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Synthesis and Photoluminescence Study of Sr_2CeO_4: Er, Tb Nano Phosphor

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ABSTRACT

A blue emitting Sr_2CeO_4 phosphor doped with the rare earth erbium and co-doped Terbium were synthesized by Solid state reaction method. The powders were fired at 1200^0 C for four hour. The photoluminescence study of these materials reveals the emission in the bluish green region. The X-Ray diffraction pattern reveals that the size of particles. The materials were conforming from EDAX and the morphological study of material gives from SEM. In present paper we reported the excitation and emission of pure Sr2CeO4 phosphor and $SrCeO_4$: Er, Tb which gives emissions with good intensity at 474, 527, 536, 550 and 568 nm.

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

INTRODUCTION

Phosphors activated with rare earth metal have been widely investigated in the past few years on account of their technological importance to improve their luminescent properties and to meet the requirement of different display and luminescence devices. Inorganic compounds doped with rare earth ions form important class of phosphors as they possess a few interesting characteristics such as excellent chemical stability, high luminescence efficiency and flexible emission colors with different activators [1]. 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 Starting materials taken for the synthesis of the Sr_2CeO_4 were namely; Strontium Carbonate $SrCO_3$, Cerium Oxide CeO_2, , Er_2O_3 and Tb_4O_7 supplied by National Chemicals, Baroda, (Gujarat State) of 99.9 % purity. These materials were taken in Stoichometric proportions of Sr: Ce as 2:1. $SrCO_3$ and CeO_2 with rare earth 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 ate the rate of 300^0 C/hr. The samples was kept at the set temperature for four hours then cooled down naturally and again grinded thoroughly to get fine powder, the final product was soft cream color powder.

Scanning Electron Microscopy, EDX and XRD was taken from NCL Pune. The photoluminescence spectra were recorded at room temperature using Spectroflurophotometer (SHIMADZU, RF – 5301 PC) using Xenon lamp as excitation source at Display research Lab. Department of Applied Physics, M. S. U. Baroda.

RESULTS AND DISCUSSION

X- Ray Diffraction (XRD)

The structure and phase purity of the Sr2CeO4 phosphor were investigated by XRD. The XRD patterns were obtained using Rigaku, Minislex model at NCL Pune. Results are shown in Fig. 1 and 2 for the pure Sr2CeO4 and for Sr2CeO4: Er(.5%),Tb(.1%). 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°. The crystal The XRD patterns of the powders revealed that the structure of Sr2CeO4 is Orthorhombic [1], 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].

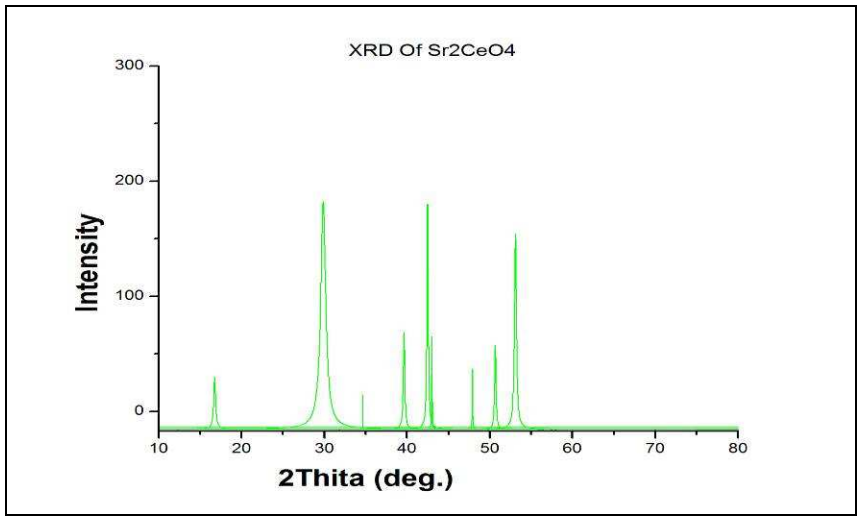

Figure 1 XRD for Sr2CeO4

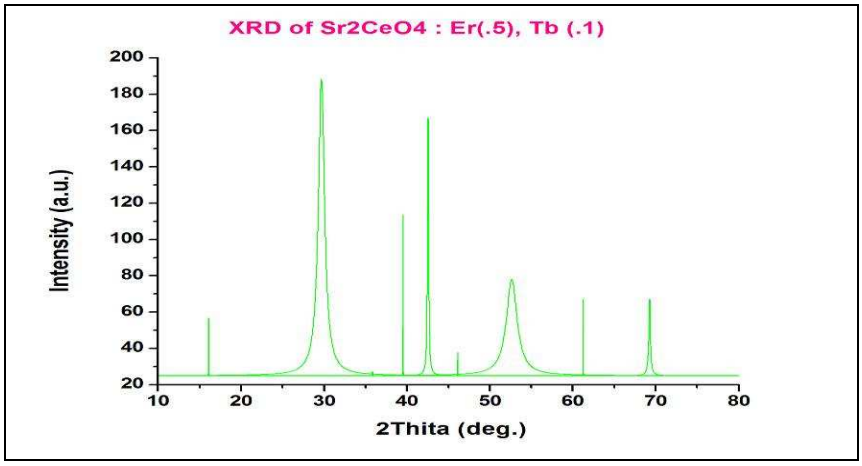

Figure 2 XRD Of Sr_2CeO_4: Er (.5 %), Tb (.1%0

The grain size of the particles of powder samples were calculated using Scherrer equation d = 0.9λ / βcosθ, Where β represents the full width at half maximum (FWHM) of XRD lines. The average grain size of the Sr2CeO4 phosphor is 22 nm. And when Sr2CeO4: Er (0.5%) and codoped with Tb(0.1%) the grain size is 19 nm.

Electron Scanning Microscope (SEM)

Fig.3 Shows the SEM images, which is the un-uniform this may be due to the formation of fractal attribution to sort of self organization. The fig 3 a) shows SEM image of pure Sr_2CeO_4 sintered at 1200^0 C for 3hrs, appears to irregular shape having an average basal diameter of 500nm and length of 1.4µm. Fig 3 b) Shows SEM of Sr_2CeO_4: Er (0.5), Tb(0.1)

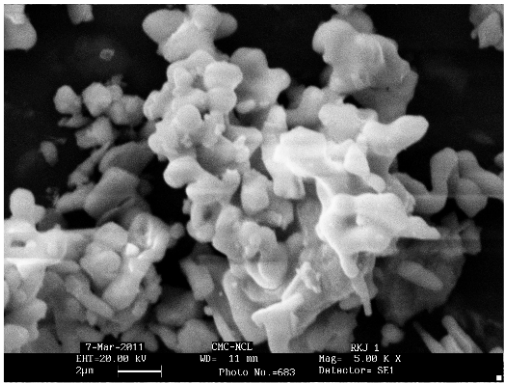

Figure 3 a) SEM Image of Sr2CeO4

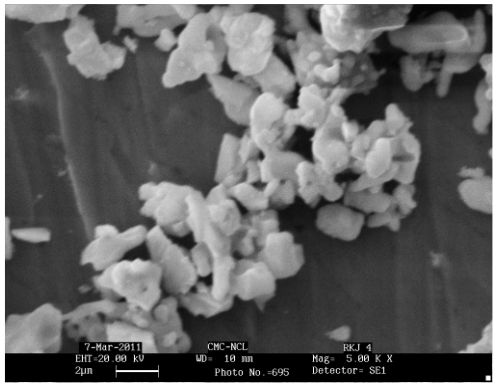

Figure 3 b) SEM Image of Sr2CeO4:Er (5.0%)Tb(.1%).

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-4 shows the EDX spectra of Sr_2CeO_4: Er in which the presence of Sr, Ce, Tb and O are clearly identified From table 1 the spectral data , it can be visualized that the compound is found to be virgin and possesses high purity[14].

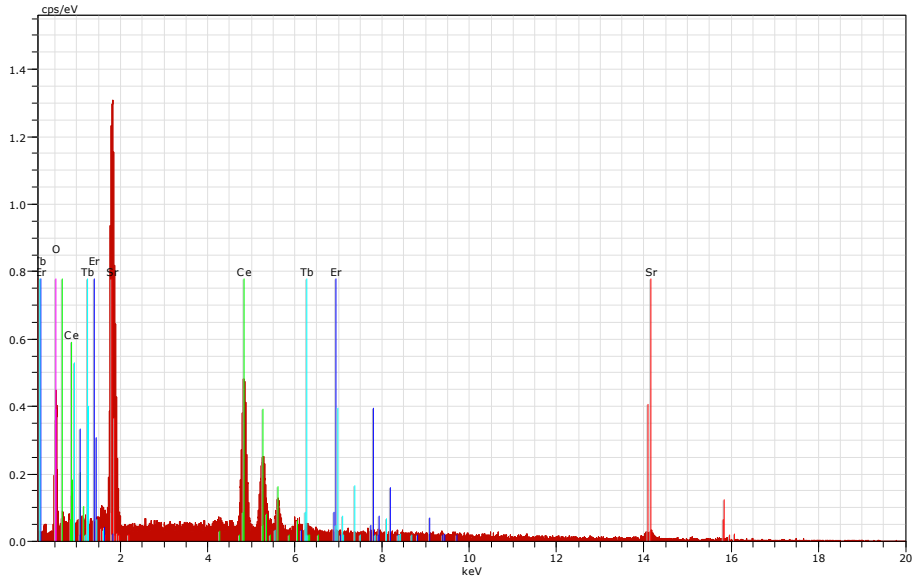

Figure 4: EDAX of Sr_2CeO_4: Er, Tb

Table 1: Quantitative Results of Sr_2CeO_4:Er,Tb

Elements	Net counts	C norm. Weight %	C Atom. Weight %
Sr	38	45.67	35.63
Ce	58	37.80	18.44
O	8	10.13	43.27
Er	68	4.57	1.87
Tb	65	1.83	0.79
Total:		**100.00**	**100.00**

Photoluminescence Study

The photoluminescence emission spectrum of pure Sr_2CeO_4 phosphor is shown in fig -5.which is obtained under the excitation wavelength 262nm. When the pure Sr_2CeO_4 phosphor excited with 262nm emission peak at 470nm a perfect blue region with very good intensity.

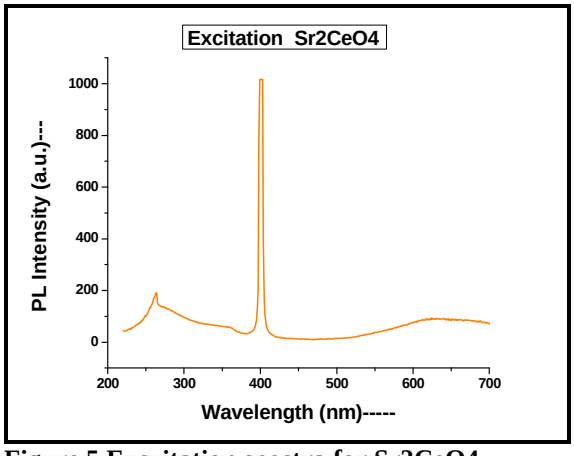

Figure 5 Excvitation spectra for Sr2CeO4

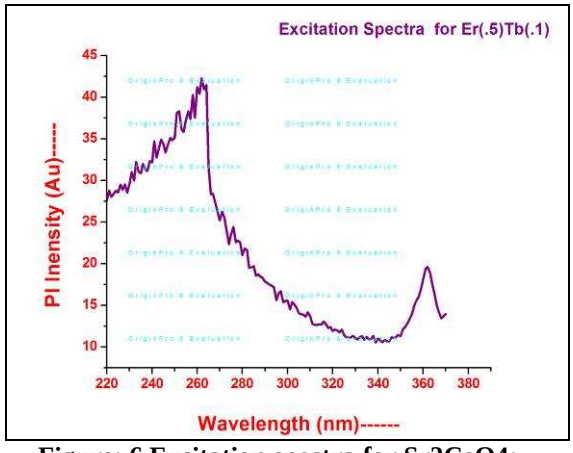

Figure: 6 Excitation spectra for Sr2CeO4: Er(0.5%), Tb(0.1%)

However the effect of Er, Tb depends effectively modified the emission wavelength of pure phosphor and the intensity was slightly decreased. The excitation spectra of Sr_2CeO_4: Er (0.5 %)

,Tb (0.1 %) shows in fig. 6 which reveals broad excitation spectra from 220 to 265 nm. When the excitation of the samples was kept at 262 nm, Sr_2CeO_4: Er, Tb was observed emission peaks at 474, 527, 536, 550 and 568 nm as shown in figure 7.

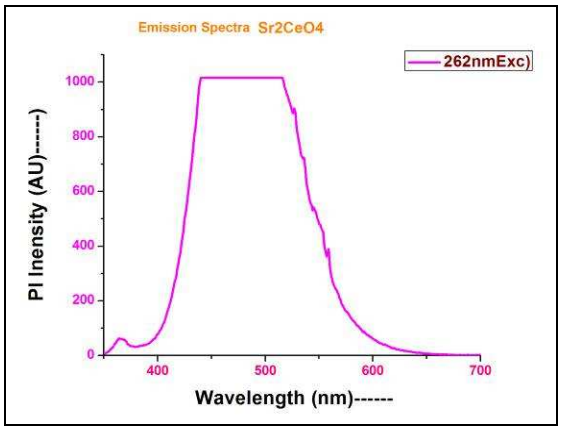

Figure 7 Emission spectra for Sr2CeO4

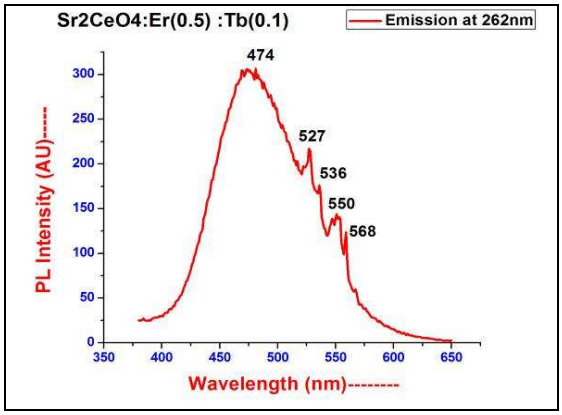

Figure 8 Emission Spectra of Sr2CeO4: Er(0.5%), Tb(0.1%).

CONCLUSION

The XRD pattern confirms the formation of majority of Sr_2CeO_4 compound in single phase. From XRD it is found the mean crystallite size is 22 nm. EDX spectra of Sr_2CeO_4: Er,Tb in which the presence of Sr, Ce O, Er and Tb are clearly identified. PL emission of undoped Sr_2CeO_4 phosphor was observed at 470 nm and Sr_2CeO_4: Er, Tb was observed emission peaks at 474, 527, 536, 550 and 568nm which are at bluish green region.

Acknowledgment

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