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Photoluminescence Properties of Trivalent Erbium Doped With Sr_2CeO_4 Blue Nano Phosphor

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ABSTRACT

The present paper reports a blue emitting Sr_2CeO_4 phosphor doped with Erbium with different concentration (.1, 1.5, 2.0 %) synthesized by solid state reaction method. The powders were fired at 1200^0 C for four hour. The X-Ray diffraction pattern reveals the grain size of particles. The materials were conforming from EDAX. PL. emission of pure Sr_2CeO_4 phosphor was observed at 470nm and the effect of different concentration of Erbium doped with Sr2CeO4 also has been discussed.

Keywords: Photoluminescence, solid state reaction method, XRD, Phosphor.

INTRODUCTION

The research for oxide-based phosphors has been increasing due to their applications in many field, such as cathode ray tubes (CRTs), light-emitting diodes (LEDs) and field emission displays (FEDs). Oxide-based phosphors attract researcher's attention due to the advantages of their good stability upon excitation by electron beam. For FEDs application, red and green phosphors have been commercially used. However, comparable blue emitting phosphors are still few [1-10]. It is important to develop phosphors with high quantum efficiency, controlled morphology, and small particle sizes. Rare earth applications in the field of display devices is still a hot topic much of the research around the globe is to improve the phosphor efficiency and to enhance the luminescence properties of the phosphor with discovery of blue light emitting Sr_2CeO_4 by combinatorial chemistry method in 1998 by Danielson [3]. Sr_2CeO_4 consist of infinite edge-shearing CeO_6 octahedra chains separated by Sr atoms [2]. The luminescence originates from a ligand-to metal Ce^{4+} charge transfer [1]. The broad emission band is suitable for the doping of rare earth ions in pursuing new luminescent materials. The blue phosphors are very few and if a suitable blue phosphor is found then it can be added to the well studied red and green combination for white light emission from the phosphor. If blue phosphor Sr_2CeO_4 doped with trivalent rare earths europium and samarium emit in the red region of the visible spectra [5].The rare earth materials exhibit excellent sharp- emission luminescence properties with suitable sensitization and effectively used in designing of white light emitting materials.

MATERIALS AND METHODS

The samples prepared in the present work were designed to have an overall composition of Sr_2CeO_4: Er synthesized by standard solid state reaction technique. The main starting materials for the Sr_2CeO_4: Er phosphors were Strontium Carbonate $SrCO_3$ and Cerium Oxide CeO_2, supplied by National Chemicals, Baroda, (Gujarat State). Every starting material was of greater than 98% purity. These materials were taken in Stoichometric proportions of Sr: Ce as 2:1. $SrCO_3$ and CeO_2 with rare earth Er_2O_3 are weighed in molecular stoichiometry. These all materials were ground in an agate mortar and pestle, grinded thoroughly to get fine powder. This powder was taken in alumina crucible. After closing the cover the crucible was loaded in furnace and heated to the temperature 1200^0 C. The samples was kept at the set temperature for four hours then cooled down naturally. All samples were prepared with the same synthesis technique.

The excitation and emission spectra were recorded at room temperature using (SHIMADZU, make Spectroflurophotometer RF – 5301 PC) using Xenon lamp as excitation source. The emission and excitation slit were kept at 1.5 nm. At Display research Lab. Department of Applied Physics, M. S. U. Baroda. EDX and The XRD patterns were obtained using Rigaku, Minislex model at NCL Pune.

RESULT AND DISCUSSION

X- ray diffraction (XRD)

The structure and phase purity of the Sr_2CeO_4 phosphor were investigated by XRD. Results are shown in Fig. 1 and 2 for the pure Sr_2CeO_4 and for Sr_2CeO_4: Er (1.0%). All diffraction patterns were obtained using CuKα radiation (λ = 1.54051 A°), at 30 kV and 15 mA. Measurements were made from 2θ = 10° to 80° with steps of 0.02°.

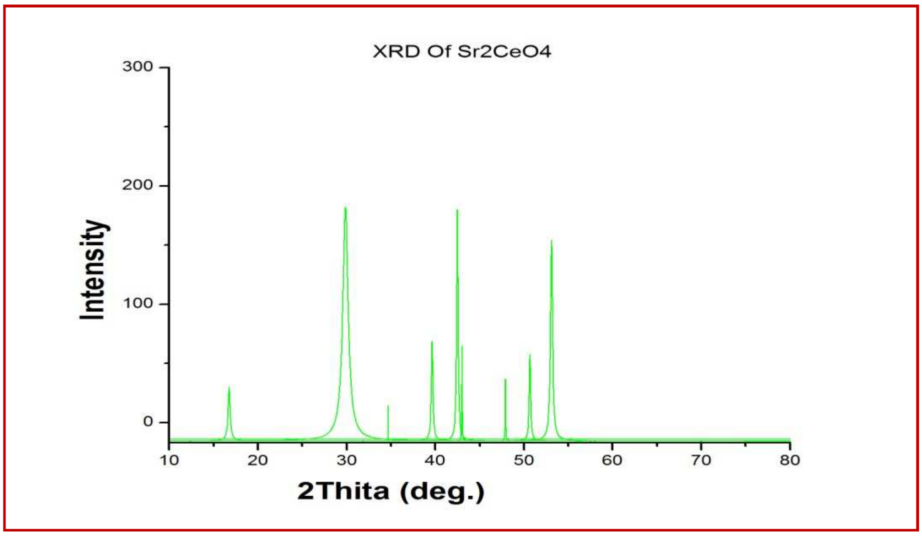

Figure 1 XRD Pattern of Sr_2CeO_4

The crystal The XRD patterns of the powders revealed that the structure of Sr_2CeO_4 is Orthorhombic, which is match with JCPDS data card No. 50-0115. When crystallites are less than approximately 100nm in size appreciable broadening in the X-ray diffraction lines occurs [8]. The grain size of the particles of powder samples were calculated using Scherrer equation

$$d = 0.9\lambda / \beta\cos\theta,$$

where β represents the full width at half maximum (FWHM) of XRD lines. The average grain size of the Sr_2CeO_4 phosphor is 22 nm. And when Er doped with Sr_2CeO_4 the grain size is 35 nm.

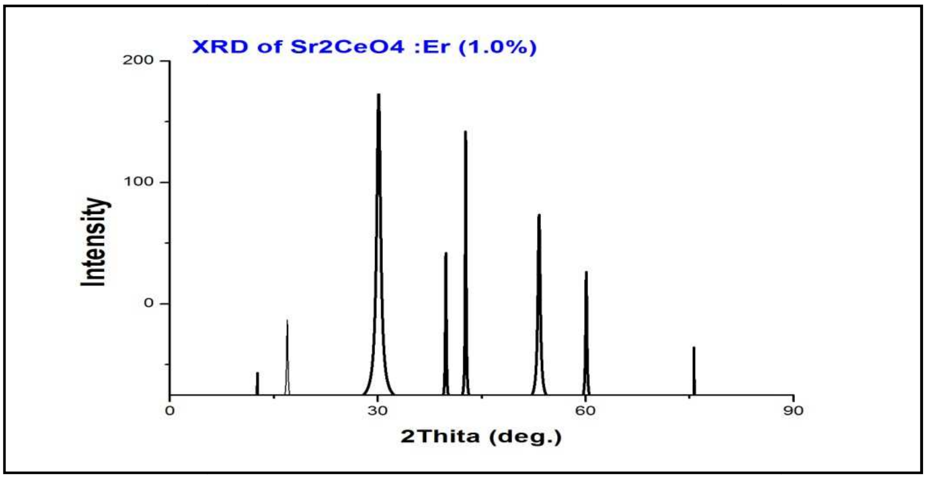

Figure 2 XRD Pattern of Sr_2CeO_4: Er (1.0%)

Energy dispersive X-ray analysis (EDAX)
An elemental analysis was carried out for Strontium Cerate (Sr_2CeO_4) doped Erbium (Er) by employing the energy dispersive X-ray analysis technique which provides local information of the concentrations of different elements in phosphor. Fig- 3 shows the EDX spectra of Sr_2CeO_4: Er in which the presence of Sr, Ce and O are clearly identified

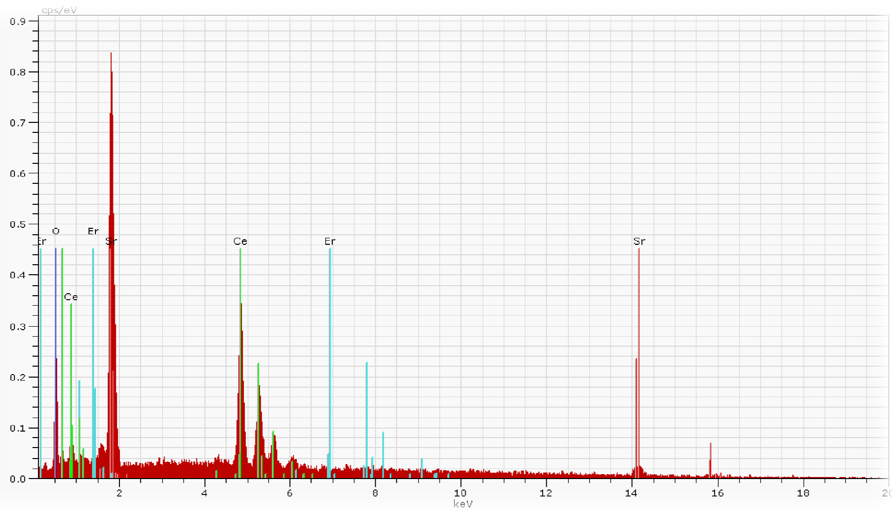

Figure 3 EDAX of Sr_2CeO_4: Er

Photoluminescence properties (PL)

The excitation spectrum of Sr_2CeO_4 sample shows broad spectra as shown in figure 5. When Sr_2CeO_4 material excited with 360 nm the emission peak is at 470nm in a perfect blue region with very good intensity as shown in figure 6.

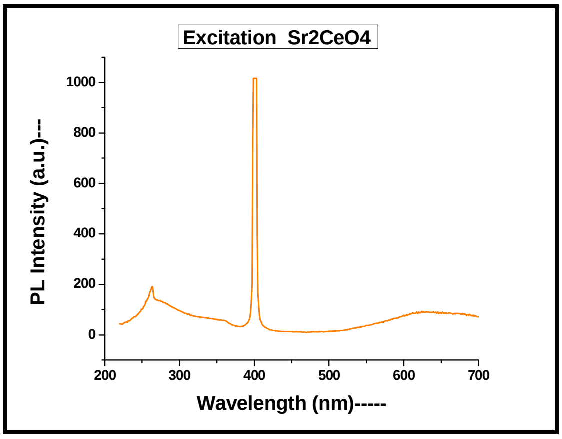

Figure 5 Excitation Spectra of Sr_2CeO_4

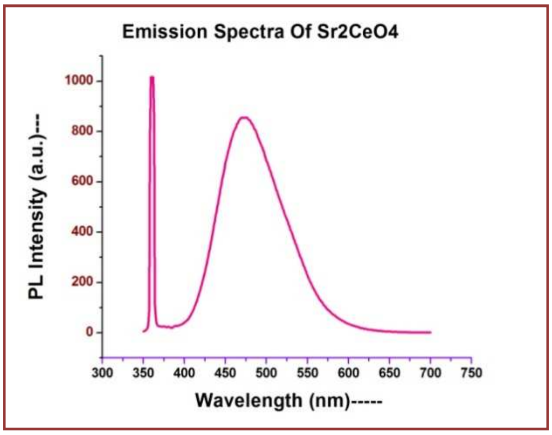

Figure 6 PL. Emission Spectra of Sr_2CeO_4

However the effect of Er dopent effectively modified the emission wavelength of pure phosphor but the intensity was slightly decreased and the intensity of green color increases as the concentration of Erbium increases. The excitation and emission spectra of all the samples doped with Erbium as shown in figure 4 and figure 5 respectively. When the excitation of Sr_2CeO_4: Er was kept at 262nm, the emission peaks at 527, 536, 554 and 559nm as shown in figure 6. All samples emitted the same wavelength at all excitation with the slight variation in the intensities. As the doping concentration increases green emission also increases.

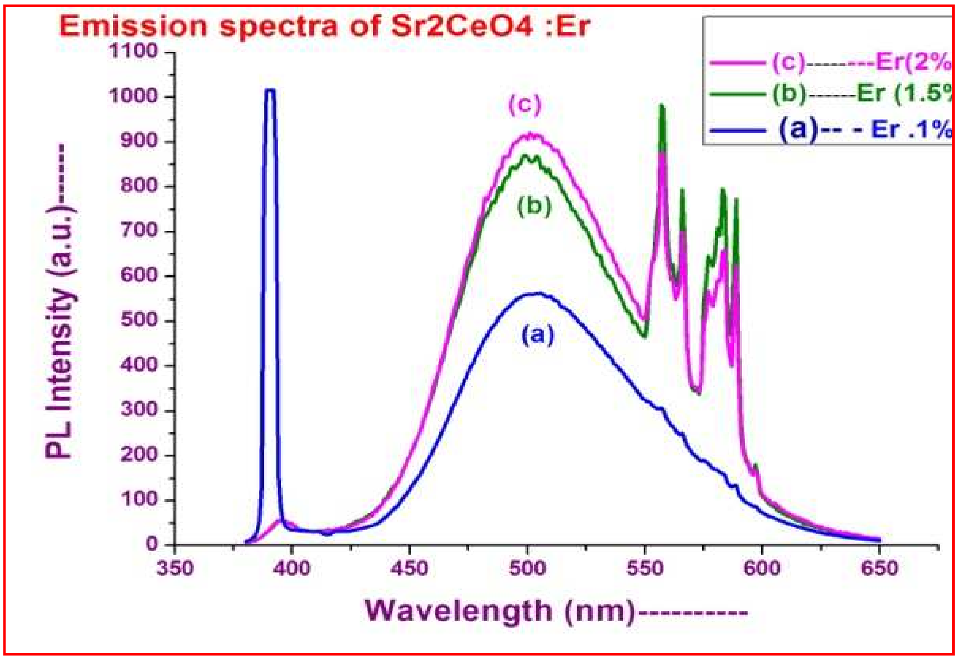

Figure 6 Emission spectra for Sr_2CeO_4 : Er(At Excitation 262 nm)

CONCLUSION

The XRD pattern confirms the formation of majority of Sr_2CeO_4 compound in single phase. The average grain size of the Sr_2CeO_4 phosphor is 22 nm. And when Er doped with Sr_2CeO_4 the grain size is 35 nm. EDX spectra of Sr_2CeO_4: Er in which the presence of Sr, Ce and O are clearly identified. PL emission of Sr_2CeO_4 phosphor was observed at 470 nm and Sr_2CeO_4: Er was observed emission in bluish green region. The phosphor Sr2CeO4 doped with Er shows good Photoluminescence Properties. This property may be useful in various source lighting applications.

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