EUROPIUM AND DYSPROSIUM IONS CO-DOPED WHITE LIGHT LUMINESCENCE MAGNESIUM SULFOBORATE GLASSES FOR WHITE LEDS

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ABSTRACT

To develop a new luminescence property of europium and dysprosium ions co-doped Magnesium sulfoborate glasses, and to apply it for white LEDs. Europium and dysprosium co-doped Magnesium sulfoborate glasses are prepared by conventional melt quench technique and their excitation and luminescence characteristic were studied. The samples were characterized using X-Ray Diffraction (XRD) and emission spectra by exciting the glass at 350 nm. XRD confirms the amorphous nature of the prepared samples. A combination of blue, green, yellow and red emission bands was shown for these glasses, and white light emission could be observed under UV light excitation. These results indicate that Europium and dysprosium co-doped magnesium sulfoborate glasses could be a potential candidate for white LEDs with excitation of a ~360 nm near UV LED chip.

Keywords: Luminescence, Glasses, Dysprosium, White light

INTRODUCTION

Presently, white light emitting diodes (white LEDs) get lots of attention in solid state lighting area, due to their advantages such as more efficient, less energy consumption, and also longer lifetime when compared with conventional lighting techniques, such as. Incandescent lamp and fluorescent lamp. Therefore, it appears that white LEDs show high potential for change of conventional lighting sources. At recently, commercial white LED is realized by using two or three kinds of phosphors or a kind of full color phosphor excited by the blue [1].

[2] suggested that Dy^{3+} doped borate glasses are the candidate materials for yellow lighting applications in the visible range by studying optical properties. [3] demonstrated that Eu^{3+} doped alkaline earth borate glasses are well suited materials for developing fluorescence display, new color light source and cathode ray tube applications. [4] showed that the high content of Eu^{3+} has led to the disappearance of broad band glass emission at the near Ultra Violet range. But to the best of our knowledge there is no report detailed on the europium and dysprosium ions co-doped white light luminescence Magnesium sulfoborate glasses for white LEDs.

MATERIALS AND METHODS

The nominal general composition of the glass samples was (in mol%): $0.5Eu_2O_3$-99.5 MSB and x($0.5Eu_2O_3$-$0.5Dy_2O_3$)-(100-x)MSB. Here x = 1.0, 0.5, 0.3 and 0.1 mol%. The glass samples were prepared from raw material of boric acid, H_3BO_3 (99.9%), magnesium oxide, MgO (99.9%),

sulfuric acid, H_2SO_4 (99.9%), dysprosium oxide, Dy_2O_3 (99.9%) and Europium oxide, Eu_2O_3 (99.9%). The batches were then mixed thoroughly in an alumina crucible. The mixed batch materials were then place in an electric furnace which is pre–heated to 400 ^oC for 30 minutes. The batches were then melted in an electric furnace at 1200 ^oC for 1hour. Then, the molten poured onto a stainless-steel plate at 400 ^oC and annealed for three hours before left to cool to normal room temperature, a transparent glass was obtained. The excitation and emission spectra were measured at room temperature using fluorescence spectrophotometer under excitation of Xe lamp.

RESULTS AND DISCUSSION

The excitation of europium and dysprosium ions co-doped Magnesium sulfoborate glasses are presented in Figure 1. The excitation spectra are monitoring at emission wavelength of 572 nm. A total of five excitation spectrum were observed from ground state of $^6H_{15/2}$ to the excited state $^6L_{19/2}$ (325 nm), $^6P_{7/2}$ (350 nm), $^6P_{5/2}$ (365 nm), $^4I_{13/2}$ (387 nm) and $^4G_{11/2}$ (414 nm) of Eu^{3+}/Dy^{3+} ions respectively. The band position and shape of the spectra do not change significantly as the Dy^{3+} ions co-doped [5]. Among the transition, the intense excitation wavelength located at 350 nm ($^6H_{15/2}\rightarrow{}^6P_{7/2}$) was chosen to measure the emission spectrum of dysprosium ions co-doped Magnesium sulfoborate glasses.

Fig. 2 exhibits the emission spectra of Eu_2O_3 and Dy_2O_3 co-doped Magnesium sulfoborate glasses under 350 nm excitation. The six major emission bands are attributed to the transitions $^4F_{9/2}\rightarrow{}^6H_{15/2}$ for Dy^{3+} at 482 nm (blue), $^4F_{9/2}\rightarrow{}^6H_{13/2}$ for Dy^{3+} at 573 nm (yellow), $^5D_0\rightarrow{}^7F_1$ for Eu^{3+} at 590 nm (greenish yellow), $^5D_0\rightarrow{}^7F_2$ for Eu^{3+} at 612 nm (yellowish red), $^5D_0\rightarrow{}^7F_3$ for Eu^{3+} at 652 nm (red) and $^5D_0\rightarrow{}^7F_4$ for Eu^{3+} at 697 nm (red). Besides these, a small emission band at 590 nm disappears in the samples of x = 1.0, 0.5, 0.3 and 0.1. This peak is probably due to part transparency of 350 nm excitation light in the emission spectra measurements using 350 nm UV cut filter. These blue, green, yellow and red transitions can be excited by UV light simultaneously in the Eu_2O_3 and Dy_2O_3 co-doped case. The intensity of these emission bands varies with variation of the proportions of europium and dysprosium. Thus, the white light emission can be achieved with appropriate combination of Eu_2O_3 and Dy_2O_3. The luminescence colors of these $0.5Eu_2O_3$ and (0.5Eu/Dy)-1.0Eu/Dy MSB samples.

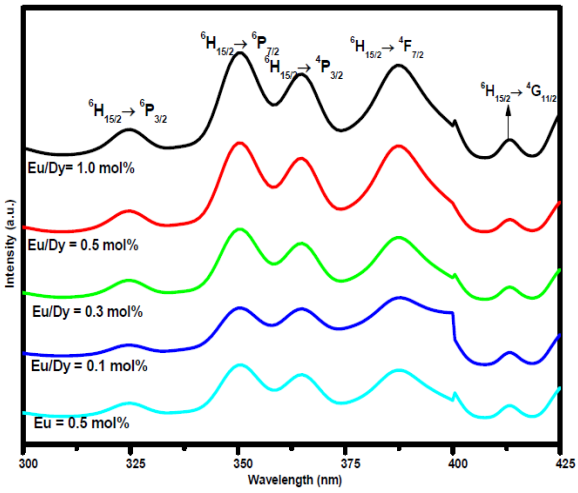

Figure 1: Excitation spectra of $0.5Eu_2O_3$ and $x(0.5Eu_2O_3\text{-}0.5Dy_2O_3)\text{-}(100\text{-}x)$MSB. x = 1.0, 0.5, 0.3 and 0.1 mol%

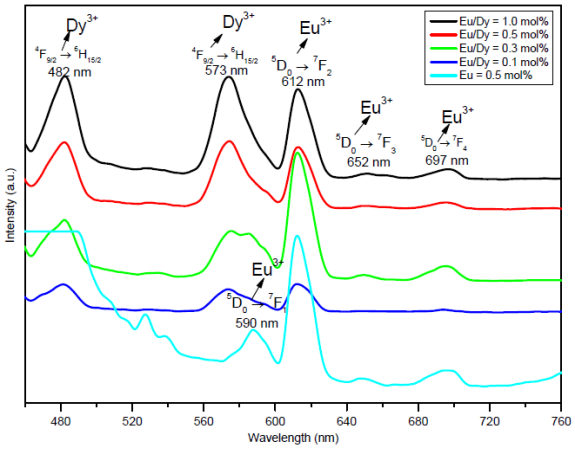

Figure 2: Emission spectra of $0.5Eu_2O_3$ and $x(0.5Eu_2O_3\text{-}0.5Dy_2O_3)\text{-}(100\text{-}x)MSB$. x = 1.0, 0.5, 0.3 and 0.1 mol%

CONCLUSIONS

The photoluminescent intensity of as-prepared magnesium sulfoborate: Eu/Dy samples was enhanced remarkably after co-doped process, suggesting glass compositions excited at 350 nm may be useful in white light emitting devices because there is a simultaneous emission of blue, blue, green and red colours.

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