SYNTHESIS AND PHOTOLUMINESCENCE OF $LiBaBO_3: RE^{3+}$ (RE = Sm & Dy) PHOSPHOR

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ABSTRACT

A series of Sm and Dy doped $LiBaBO_3$ phosphors were synthesized by solid state reaction method and their photo luminescence (PL) properties were systematically investigated. The synthesized materials were characterized using powder x-ray diffraction pattern (XRD) for confirmation. The microstructures of the phosphors were studied by scanning electron microscope (SEM). The PL emission spectra of Sm^{3+} doped $LiBaBO_3$ were observed at 565 nm and 601 nm in yellow and orange region for 401 nm excitation near UV range. Emission at 565 nm and 601nm are assigned to $^4G_{5/2} \rightarrow {}^6H_{5/2}$ and $^4G_{5/2} \rightarrow {}^6H_{7/2}$ transition of Sm^{3+} ions, respectively. Moreover, PL emission spectra of Dy^{3+} doped $LiBaBO_3$ were observed at 577 and 483 nm in yellow and blue region, respectively on the excitation of 349 nm wavelength. The emission band at 483 nm (blue) corresponds to $^4F_{9/2} \rightarrow {}^6H_{15/2}$ magnetic dipole transition and at 577nm (yellow) corresponding to $^4F_{9/2} \rightarrow {}^6H_{13/2}$ electric dipole transition. The entire characteristics indicate that Dy doped $LiBaBO_3$ phosphors are good candidate for solid state lighting device applications.

Keywords: $LiBaBO_3$,XRD, SEM, Photoluminescence, Solid state reaction

1. Introduction

In the past a few decades, rare earth borates have attracted considerable attention due to their practical applications as nonlinear optical (NLO), laser host, and luminescent materials. For example, $YAl_3(BO_3)_4$, $RECa_4O(BO_3)_3$ (RE= Y or Gd) [1], $La_2CaB_{10}O_{19}$ [2], and $Na_3La_9O_3(BO_3)_8$ [3] can be used as NLO crystals, $Yb:YAl_3(BO_3)_4$ and $Nd:GdCa_4O(BO_3)_3$ [4] are potential self frequency doubling laser crystals, and (Y, Gd) $BO_3: Eu^{3+}$ serves as a good phosphor for plasma display panels (PDPs). In order to search for new functional materials, considerable research should be carried out in the ternary systems like Li_2O-BaO-B_2O_3. The 4f–4f electronic transitions of rare earth ions play an important role in the application such as optical fiber amplifiers, solid-state lasers, planar waveguides and compact microchip lasers [5–7]. In the visible region, the Dy^{3+} ion emits intense yellow (570–600 nm) and blue (470–500 nm) luminescence corresponding to the $^4F_{9/2} \rightarrow {}^6H_{13/2}$ and $^4F_{9/2} \rightarrow {}^6H_{15/2}$ transitions, respectively. Thus, the several Dy^{3+} doped phosphors have been studied to obtain two primary color luminescent materials as well as white-light-emitting material [8, 9].

A suitable red-emitting phosphor for near-UV phosphor converted LEDs should have many potential applications, due to their excellent color rendering index, high color tolerance and high conversion efficiency into visible light [10]. Therefore, it is urgent to find new red phosphors that can be excited by NUV-LED chips for the fabrication of white LEDs. The f-f transition absorption and emission of the crystalline host activated by rare earths ions are of great importance due to their applications as luminescent optical materials emitting in the visible and near IR regions [11–13]. The selection of the rare earth ion as an activator is a key factor for the preparation of luminescence materials. Among the different rare earth ions, the Sm^{3+} ion as an activator is regarded as one of the most popular and efficient doping ions, which can produces intense orange light in the visible wavelength range. Sm^{3+} ions in various hosts show bright emission in orange or red regions because of the transitions from the excited state $^4G_{5/2}$ to the ground state $^6H_{7/2}$ and also to the higher levels ^6H_J (j=7/2, 9/2, and