



Persistence luminescence study on Eu^{2+} doped SrAl_2O_4 Phosphor

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Abstract: -The present paper reports the synthesis, Photoluminescence (PL) studies of Eu^{2+} doped SrAl_2O_4 phosphor using inorganic materials like Strontium Carbonate (SrCO_3), Aluminium Oxide (Al_2O_3), Boric Acid (H_3BO_3) and Europium Oxide (Eu_2O_3). The sample was prepared by the modified solid state reaction method, which is the most suitable for large-scale production. The prepared phosphor sample was characterized using X-Ray Diffraction (XRD) and Photoluminescence (PL). The PL emission was observed in the range 400-600nm range for the SrAl_2O_4 phosphor doped with Eu^{2+} . Broad peaks found around 554nm with high intensity. From the XRD data, using the Scherer's formula the crystallite size of Eu^{3+} doped SrAl_2O_4 phosphor is around 85nm. The present phosphor shows persistence luminescence behavior and afterglow showed in necked eyes.

Keywords: Photoluminescence (PL), persistence luminescence.

I. INTRODUCTION:

The luminescence associated with Eu^{2+} contained in different host lattices has found applications related to its red light emission which is important in the fields of displays, sensors, lasers and LEDs. The past few decades have seen a lot of work reported on the use of divalent/trivalent europium as a dopant in phosphors, as they have very good optical properties in the blue to red regions which make them part of many display devices.

Among all the rare-earth ions, Eu^{2+} is the most extensively studied owing to the simplicity of its spectra and also its use in commercial green phosphors. The luminescence spectrum of Eu^{2+} reveals spectroscopic transitions from the visible to the near-infrared region.

$\text{SrAl}_2\text{O}_4:\text{Eu}^{2+}$ phosphor samples were prepared by the solid state reaction. Phase identification of all the samples were carried out by X-ray powder diffraction. In this work, fine particles of the green phosphor $\text{SrAl}_2\text{O}_4:\text{Eu}^{2+}$ in fixed concentrations of Eu^{2+} is prepared via solid state method and a spectroscopic study is reported [1-10].

II. EXPERIMENTAL:

The solid state reaction method is the oldest and still the most commonly used method of preparing multicomponent solid materials by direct reaction of solid components at high temperatures. Since solids do not react with each other at room temperature – even if thermodynamics favours product formation-high temperatures are necessary to achieve appreciable reaction rates. The advantage of solid state reaction method is the availability of precursors in abundance and the low cost for powder production on the industrial scale [9].

To prepare SrAl_2O_4 with fixed concentrations of europium, consists of heating stoichiometric amounts of reactant mixture is taken in alumina crucible and is fired in air at 1000°C for 2 hour in a muffle furnace. The Eu^{2+} activated SrAl_2O_4 phosphor was prepared via high temperature modified solid state diffusion. The starting materials were as follows: SrCO_3 , Al_2O_3 , Eu_2O_3 and H_3BO_3 (as a flux) in molar ratio were used to prepare the phosphor. Powder was transferred to alumina crucible, and then heated in a muffle furnace at 1250 °C for 3hr in reducing atmosphere using charcoal [10]. The phosphor materials were cooled to room temperature naturally.

The photoluminescence (PL) emission and excitation spectra were recorded at room temperature by use of a Shimadzu RF-5301 PC spectrofluorophotometer. The XRD pattern used for structural analysis of the prepared sample and recorded by Pan analytical equipment, the crystallite size were determined by Scherer's formula.

III. RESULTS AND DISCUSSIONS:

In order to determine the crystal structure, phase purity, chemical nature and homogeneity of the SrAl_2O_4 phosphor, X-ray diffraction analysis was carried out. Figure-1 shows the XRD pattern of SrAl_2O_4 host. The

XRD pattern of $\text{SrAl}_2\text{O}_4:\text{Eu}^{2+}$ (1%) shows the same pattern with less intensity. From the XRD pattern analysis it was found that there is a prominent phase of

SrAl_2O_4 and well matched with the JCPDS card No 050-0115. This reveals that the structure of SrAl_2O_4 is monoclinic. The crystallite size was determined using the Scherer's equation $D = k\lambda / \beta \cos \theta$, where k the constant (0.94), λ the wavelength of the X-ray (0.154 nm or 1.54 Å), β the full-width at half maxima (FWHM) and θ the Bragg angle of the XRD peak (1,1,1). From XRD data by using the Scherer's formula the calculated mean crystallite size of SrAl_2O_4 and Eu (1%) doped SrAl_2O_4 is 88, 91nm respectively.

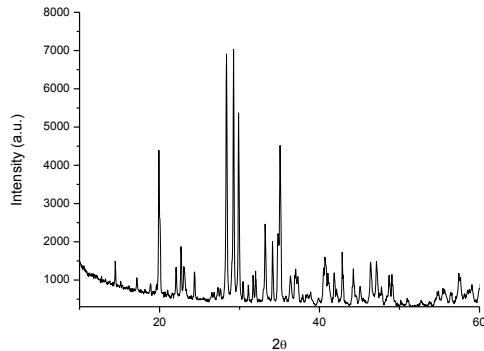


Figure 1 XRD pattern of $\text{SrAl}_2\text{O}_4:\text{Eu}^{2+}$ (1%) phosphor

IV. PHOTOLUMINESCENCE STUDY:

From the PL excitation spectra of prepared phosphor shows broad excitation peak centered at 265nm (figure 2) and PL emission spectra shows at 554nm (figure 3). Broadband emission spectra centered at 554 nm (Green region) observed under the ultraviolet excitation of 265 nm correspond to the Eu^{2+} emission arising due to transitions from sublevels of $4f^65d^1$ configuration to $^8S_{7/2}$ level of the $4f^7$ configuration but with Eu^{2+} occupying different lattice sites. Since the crystal field can greatly affect the $4f^65d^1$ electron states of Eu^{2+} , it suggests that the crystal field is not changed much with the compositional variation [12-13]. Eu^{2+} ion is expected to replace Sr^{2+} site in the tetragonal SrAl_2O_4 structure. Since the ionic radii of the eight fold coordinated species are almost same, Sr^{2+} : 0.126 and Eu^{2+} : 0.125 nm [3].

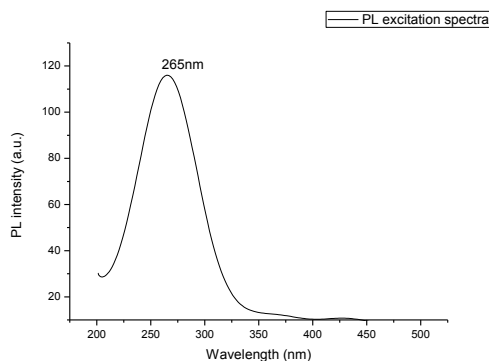


Figure 2 PL excitation spectra of prepared phosphor

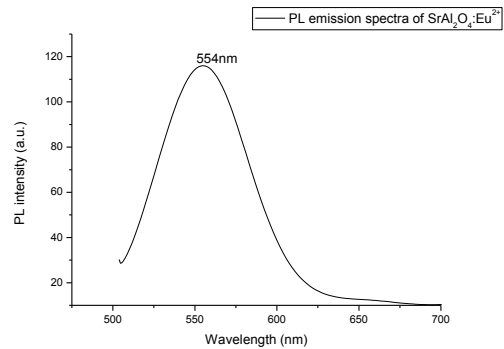


Figure 3 PL emission spectra of prepared phosphor

V. CONCLUSION:

1. The phosphor prepared by solid state reaction method in reducing atmosphere.
2. The prepared phosphor shows monoclinic structure.
3. The crystallite size found at 81-99nm ranges.
4. The PL excitation spectra shows broad excitation peak centered at 265nm.
5. The PL emission spectrum shows broad emission at 554nm.
6. Phosphor shows persistence luminescence behavior.

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