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PHOTOLUMINESCENCE AND THERMOLUMINESCNCE OF BaS:Ce NANOPHOSPHORS

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We have synthesized the cerium doped barium sulfide nanophorsphors of average grain size of 38 nm by solid state diffusion method using sodium thiosulfate as a flux. The samples are characterized by XRD, TEM and PL.Also the thermoluminescnce studies of these samples are studied after exposed the UV radiation. The average grain size of particles is found about 38 nm which is confirmed by TEM. In photoluminescence spectra there is main peak at 540 nm which corresponds to green color and also a shoulder at 600 nm. In TL spectra there are two peaks at 373k and 650k while corresponding peak in their bulk counterparts was reported at 365 k. The effect of different heating rates has also been discussed.

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1. Introduction

Alkaline earth sulphide (AES) have been known for a long time as versatile host materials for preparation of phosphors, and have regained great attention in recent years [1-5] due to their potential for application in displays, lasers, supersonic conductors, high pressure mercury lamps, IR sensors, paints, dosimetry, random access optically erasable memory devices, magneto-optical devices. However, in comparison with II^B-VI compounds such as ZnS and CdS, these materials have not been extensively studied, principally because of difficulties in material preparation. By controlling the grain size of these phosphors, one can tailor the optical properties of phosphors. The properties of phosphors at micro level are the same as in bulk form but these are totally different at nanoscale. Different behavior of grain at nanoscale can be explained on basis of quantum size effect and large surface to volume ratio. For the synthesis of CaS and SrS nanocrystallites containing different dopants, some methods like solvo-thermal, sol-gel, wet chemical co-precipitation, solid state diffusion have been successfully used. It was, therefore decide to synthesis BaS phosphors doped with bismuth by solid state diffusion method. This method has been successfully used for synthesis of CaS and SrS by Vijay Singh et.al. With the advent of nanotechnology, there is still a considerable amount of research involved in the search for a new nanocrystalline phosphor material with better TL and dosimetric properties.Vinay et.al [6] found that due to nanocrystalline sizes the peak temperature shifts towards higher side due to the formation of deep traps. This is important from the dosimetry point of view because the higher the temperature of the dosimetric peak the lesser the room temperature fading. In this study, we present the photoluminescence and TL glow curve of BaS:Ce nanocrystalline phosphors exposed to the UV radiations. The effect of different heating rates on the glow curves has been discussed.

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2. Experimental

Solid state diffusion method was used for the preparation of BaS:Ce nanocrystallites. The starting material are $BaSO_4$, sodium thiosulfate, $Ce(NO_3)_3.5H_2O$(99.5%) and carbon powder acquired from CDH,New Delhi. In this method two reactions are assumed to take place at the same time at temp of firing namely (1) Reduction of alkaline sulphate to its sulfide by a reducing agent and (2) incorporation of activator in the crystal lattice in presence of suitable fluxes. The detail of sample preparation is reported elsewhere [7]. XRD of the given samples was obtained using a model D8-Advance of Bruker (Germany), of CuKα radiation, the energy of which was 8.04 keV and wavelength was 1.54 Å.The applied voltage was 40 kV and current was 25 mA. A UVS-12 Mineralight (UV product, an Gabriel, USA) lamp emitting a peak intensity at 254 nm was used for UV exposure at room temperature. One minute of UV exposure from this lamp corresponds to irradiation of $2.7x10^{-6}$ Jcm^{-2}.Before to UV exposure; the samples were annealed at 300 ^oC for 20 minutes and then quenched on a metallic plate at room temperature to erase any residual information. After desired exposure, TL glow curves were recorded on a Harshaw TLD reader (Model 3500) taking 5mg sample each time in nitrogen atmosphere at different heating rates of $2ks^{-1}$, $5Ks^{-1}$and $10Ks^{-1}$.The morphology and sizes of the phosphors were determined by TEM carried out on a H-7500(Hitachi Ltd Tokyo Japan) operated at 120kV. Diluted nanophosphors suspended in absolute ethanol were induced on carbon coated copper grid, and allowed to dry in air.

3. Results and discussion

XRD

Fig. 1 shows the X-Ray Diffraction (XRD) patterns of the BaS. The X-Ray Diffraction (XRD) were obtained with Bruka D8 Advanced X-Ray diffractometer ((Bruker AXS) using Cu K-alpha radiation of wavelength 0.1543nm.The XRD patter matched perfectly with the JCPDS.

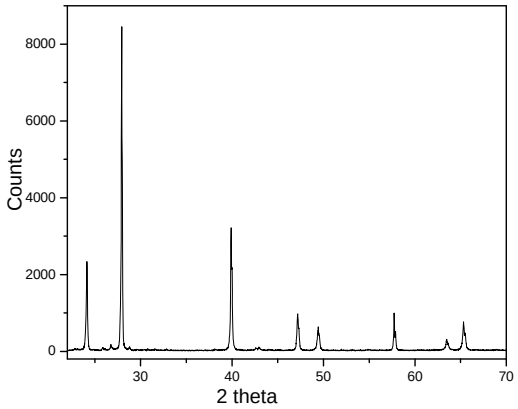

Fig.01 XRD of BaS:Ce Nanoparticles

The mean size of the particles can be estimated by using Scherer equation [8]

$$d = \frac{0.89\lambda}{\beta \cos\theta_B} \quad (1)$$

Where d is the crystalline size, λ is the wavelength, β is full width at half maximum (FWHM) expressed in radians and θ_B is Bragg angle. The average particle size was found 38 nm. Fig.2

shows the TEM images of BaS:Ce , which reveals the uniform distribution of particles size in the range of 20-30nm.

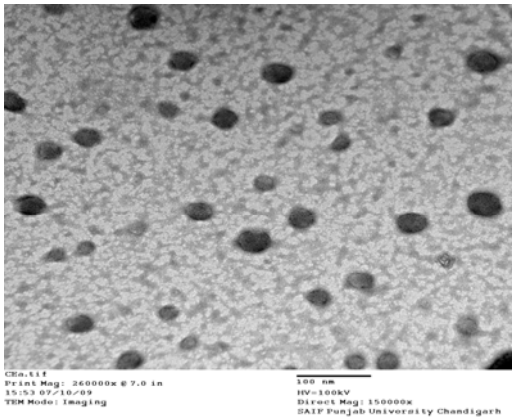

Fig 2 TEM images of BaS:Ce nanoparticles

4. Photoluminescence and thermoluminescence

The emission spectra (fig.3) were recorded by exciting the samples at 420 nm at room temperature. Trivalent cerium ion produced one emission band in BaS, whose peak occurs at 547 nm which correspond to green color. However, for the bulk phosphors the emission peak obtained at 608 nm which correspond to red color. This is due to the quantum size confinement.

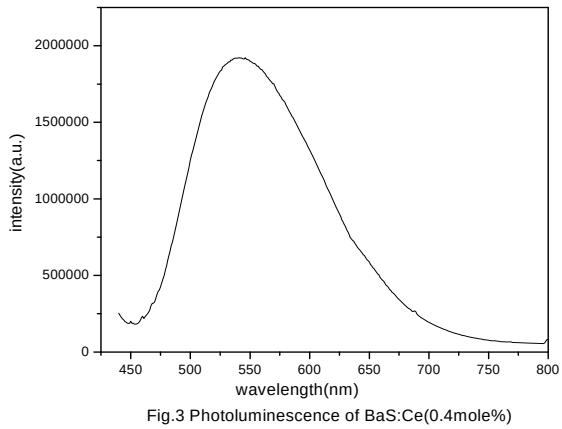

Fig. 3. Photoluminescence of BaS:Ce(0.4mole%)

Fig.4 shows the TL spectra of BaS:Ce by irradiating with UV ray at various doses. There are mainly two peaks in this spectra one at 373 k and other is at 635 k.While in their bulk counterparts the TL peak is at 365 k hence we can say that in nanomaterial there are deeper traps.

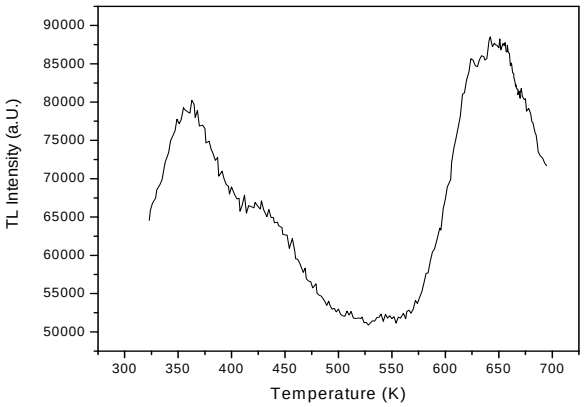

Fig.4 Thermoluminescence of BaS:Ce(0.4 mol%).

5. Conclusions

We have synthesized BaS nanocrystalline phosphors activated by Ce ions. The photoluminescence and thermoluminescnce studies in BaS:Ce nanocrystalline phosphors irradiated with UV rays have been presented. The samples were characterized by XRD, TEM and PL. The thermoluminescence properties were studied after exposition to UV radiation.

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