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Luminescence Behavior of Dy^{3+} Ions in Calcium Sulfo Borophosphate Glass for White Leds

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Abstract

Objectives: To Determine the optical properties of glass by means of ultraviolet, visible and luminescence spectroscopy. **Methods/Analysis**: Different concentrations of dysprosiumdopedcalcium sulfoborophosphate (CSBP) glasses were produced by the melt quenching method and characterized through absorption, excitation and luminescence spectroscopy and its glassy form was ascertain by XRD. **Findings**: The emission spectrum of calcium sulfo borophosphate doped Dy^{3+} glasses displays bands at 482 nm (blue) and 572 nm (yellow) underneath excitation 350 nm, which agree to the transitions of $^4F_{9/2}\rightarrow{}^6H_{15/2}$ and $^4F_{9/2}\rightarrow{}^6H_{13/2}$ of Dy^{3+} respectively. The spectrum of the excitation for 572 nm emission takes numerous bands at 321 nm, 347 nm, 386 nm, 422 nm, 449 nm and 470 nm, which is in correspondence with the ultraviolet light emitting diode (320–410 nm) and blue light emitting (450–470 nm). **Application**: The findings show that calcium sulfo borophosphate doped with Dy^{3+} glasses could be certainly used as white LEDs.

Keywords: Borophosphate Glass, Dy^{3+} Ion, Luminescence, White LEDs

1. Introduction

Previously, dysprosium ions doped phosphates glass has been widely examined due to their vital in commercial and technological applications. The luminescence spectrum of dysprosium doped glasses have two powerful bands, equivalent to the blue at 484 nm ($^4F_{9/2}\rightarrow{}^6H_{15/2}$; blue) and 575 nm ($^4F_{9/2}\rightarrow{}^6H_{13/2}$; yellow)[1–3]. Commonly, three major techniques are used to study white light emission. These are primary tricolor phosphor, Ultraviolet –Light emitting diode, and blue light emitting diode combined with yellow emitting phosphor[4,5]. White light emitting diodes have certain tremendous advantages such as high illumination, minimal energy consumption, durability, dependability first-rate low temperature indicators; dysprosium ions can produce white light in a glassy material by changing the excitation wavelengths and composition of the glass. In[6], limited research has been conducted as regards to calcium sulfo borophosphate doped Dy^{3+} ion glasses for white LEDs application. In the present paper calcium sulfo borophosphate doped dysprosium ions-glasses was analyzed using melt quenching method. The excitation and emission photoluminescence properties were examined.

2. Materials and Methods

Calcium Sulfo borophosphate doped Dy^{3+} ion glasses were formed through melt quenching method with the Following chemical composition: $30CaO+10SO_4+20B_2O_3+(40\text{-}X)P_2O_5$(x = 0.1, 0.3, 0.5, 0.7 and 1.0 mol%). The samples were carefully combined in an agate mortar to ensure uniformity. The Combinations is placed in alumina crucible and were heated in electric furnace at 300 °C for 30 minutes, later the temperature was increased to 1300 °C for 60 minutes. The mixture was

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transferred onto a preheated brass plate and annealed at 400 ºC for about 3hrs to removed thermal strain. Good transparent white glasses were formed. All samples were allowable to cool to room temperature and then refined for optical assessments. The X-ray Diffraction (XRD) outlines were examined by INEL C120 diffractometer employing Co Kα radiation. The absorption spectra were verified at room temperature in the wavelength 300-1800 nm and optical investigation was carried out using UV Vis NIRspectrophotometer the photoluminescence studieswere determined by Perkin Elmer LS55 Luminescence Spectrophotometre. The samples had been excited with a xenon discharge lamp (200 < λ < 900 nm). Based on the emission and excitation method, the luminescence signal was examined using a Monk Gilliesonmonochromator, photodiode detector at precise excitation wavelength.

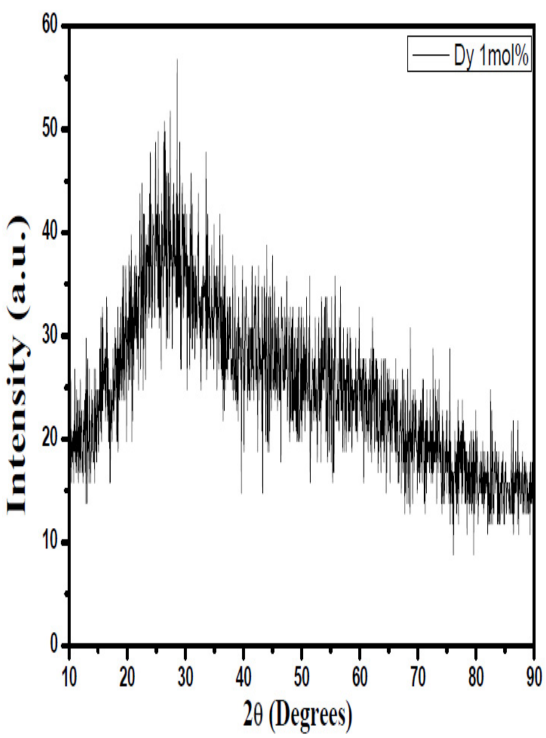

Figure 1. XRD spectrum for 1.0 mol% of Dy^{3+} ion doped calcium sulfo borophosphate glasses.

3. Results and Discussion

3.1 XRD Spectral Analysis

Non-crystalline form of the Calcium sulfo borophosphate doped Dy^{3+} ion glasses, XRD measurements were taken for 1.0 mol% of Dy^{3+} doped Calcium sulfo borophosphate glass as shown in Figure 1. The XRD spectrum of the prepared Calcium sulfo borophosphate doped 1.0 mol% of Dy^{3+} ion glass confirms the amorphous nature.

3.2 Absorption Spectral Analysis

Figure 2 shows the absorption spectrum of various concentrations of dysprosium ions doped Calcium sulfo borophosphate glasses transcribed at room temperature in the wavelength range 300–1800 nm. The spectra absorption for the glasses is having similar strength. Each spectrum consists often absorption bands equivalent to the transitions $^6H_{15/2} \rightarrow {}^4F_{7/2}$, $^6H_{15/2} \rightarrow {}^4I_{15/2}$, $^6H_{15/2} \rightarrow {}^4F_{9/2}$, $^6H_{15/2} \rightarrow {}^6F_{1/2}$, $^6H_{15/2} \rightarrow {}^6F_{3/2}$, $^6H_{15/2} \rightarrow {}^6F_{5/2}$, $^6H_{15/2} \rightarrow {}^6F_{7/2}$, $^6H_{15/2} \rightarrow {}^6F_{9/2}$, $^6H_{15/2} \rightarrow {}^6F_{11/2}$, $^6H_{15/2} \rightarrow {}^6H_{11/2}$ and the determination of bands were shown in Figure 2. The bands determined at 382 nm ($^6H_{15/2} \rightarrow {}^4F_{7/2}$) and 449 nm ($^6H_{15/2} \rightarrow {}^4I_{15/2}$) are very weak because of the powerful absorption of the network glass in ultraviolet region.

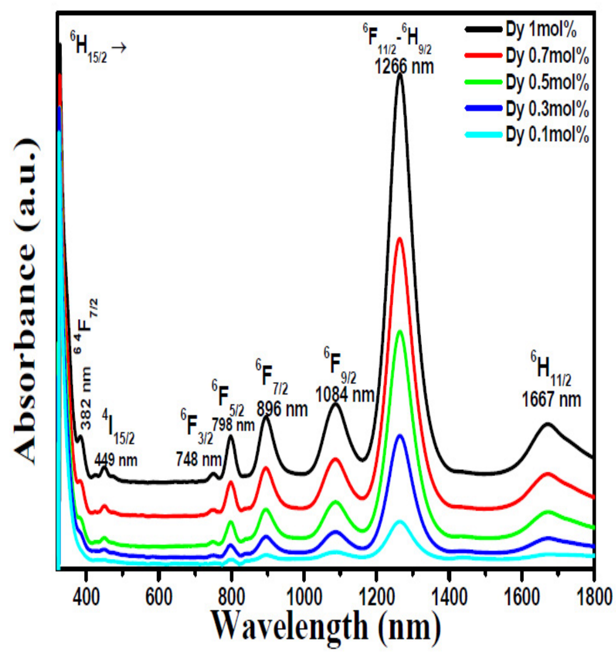

Figure 2. Absorption spectrum of calcium sulfo borophosphate doped Dy^{3+} glasses.

3.3 Excitation and Emission Spectral Analysis

In Figure 3 shows the excitation spectra of calcium sulfo borophosphate doped Dy^{3+} glasses. The spectrum of excitation for 572 nm emission displaced six bands at 321 nm, 347 nm, 386 nm, 422 nm, 449 nm and 470 nm. It was observed that the calcium sulfo borophosphate doped Dy^{3+} glassesmay be excited by UV radiation. Upon all the excitation bands, the band at 347 nm possessed the highest intensity. Therefore, the emission spectra were observed at 350 nm in order to enhance Dy^{3+} concentration.Figure 4 shows the emission spectra of calcium sulfo borophosphate doped Dy^{3+} glasses, which exhibit two intense peaks at 572 nm (yellow) and 482 nm (blue) underneath excitation 350 nm equivalent to the transitions of $^4F_{9/2} \rightarrow {}^6H_{15/2}$ and $^4F_{9/2} \rightarrow {}^6H_{13/2}$ of Dy^{3+} respectively. In[7] the emission intensities are increases with various increasing dysprosium ions concentration. The excitation and emission peaks indicated that the white LED can be a good source for ultraviolet chip with calcium sulfo borophosphate doped Dy^{3+} glasses.

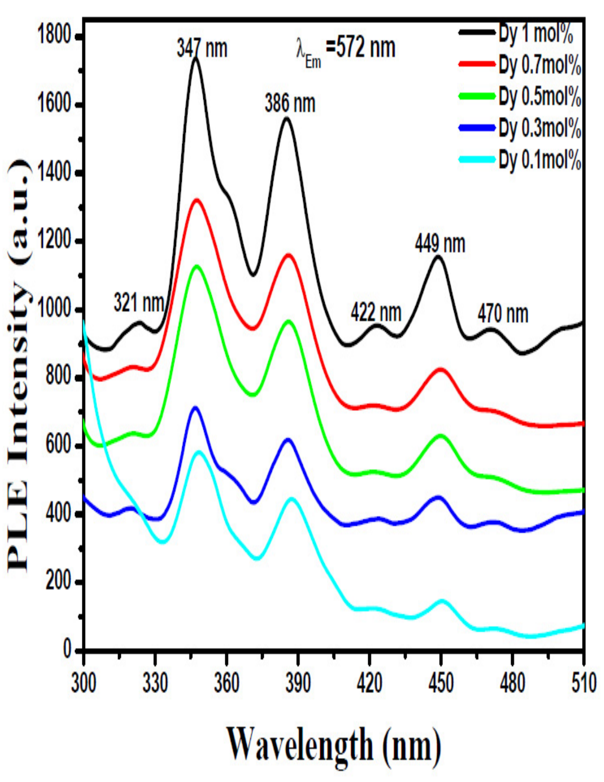

Figure 3. The excitation of calcium sulfo borophosphate doped Dy^{3+} glasses.

4. Conclusion

Calcium sulfo borophosphate doped with various concentration of Dy^{3+} glasses by melt quenching method have been prepared. The emission spectrum of calcium sulfo borophosphate doped Dy^{3+} glasses shows two bands at 482 nm and 572 nm underneath excitation 350 nm, which equivalent to the transitions of $^4F_{9/2} \rightarrow {}^6H_{15/2}$ and $^4F_{9/2} \rightarrow {}^6H_{13/2}$ of Dy^{3+}, respectively. The spectrum of excitation for 572 nm emission display several bands positioned at 321 nm, 347 nm, 386 nm, 422 nm,449 nm and 470 nm.The results are in good correspondence with the ultraviolet light emitting diode (320-410nm) and blue (450-470nm).The results obtained indicated that Calcium sulfo borophosphate doped Dy^{3+} glasses could be hypothetically used for white LEDs application.

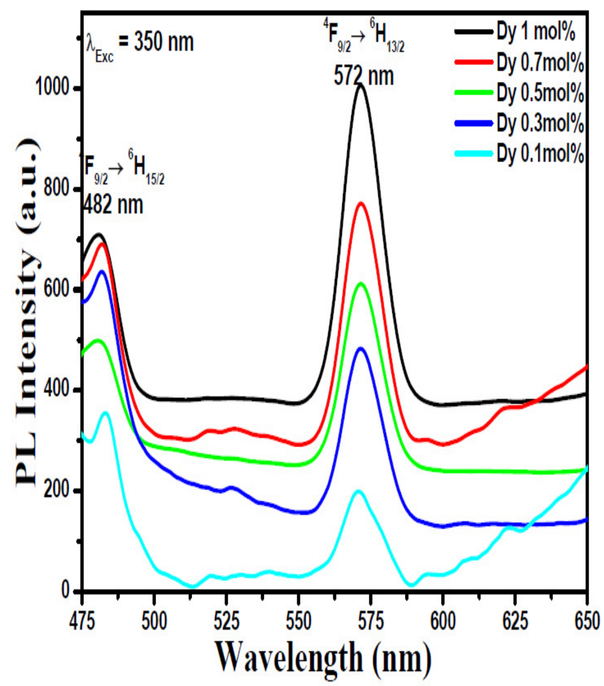

Figure 4. The emission of calcium sulfo borophosphate doped Dy^{3+} glasses.

5. Acknowledgments

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