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Luminescence study of $SrAl_2B_2O_7$: Tb^{3+} Phosphor for white LED

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Abstract
By using nitrates as starting materials, SrAl2B2O7:Tb3+ powder phosphors were prepared by combustion synthesis method. X-ray diffraction (XRD),photoluminescence excitation and emission, as well chromaticity coordinates were employed to characterize the resulting samples. The results show that under 380nm excitation spectra of prepared phosphor showing emission at 546 nm (green) due to 5D4-7F5 transitions. The chromaticity coordinates is found to be (Cx =0.269, Cy =0.717).This kind of materials plays a relevant role in the applications as a green emitting phosphor for solid-state lighting.
Keywords:- Photoluminescence, phosphor, XRD,CIE

Introduction

The photoluminescence at the blue–green visible region of trivalent RE-doped alkaline earth aluminates phosphor has widely been studied because they have good luminescent properties, which have been of considerable interest for possible applications in light-emitting devices and full color displays.[1] Aluminate phosphors have extensively been investigated because of their high chemical stability and bright emission characteristics in the visible region [2-3]. Among those, magnesium aluminate phosphors doped with rare-earth metal ions have emerged as materials with great potential. Trivalent terbium ions (Tb^{3+}) have widely been used to obtain green-color-emitting phosphors [4-5]. Terbium ions can be widely used as luminescent centers for a lot of phosphors which exhibit characteristic green emission of $^5D_4$-$^7F_5$ transition [6-7]. These phosphors doped with Tb^{3+} ions belong to the main green emissive components for trichromatic fluorescence materials [8]. Considerable efforts are underway to develop new phosphors as well as to improve the performance of the existing phosphors. Trivalent terbium ions are expected to provide optical materials for blue and green color emissions in various compounds[9-10]. Results of the X-ray diffraction (XRD), photoluminescence spectra, of Tb^{3+} $SrAl_2B_2O_7$ phosphors have been explained.

Experimental

Phosphors in the formula of $SrAl_2B_2O_7$:Tb^{3+} were prepared by the combustion synthesis method. The raw materials, $Sr(NO_3)_2$ (99.99%), $Al(NO_3)_3{\cdot}9H_2O$ (99.99), H_3BO_3 and Tb_4O_7(99.99%), were mixed thoroughly in an agate mortar. The mixtures were kept in a vertical furnace for a very short time duration preheated to 500^{0}C, within minutes the combustion takes place. The phase of the synthesized powder was identified by XRD of the film samples, and was examined on a powder X-ray diffractometer. The excitation and emission spectra were obtained on a RF 5301 spectrophotometer; all the measurements were performed at room temperature

Result and Discussions

XRD

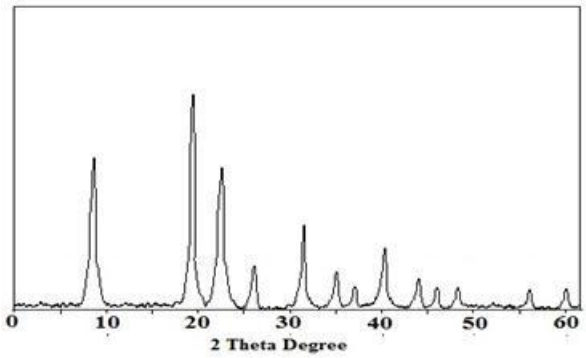

Fig 1:XRD of $SrAl_2B_2O_7$phosphor

To study the crystalline nature of the phosphor products, XRD measurements were carried out at room temperature. The XRD pattern of the powder was recorded on an X-ray diffractometer using CuKα radiation (1.54060 nm) and at a scanning scan step time of 10.3377 s. The scan type was continuous. The XRD-pattern of the as prepared phosphor powder shows good agreement with standard JCPDS File no.47-0182

Luminescence Properties

Alkaline earth borate is an important luminescent material because of its excellent chemistry and thermal stabilization, facile synthesis and cheap raw material , so it has been

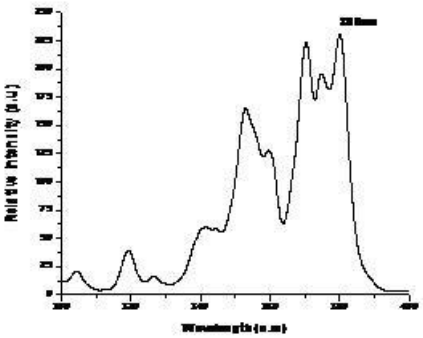

Fig2: Excitation spectra of $SrAl_2B_2O_7:Tb^{3+}$ phosphor (λ_{em}=546 nm)

The series of all the emission peaks mentioned above correspond to the typical 4f-4f intra-configuration forbid transitions of Tb^{3+} ion [14].

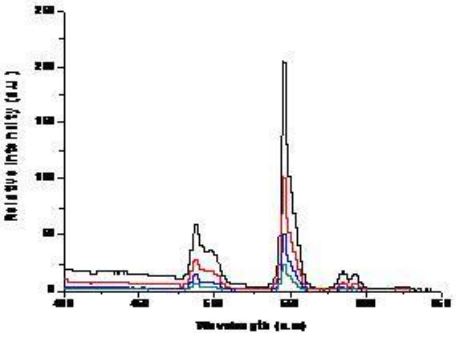

Fig3: Emission spectra of $SrAl_2B_2O_7:Tb^{3+}$ phosphor (λ_{ex}=380 nm)

extensively applied in phosphor for lamps [11-12]. Fig. 2 and 3 shows the excitation and emission spectra of $SrAl_2B_2O_7:Tb^{3+}$ phosphor prepared by using combustion synthesis method. $SrAl_2B_2O_7:Tb^{3+}$ phosphor is excited with 380nm wavelength and shows green light luminescence with a peak wavelength of 546 nm. Moreover, six peaks around in the range of 400 to 650 nm are also observed, including the blue emissions below 450 nm produced from $^5D_3$-^7F_J transitions of Tb^{3+} ion (J = 5 and 4, respectively) and the yellowish green and red emissions above 450 nm produced from $^5D_4$-^7F_J transitions (J = 6, 5, 4 and 3, respectively) [13].

Chromaticity coordinates

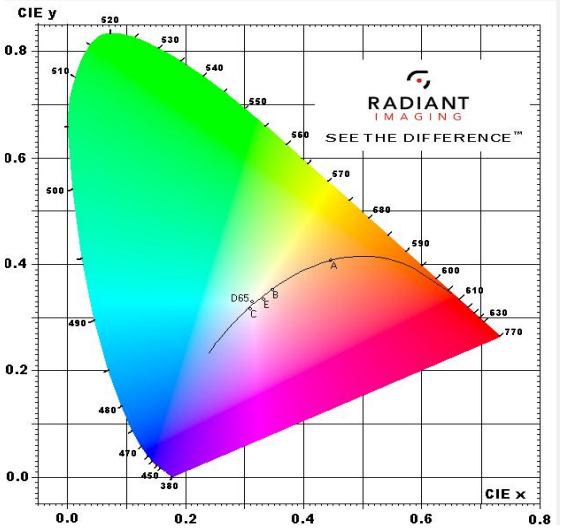

Fig 4 Chromaticity coordinates of $SrAl_2B_2O_7:Tb^{3+}$ phosphor

In general, color is expressed by means of color coordinates and the Commission International de l'Eclairage (CIE) 1931 is a two dimensional graphical representation of any color perceptible by the human eye on an x-y plot. The result indicates an excellent stability of the $SrAl_2B_2O_7:Tb^{3+}$ (C_x = 0.277, C_y=0.713)

phosphor prepared using the combustion synthesis method.

Conclusion

In this work we developed Tb^{3+}doped $SrAl_2B_2O_7$ green-emitting phosphor synthesized and its luminescence properties have been investigated. Photoluminescence and XRD characterization with CIE done. The PL spectra show a strong emission at 546 nm ($^5D_4$-$^7F_5$) of Tb^{3+} with a chromaticity coordinates are Cx=0.277 and Cy=0.713 This phosphor presents a bright green emission, which can be used as a promising phosphor for green luminescent solid state lighting applications.

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