21 September 2017

Accepted Date: 22 September 2017

Please cite this article as: Aryal P, Kesavulu CR, Kim HJ, Lee SW, Kang SJ, Kaewkhao J, Chanthima N, Damdee B, Optical and luminescence characteristics of Eu3+-doped B2O3:SiO2:Y2O3:CaO glasses for visible red laser and scintillation material applications, *Journal of Rare Earths* (2018), doi: 10.1016/j.jre.2017.09.017.

Optical and luminescence characteristics of Eu^{3+}-doped B_2O_3:SiO_2:Y_2O_3:CaO glasses for visible red laser and scintillation material applications

PabitraAryal[a], C.R. Kesavulu[a], H. J. Kim[a,*], S.W. Lee[a], Sang Jun Kang[b], J. Kaewkhao[c,d], N. Chanthima[c,d], B. Damdee[c,d]

[a]Department of Physics, Kyungpook National University, Daegu 41566, Korea

[b]College of Liberal Arts, Semyung University, Jechon 27136, Korea
[c]Center of Excellence in Glass Technology and Materials Science (CEGM), Nakhon Pathom Rajabhat University, Nakhon Pathom 73000, Thailand
[d]Physics Program, Faculty of Science and Technology, Nakhon Pathom Rajabhat University, Nakhon Pathom 73000, Thailand.

Abstract: Europium (Eu^{3+}) doped glasses of chemical compositions (55-x)B_2O_3:10SiO_2:25Y_2O_3:10CaO:xEu_2O_3, where x denotes mol% and ranges $0 \leq x \leq 2.5$, were synthesized by adopting conventional melt quenching technique. Physical properties like density, molar volume, polaron radius, inter-ionic distance and field strength of the glass samples were investigated to assess the impact of Eu_2O_3. Optical and luminescence properties of the glasses were characterized with optical absorption, photoluminescence, X-ray induced emission spectra, temperature dependence emission spectra and decay times. Judd-Ofelt (JO) intensity parameters (Ω_λ) of the glasses were evaluated based on the absorption spectrum of 0.5 mol%. JO parameters, calculated from absorption spectra with thermal corrections on oscillator strength, were used to evaluate radiative properties like radiative transition probability (A_R), branching ratio (β_R), stimulated cross section emission (σ) and radiative lifetime (τ_R) for $^5D_0 \rightarrow {}^7F_J$ (J = 0,1,2,3 and 4) transitions. The decay rate of $^5D_0$ fluorescent level for all the glass samples was single exponential. Lifetimes of the $^5D_0$ level were decreased with increasing concentrations from 0.05 mol% to 2.5 mol% of Eu^{3+}ions which might be due to energy transfer through cross-relaxation in the glasses. The chromaticity coordinates (x, y) were similar for all BSYCaEu glasses and were located at the red region of CIE 1931 color chromaticity diagram. Hence, these results confirm that the Eu^{3+}doped BSYCaEu glasses could be useful for visible red lasers and glass scintillation applications.

Keywords: BSYCaEu glasses; Judd-Ofelt intensity parameters; luminescence properties; CIE color co-ordinates; glass scintillation; rare earths

---

Foundation item: Project supported by the Ministry of Science and Technology (MEST), Korea (2015R1A2A1A13001843) and Kyungpook National University Research Fund, 2016.
***Corresponding author: E-mail:** hongjoo@knu.ac.kr (H. J. Kim); **Tel:** +82-53-950-5323.

1. Introduction

Glasses, an important class of materials having multiple uses, consist of three main components: glass formers, glass modifiers and intermediates. The proportion of these three components accounts for specific characteristic of a particular glass. High chemical and thermal stability, low cation size and high field strength [1, 2] are some of the specific characteristics of SiO_2 and B_2O_3 glass formers. Thus, the combinations of silicate and borate which give a novel host of silicoborate glasses are extensively used for different purposes such as manufacturing chemical resistant laboratory wares, heat resistant cooking wares and liquid crystal display (LCD); sealing glasses, optical fibers, light emitting devices and immobilizing nuclear wastes [3-