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Study of some Luminescence Properties of Dy Doped $CaSO_4$ Phosphor

U. A. Thakare
Department of Physics, S. P. M. Science and Gilani Arts Commerce College, Ghatanji, Maharastra, India

ABSTRACT

The present investigation reports the combustion synthesis of $CaSO_4$ phosphor doped with Dy and study of their luminescence properties such as TL, OSL and its TL response after a proton dose. We studied the performance and details about synthesis and the observed luminescent characteristics of these phosphors were reported. Thermoluminescence dosimetry has been very successful in monitoring the personnel level doses due to high sensitivity and reusability. However, these dosimeters saturate at high doses involved in radiation processing.

Keywords : TL, $CaSO_4$: Dy Phosphor, OSL

I. INTRODUCTION

Luminescence is a phenomenon that has captivated mankind for a long time. Light, emitted by glow worms, the Aurora Borealis, rotting fish, luminescent wood, and meat belongs to the family of naturally occurring luminescence. The first study of luminescent materials started in 1603. Although it is not clear which dopant or dopants are actually responsible for persistent luminescence, BaS was a largely investigated host material. BaS, made accidentally, is supposed to be the first-ever synthesized sulfide phosphor. The name phosphor was already in use in ancient times, even though the chemical element phosphorous was only isolated in 1669 by the German alchemist Hennig Brand. Phosphorous becomes luminescent under moist conditions upon oxidation. Thus, phosphorous is a chemiluminescent (CL) material, and the name phosphorescence, generally used for persistent photoluminescence, is inaccurate. In the subsequent centuries, many scientists synthesized and investigated glowing materials, but it was too untimely for a systematic study. However, the amalgamation of CaS as a phosphor in 1700 by Friedrich Hoffmann and of SrS in 1817 by J. F. John are important to mention. Curiously enough, the luminescent properties of ZnS, which was going to become one of the largest investigated luminescent hosts in the twentieth century [1-8].

$CaSO_4$: Dy is applicable in monitoring the hot wastes and measuring doses inside a reactor. It also applicable in food processing, medical sterilization and material processing. In the present investigation TL and OSL properties of Dy Doped $CaSO_4$ Phosphor has been studied [9-11].

II. Experimental

Dysprosium doped CaSO4 was prepared by combustion synthesis. This method is modified number of times for systematic synthesis of samples by changing the starting materials and synthesis conditions and prepared precipitation. Many attempts were made for improvement in thermoluminescence and photoluminescence emission of the synthesized phosphors. The concentration of dysprosium used to

prepare the phosphor was 0.2 mol%. The sources used for exposure consisted gamma cells which gives doses up to 50 kGy [12].

III. Results and Discussion

Figure 1 shows the typical glow curves for $CaSO_4$ doped with Dy and thermoluminescence glow curves were taken after γ- ray exposure of 5 Joule/Kg. The glow curves of CaSO4: Dy consist of a peak around 200°C. The intensities of glow curves increase with respect to increase in dose of Dy, it is maximum for 50 kDy and intensity is weak for 5 kDy. Hence high dopant $CaSO_4$ was considered for further study. These TL peaks, however, are resolved in the samples, which were annealed to 900^{0}C for an hour after exposure to high doses.

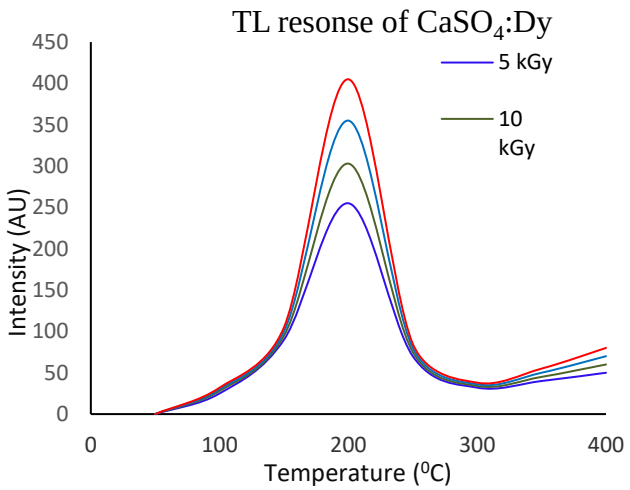

Figure 1: TL response of $CaSO_4$: Dy (0.2%) as a function of g-dose, mass of TL phosphor 5 mg; rate of heating 2 C/s.

Figure 2 represents the TL response of $CaSO_4$: Dy (0.2%) after a proton dose of 20 kGy. The TL peaks can be clearly resolved at 100^{0}C and 200^{0}C after annealing the sample to 900^{0}C. These peaks were also studied for their response to high doses delivered by gamma cell as well as by proton beam.

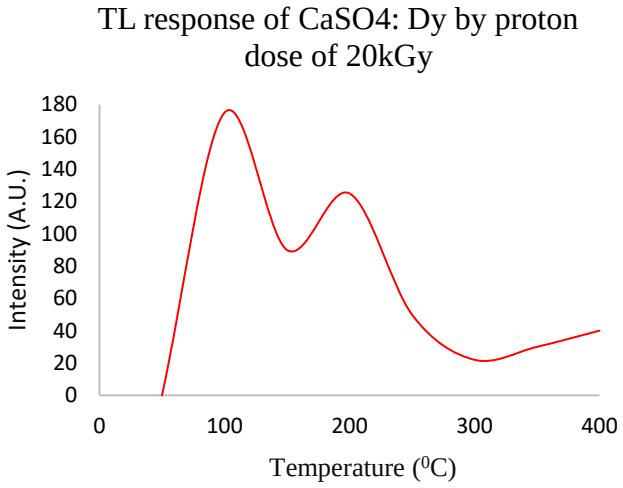

Fig. 2. TL response of $CaSO_4$: Dy (0.2%) after a proton dose of 20 kGy

Figure 3 shows the optically stimulated luminescence (OSL) of $CaSO_4$: Dy irradiated by exposure of 0.5 Joule/Kg, indicating that the OSL intensity of CaSO4: Dy is very high about 10000 at beginning then it exponentially decreases rapidly, it is due to sudden fall in the intensity of CaSO4: Dy. Blue light was used for stimulation. The number of counts obtained were directly related to the time for which the stimulant light falls on the sample. We can estimate the dose absorbed by the sample by considering integrated counts.

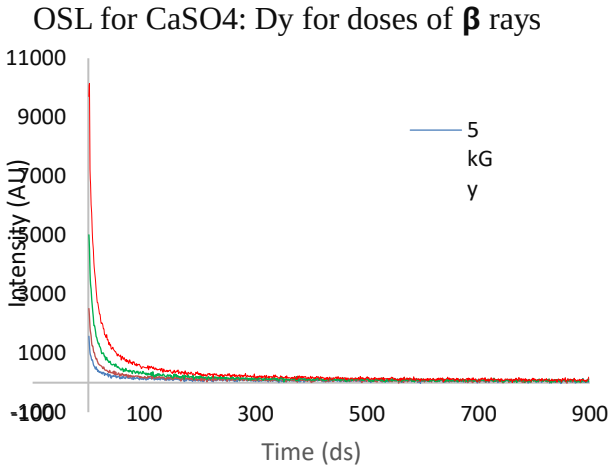

Figure 3. OSL of CaO_4: Dy irradiated by β exposure of 0.5 Joule/Kg

IV. Conclusion

1. The optimum concentration of Dy for high dose measurement is 0.2 mol%,
2. The use of high temperature thermoluminescence peaks makes this material quite suitable for use in reactor or hot waste dosimetry.
3. The TL and OSL behavior of $CaSO_4$:Dy has been studied.

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