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Abstract – *A blue emission powder phosphor , Sr_2CeO_4 was prepared using solid-state reaction technique. The powder fired at 1100^0C for 3 hours gave good luminescence yield. The emission peak of this phosphor is at 470 nm. To use this phosphor in a tricolor lamp effectively, studies have been carried out to see the effect of rare earth dopants on the luminescence spectra of this phosphor. The effect of the dopants on phosphor efficiency has been evaluated and the effect of using these dopants and material characterization of these phosphors using optical and structural techniques are discussed in this paper.*

Keywords: *solid state reaction , emission.*

I. Introduction

In recent years the Plasma Display Panels (PDP) are replacing the conventional color televisions. In phosphor area today top priority is to replace the high performance expensive rare earth activated phosphors with cheaper equivalent materials. This essentially means replacing the rare earth ions with transition metal ions or post transition ions[1]. The advances in the optical spectroscopy of solids, especially those of transition metal ions help to evolve research on phosphor and solid-state luminescence. In 1960s, efficient rare earth activated phosphors were developed for use in color televisions(Tb^{3+}-green, Eu^{3+}-red and Dy^{3+}-yellow) and in 1970 tricolor lamp was introduced. Blue emission from Eu^{2+}, red emission from Eu^{3+} and green emission from Ce^{3+}- Tb^{3+} pair was used in tricolor lamps. At present a combination of halo phosphate and tri-band phosphor blend is commonly used in many lamps as a compromise between performance, phosphor cost and the lamp making cost[2,3].However to improve the performance of the already existing low cost phosphors require better materials. One such material being strontium cerate, phosphors based on this material were synthesized and characterized using photoluminescence. XRD and Scanning Electron Microscope(SEM) techniques.

II. Experimental

Pure rare earth doped Sr_2CeO_4 phosphor samples were prepared by the conventional solid state reaction method[4]. Strontium carbonate $SrCO_3$ and Cerium oxide CeO_2 (high purity chemicals) were used as stating materials for preparation of blue phosphor Sr_2CeO_4 and added them as a stoichiometric proportions of Sr : Ce as 2:1.

compound obtained was grinded into a fine powder and fired at 1100^0C for 3 hours in a muffle furnace. The photoluminescence spectra were recorded at room temperature using Spectrofluorophotometer (SHIMADZU, RF-5301 PC). XRD (Rigaku-D/max 2500 make with Cu Kα radiation) and SEM (XL30 CP Philips) [5] studies are done on the prepared samples for the microstructure evaluation.

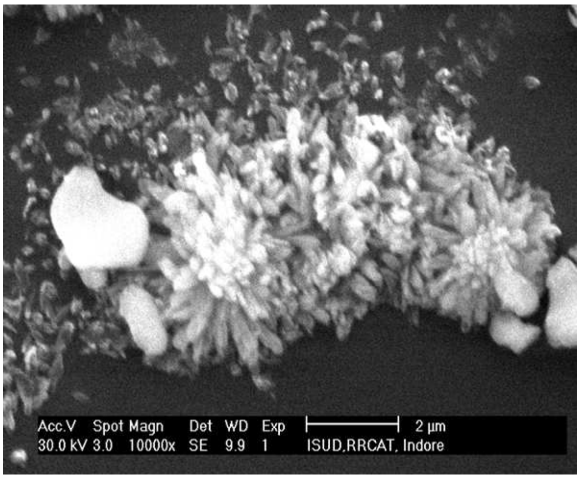


Figure 1. SEM of pure Sr_2CeO_4 phosphor

III. Results and discussion

Tables Figure.1 shows the SEM micrograph of the pure phosphor. The microstructure appears to consist of ellipsoidal flakes type particulates having an average basal diameter of ~450 nm and a length of 1.4 µm. In order to determine the crystal structure, phase purity, chemical nature and homogeneity of the Sr_2CeO_4

phosphor, X-ray diffraction (XRD) studies were carried out for pure sample prepared and the rare-earth doped samples. Figure.2 shows the XRD pattern of Sr_2CeO_4 sintered at 1100^0C and the experimentally observed XRD peak positions for pure Sr_2CeO_3 and Sr_2CeO_4 . The XRD pattern of Sr_2CeO_4 shows the formation of Sr_2CeO_4 as major single-phase compound along with traces of Sr_2CeO_3. Figure.3 show the XRD spectra of the strontium cerate samples doped with different rare-earths. Figure. 4 shows the excitation spectra and emission spectra of these phosphors. Sr_2CeO_4 when excited with 280nm the emitted spectrum peaks at 470nm covering the entire blue region with very good intensity. The excitation spectrum of Sr_2CeO_4 sample shows an excitation peaks at 254, 260, 280 and 340nm for the emission at 467nm. The emission spectrum of Sr_2CeO_4 shows a broad band due to $f \rightarrow t_1g$ transitions of Ce^{4+}.
However effect of various dopants modified the emission energy range but with decreased intensity. The Sr_2CeO_4 phosphor doped with different rare-earth dopants (0.5%) does not show any change in the excitation spectrum.

The emission spectra for rare-earth doped phosphors were recorded using 254nm excitation. Table.1 gives the change in luminescence observed with different rare earth ion doping(0.5%). When excited with 254nm recorded at room temperature but corresponding emission spectrum for Eu^{3+}(0.5%) doped phosphor shows peaks at 467, 490, 512, 537, 556, 587 and 616nm. The peaks depicted in the spectra are from the transitions $^5D_2 \rightarrow {}^7F_{0,2,3}$, $^5D_1 \rightarrow {}^7F_{0,1,2,3}$, and also from $^5D_0 \rightarrow {}^7F_{1,2,3}$. The peak around 610 -620nm is due to the electric dipole transition of $^5D_0 \rightarrow {}^7F_2$ which is induced by the lack of inversion symmetry at the Eu^{3+} sites and is much stronger than the $^5D_0 \rightarrow {}^7F_1$ transition. It is well known that the $^5D_0 \rightarrow {}^7F_2$ / $^5D_0 \rightarrow {}^7F_1$ intensity ratio is a good measure of the site symmetry of rare-earth ions in a doped material[6,7].

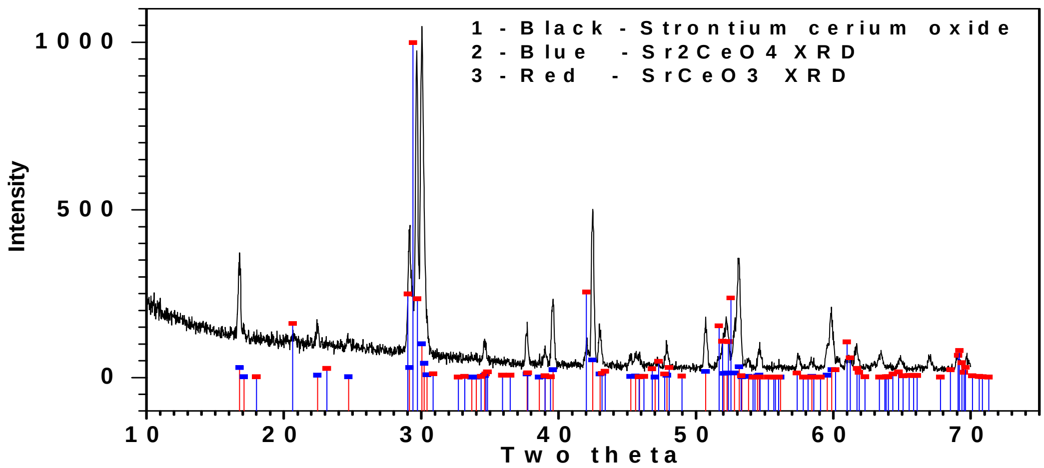
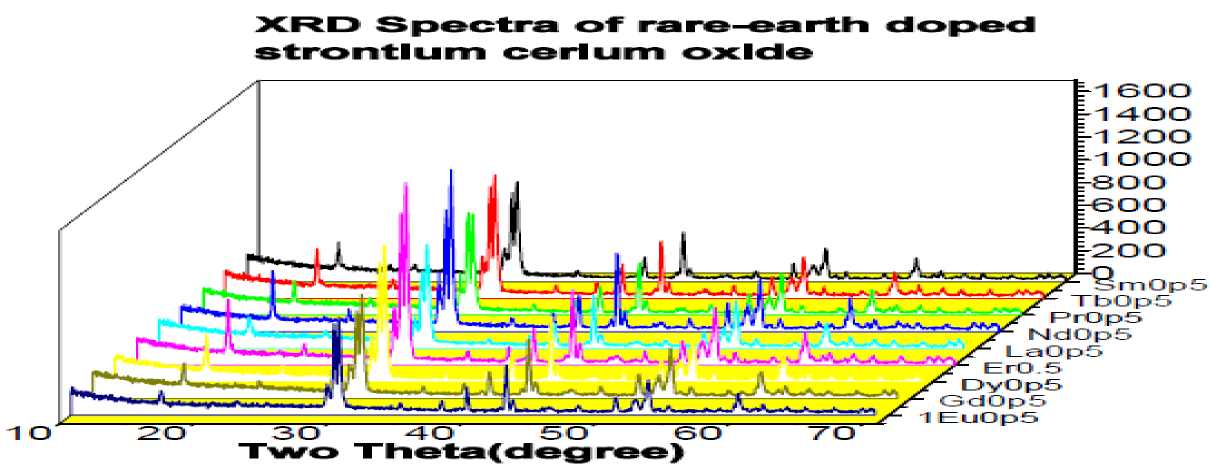


Fig. 2: XRD of Sr_2CeO_4 phosphor



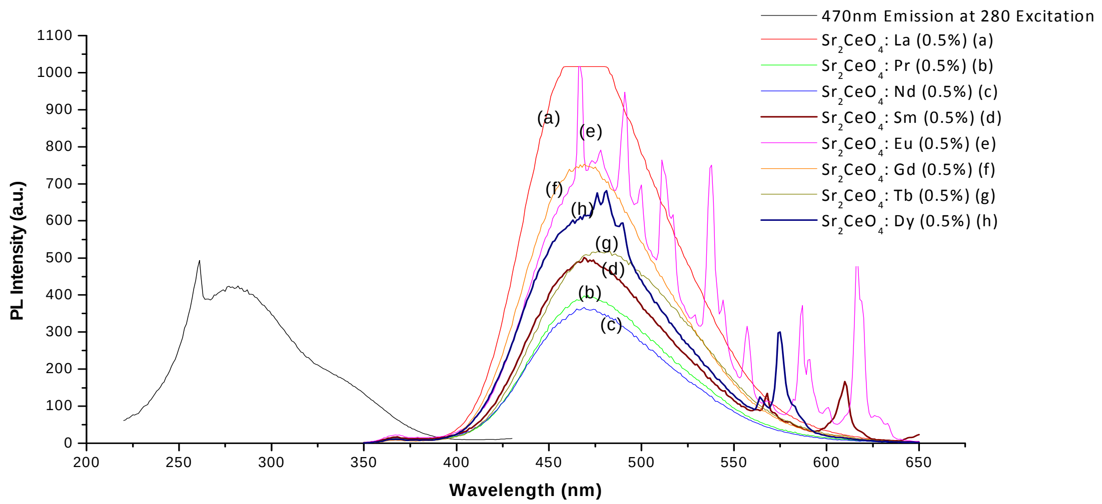


Fig 4: Excitation and emission spectra of RE doped Sr_2CeO_4 at 1100°C

S.No.	Name of the dopant	Emission Wavelength	Emission Intensity
1	La	467	>1000
2	Pr	470	402
3	Nd	467	364
4	Sm	468	502
5	Eu	467	>1000
6	Gd	468	753
7	Tb	477	521
8	Dy	467	614

Table.1. PL emissions of various rare-earth dopants in Sr_2CeO_4

IV. Conclusion

The XRD data analysis of Sr_2CeO_4 phosphor shows the formation of majority single phase compound along with Sr_2CeO_3. From SEM data it is found the mean particle size is average basal diameter of ~450 nm. The emission spectrum of Sr_2CeO_4 shows a broad band due to f → t_1g transitions of Ce^{4+}. The two excitation peaks may be assigned to the two kinds of Ce^{4+} ions present in Sr_2CeO_4. There are two different Ce^{4+}- O^{2-} bond lengths in the lattice and hence two different charge transfer transitions. The Sr_2CeO_4 phosphor doped with various rare –earths (0.5%) shows good PL intensity may be useful in various sources for lighting applications.

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