National Conference on Recent Trends in Synthesis and Characterization of Futuristic Material in Science for the Development of Society (NCRDAMDS-2018)
In association with
International Journal of Scientific Research in Science and Technology

Thermoluminescence (TL) Glow Curve Study of Srba$(SO_4)_2$:Tb and Srba$(SO_4)_2$: Ce,Tb Phosphor

V. C. Kongre[1], S. C. Gedam[2], S. J. Dhoble[3]
[1,3]Department of physics, Sardar Patel College Chandrapur, Maharashtra, India
[1,3]Department of physics, R.T.M. Nagpur University, Nagpur, Maharashtra, India
[2]K. Z. S. Science College, Kalmeshwar, Nagpur, Maharashtra, India

ABSTRACT

$SrBa(SO_4)_2:Ce^{3+},Tb^{3+}$ new sulphate phosphors were synthesized by co-precipitated method.$SrBa(SO_4)_2$: Tb and $SrBa(SO_4)_2$: Ce,Tb both phosphors show the high temperature TL for γ –irradiated phosphors exhibit a single glow peak at 245 ^{0}C with hump at lower temperature around 170 ^{0}C and at 232 ^{0}C with hump at higher temperature around 320 ^{0}C respectively. In this phosphor Ce enhance the TL sensitivity.

I. INTRODUCTION

Sulphate based phosphors, because of its high sensitivity, easy method of preparation and stability of response in adverse climates have already been very popular for use in radiation dosimetry, personal dosimetry and environmental monitoring [1,4]. Spatially, alkaline earth sulphate doped with rare earth ions are widely studied phosphor materials. Since the ionic radii of the trivalent rare earth cations of the light lanthanide (La-Eu) are very similar to alkaline earth metal ions (Ca^{2+}, Ba^{2+}, Sr^{2+} and Mg^{2+}), thus isomorphic substitution of alkaline earth metal ion should be possible. These phosphors have already been very popular for use in thermoluminescence dosimetry, imaging plates, and thin film electroluminescence displays.

Although high TL is obtained from most alkaline earth sulphates and mixed sulphate phosphors and used in many applications. Energy transfer processes in the alkaline earth (Ca, Sr or Ba) sulphates with Ce^{3+} and Tb^{3+} co-doping were also reported by Lakshamanan et al. [5]. Ce^{3+} to Tb^{3+} energy transfer process enhances the Tb^{3+} green emission in co-doped alkaline earth sulphates. Y. Rangeela Devi was reported that BaSO4:Eu.Dy of different dopent concentrations has different TL intensities. The phosphor $Ba_{0.96}SO_4:Eu_{0.02}Dy_{0.02}$ has highest intensity and she also studied the effect of annealing temperature, TL intensity increases with the increase in duration time and temperature of annealing [6]. Researchers are still working on sulphate base phosphor to improve its luminescence properties.

II. EXPERIMENTAL

The sample $SrBa(SO_4)_2$ (pure), $SrBa(SO_4)_2$:Ce, $SrBa(SO_4)_2$:Tb and $SrBa(SO_4)_2$:Ce,Tb were prepared by co-precipitation method. All starting materials crush with additive solution with constant pH and filtered out and washed several times at constant temperature with activators. While preparing the samples the constituents $BaSO_4$, $SrSO_4$ and sulphate salts of cerium $Ce_2(SO_4)_3$ and terbium $Tb_2(SO_4)_3$ were taken in a stoichimetric ratio and precipitated. Then ppt was kept in oven for 12 hrs. Then this material was heated at 900 ^{0}C for 2 hrs, results the compound of $SrBa(SO_4)_2:Ce^{3+}$, $SrBa(SO_4)_2:Tb^{3+}$ and $SrBa(SO_4)_2:Ce^{3+},Tb^{3+}$,in powder form. The sample was then slowly cooled at room temperature. The resultant polycrystalline mass was crushed to fine particle in a crucible, this powder form was used in further study.

The pure compound was confirmed by taking the x-ray diffraction (XRD). For thermoluminescence study samples were exposed to gamma rays from a ^{60}CO source at room temperature at the rate of 0.39 kGyh^{-1}

for1 min. After desired exposure, TL glow curves were recorded for 5 mg of sample each time at a heating rate of 5 $^{0}Csec^{-1}$. The TL glow curves were recorded with the usual set-up consisting of a small metal plate heated directly using a temperature programmer, photomultiplier (931 B), dc amplifier and a millivolt recorder.

III. RESULTS AND DISCUSSION

3.1. Structural studies and morphology

The formation of synthesized compound $SrBa(SO_4)_2$ was confirmed by studying diffraction pattern shown in Figure 1.The XRD pattern of prepared sample matches well with standard data available in JCPDS database of file number 41-1387. The sharp diffraction peaks in XRD pattern suggest the formation of single- phase compound. The compound exhibits orthorhombic crystal structure.

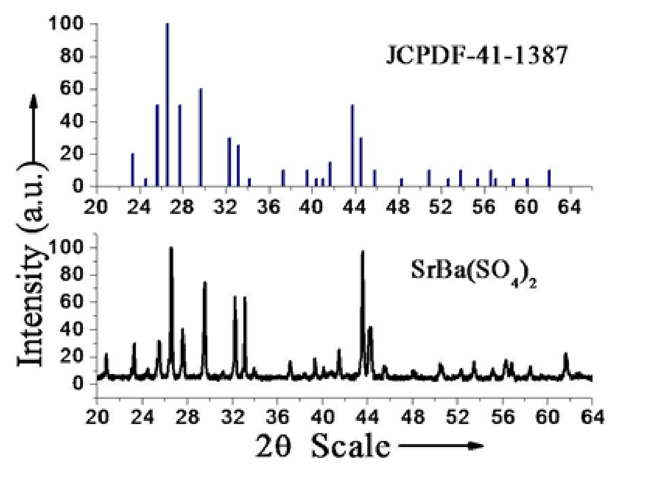

Figure 1. X-ray diffraction pattern of $SrBa(SO_4)_2$ host lattice.

The morphological properties of prepared $SrBa(SO_4)_2$ powder investigated by SEM. Figure 2. Presents the SEM image of the prepare phosphor. As can be seen, the sample has good dispersions and relatively narrow size distribution. The grains are irregular shaped with an average crystallite size of about 2μm to 10 μm.

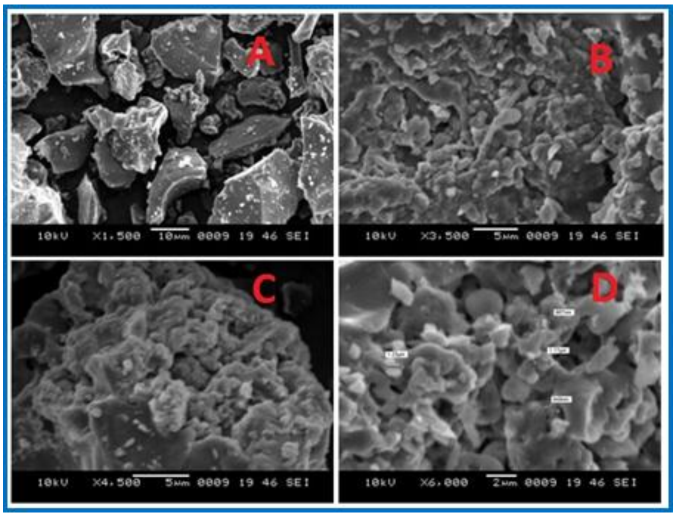

Figure 2. SEM micrographs of $SrBa(SO_4)_2$ phosphor at different magnification range **(A)** x 1,500, **(B)** x 3,500, **(C)** x 4,500 and **(D)** x 6,000.

3.2. Thermoluminescence (TL) glow curve study of $SrBa(SO_4)_2$:Tb and $SrBa(SO_4)_2$: Ce,Tb phosphor

Phosphor $SrBa(SO_4)_2$: Tb (0.1,0.2,0.5mol%) and $SrBa(SO_4)_2:Ce_{0.05},Tb_x$ (0.1,0.2,0.5mol%) were exposed to gamma rays from ^{60}CO source at room temperature at the rate of 0.37kGy/hr for 30sec. After desired exposure, TL glow curves were recorded on a Nucleonix TLD Reader 10091 immediately after the irradiation by taking 5mg of sample at the linear heating rate of 5 $^{0}C\ s^{-1}$ for the same dose. From Figure 3 shows that the TL glow curve of $SrBa(SO_4)_2$: Tb phosphor has prominent peak at 278 ^{0}C and hump at lower temperature around 187 ^{0}C.

One at lower temperature and other at higher temperature are due to creation of shallow as well as deep traps inside host material, respectively, indicating two different kinds of traps. In pure $SrBa(SO_4)_2$ sample no TL glow curve was observed and .TL intensity of glow curve is goes on increasing with increasing in concentration of Tb without change in shape and position of TL peaks (not show here). The maximum intensity was observed for 0.5 mol% concentration of Tb. From Figure 3. observed that The TL glow curve of $SrBa(SO_4)_2$:Ce,Tb phosphor has prominent peak at 237 ^{0}C and hump at higher temperature around 330 ^{0}C. One at lower temperature and other at higher temperature are due to creation of shallow as well as deep traps inside host material, respectively, indicating two different kinds of traps. TL intensity of glow curve is goes on increasing with increasing in concentration of Tb without change in shape and position of TL peaks (not show here). The maximum intensity was observed for 0.5 mol% concentration of Tb.

It is clear from Figure 3 that the TL sensitivity is increased in the presence of Ce co-dopant for $SrBa(SO_4)_2:Tb_{0.005}$ phosphor. The TL glow curve for Ce doped in $SrBa(SO_4)_2$ was not observed but it change the glow curve of Ce doped $SrBa(SO_4)_2:Tb_{0.005}$ with increasing intensity. It change the trapping centers in $SrBa(SO_4)_2:Tb_{0.005}$ phosphor.

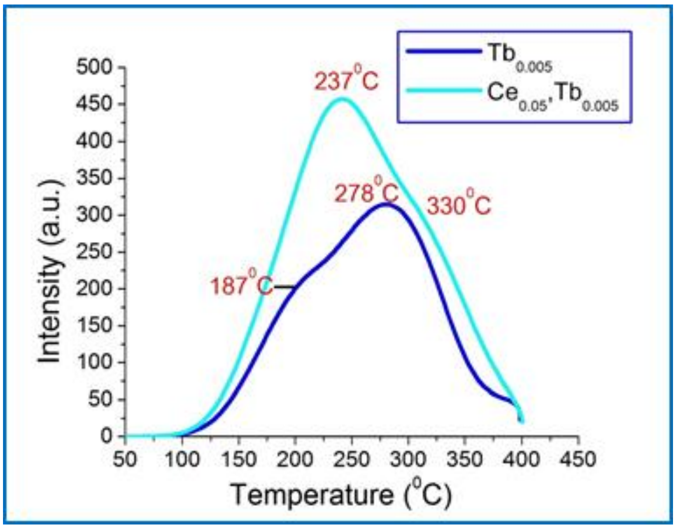

Figure 3. TL glow of $SrBa(SO_4)_2$: Tb and $SrBa(SO_4)_2$:Ce,Tb phosphors irradiated with ϒ-rays from ^{60}CO source of 5 Gy.

IV. CONCLUSIONS

From the result and discussion, it is concluded that $SrBa(SO_4)_2:Tb^{3+}$ and $SrBa(SO_4)_2:Ce^{3+},Tb^{3+}$ new sulphate phosphors were synthesized by co-precipitated method.$SrBa(SO_4)_2$: Tb and $SrBa(SO_4)_2$: Ce,Tb both phosphors show the high temperature TL for γ – irradiated phosphors exhibit a single glow peak at 245 ^{0}C with hump at lower temperature around 170 ^{0}C and at 232 ^{0}C with hump at higher temperature around 320 ^{0}C respectively. It concluded that in $SrBa(SO_4)_2$: Tb phosphor Ce enhance the TL sensitivity.

V. REFERENCES

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