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Short Communication

TL Glow Curve and Kinetic study of Eu^{3+} doped SrY_2O_4 Phosphors

Kaur Jagjeet, Suryanarayana N.S., Dubey Vikas and Neha Rajput
Department of Physics, Govt. Vishwanath Yadav Tamaskar Post Graduate Autonomous College, Durg (C.G.), INDIA

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Abstract

The present paper reports TL glow curve of Eu^{3+} doped SrY_2O_4 phosphor with different UV exposure time. The glow peak shows second order kinetics and evaluations of kinetic parameter were done by peak shape method. Calculations of trap depth were done with different methods and order of kinetics, activation energy and frequency factor are calculated. The recorded glow curve shifts longer temperature side with respect to UV exposure. The peaks were found 155^0C, 160^0C, 164^0C and 168^0C respectively using the heating rate 3^0C/s.

Keywords: Thermoluminescent property, kinetic parameter, rare earth doped phosphor.

Introduction

$SrY_2O_4:Eu^{3+}$ is one of the promising red phosphors for FED applications. Upon excitation with 250 and 260 nm light, all the powder samples of $SrY_{2(1-x)}O_4:Eu_{2x}$ show bright red emission due to the 4f–4f transitions of Eu^{3+} ions and the highest photoluminescence intensity at 610 and 615 nm was found at a content of about 9 mol% Eu^{3+}. Splitting of the $^5D_0$–$^7F_0$ and $^5D_0$–$^7F_1$ transitions revealed that the Eu^{3+} ions occupied two nonequivalent sites in the crystallite by substituting Y^{3+} ions [1]. Luminescence spectra of SrY_2O_4:Eu show two kinds of Eu^{3+} emissions, which could be assigned to Eu^{3+} ions in the Sr-site and the Y-sites with the dependence of emission spectra on Eu^{3+} concentration[2]. The SrY_2O_4 lattice of the $CaFe_2O_4$ structure has two types of Y sites. One is an almost undistorted octahedral site and the other is a substantially distorted one. Strontium occupies the bicapped trigonal prismatic site. In this study, various isomorphic compounds doped with Eu^{3+} ions have been prepared and their luminescent spectra have been measured in order to identify Eu^{3+} sites in SrY_2O_4: Eu.

Rare earth oxides (RE_2O_3) are the most stable rare earth compounds, in which the rare earth ions hold typically a trivalent state[3]. Because of their optical, electronic and chemical properties resulting from their 4f electrons, rare earth oxides have been widely used in the field of luminescent devices, optical transmission, bio-chemical probes, medical diagnosis and so for[4].

Thermoluminescence characteristics of phosphors have been widely used as a means of investigating the mechanism of luminescence. The often significant information about the kinetics involved in the process and serve as a tool for evaluating the various trapping parameters. TL curves are markedly sensitive to the presence of impurities and thermal treatment, the role of impurities as traps or centres and of thermal treatment probably being different in different systems. Extremely low concentration of defects can be studied in principle, using sensitive TL recording arrangements. The effect of impurities on the TL process has been extensively studied.

Material and Methods

The specimen SrY_2O_4 doped with Eu^{3+} has been prepared by the solid state reaction. The appropriate oxides and carbonates ($SrCO_3$, Y_2O_3, Eu_2O_3 and H_3BO_3) were thoroughly grinded in a mortar for 30 minutes and fired at 1000^0C for 2 hours at 1350^0C for 3 hours. Thermally stimulated luminescence glow curves were recorded at room temperature by using TLD reader I1009 supplied by Nucleonix Sys.Pvt.Ltd. Hyderabad. The obtained phosphor under the TL examination is given UV radiation 365nm. Heating rate used for TL measurement is 3.0^0C/s.

Results and Discussion

This paper reports the trapping parameters such as trap-depth (E), escape frequency factor (s) and "order of kinetics" for the glow peaks obtained under ultraviolet excitation. The TL glow curve $SrY_2O_4:Eu^{3+}$ phosphor shows second order kinetics.

SrY_2O_4 doped with Eu is found to be very good thermoluminescence phosphor. The following are the results of present studies. The phosphor was given a UV irradiation with 365nm UV source. The heating rate is 3.0^0C/s. Every time 5 mg of weighed irradiated phosphor was taken for TL measurements.

The TL glow curve of SrY_2O_4 doped with Eu has been shown in figure 1-4 and the variation of the TL glow curve as a function of UV exposure time has been presented in figure 5. In all the glow curves, only single peaks are observed around 155^0C, 160^0C, 164^0C and 168^0C. However it is interesting to note that the peak temperature around 155^0C increases by increasing UV exposure time. From the table 1 it can be easily seen that the variation with UV exposure. Figure 5 shows the variation of TL glow curve with a function of UV exposure time.

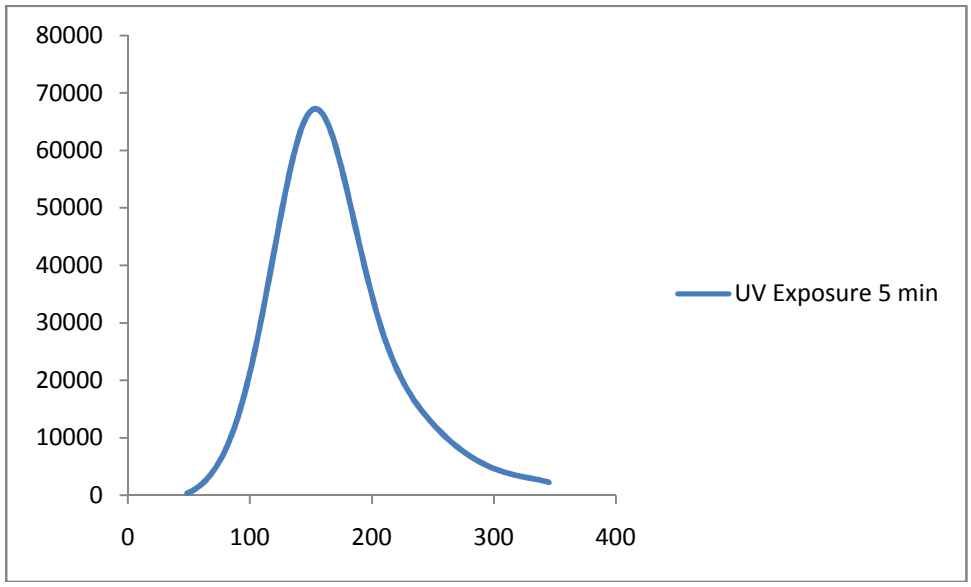

Figure-1
TL glow curve of $SrY_2O_4:Eu^{3+}$ 5 min UV exposure

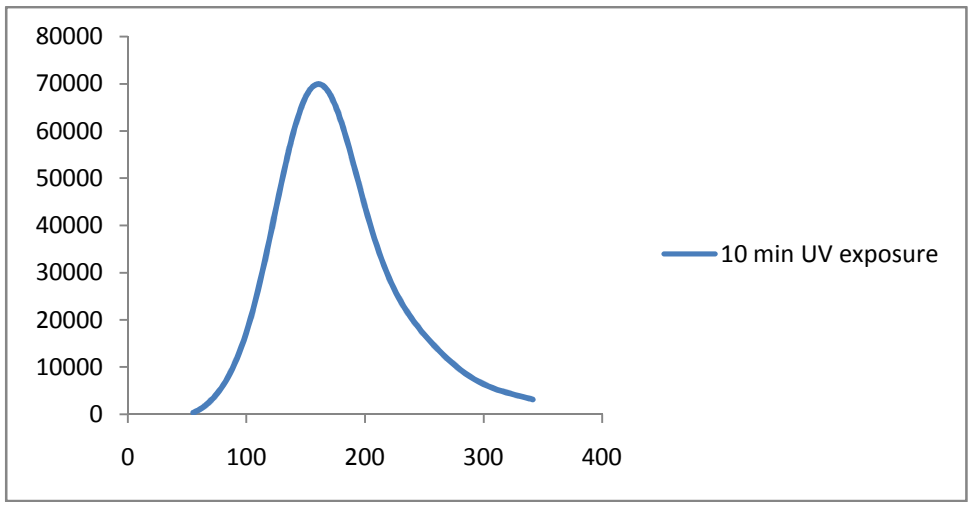

Figure-2
TL glow curve of $SrY_2O_4:Eu^{3+}$ 10 min UV exposure

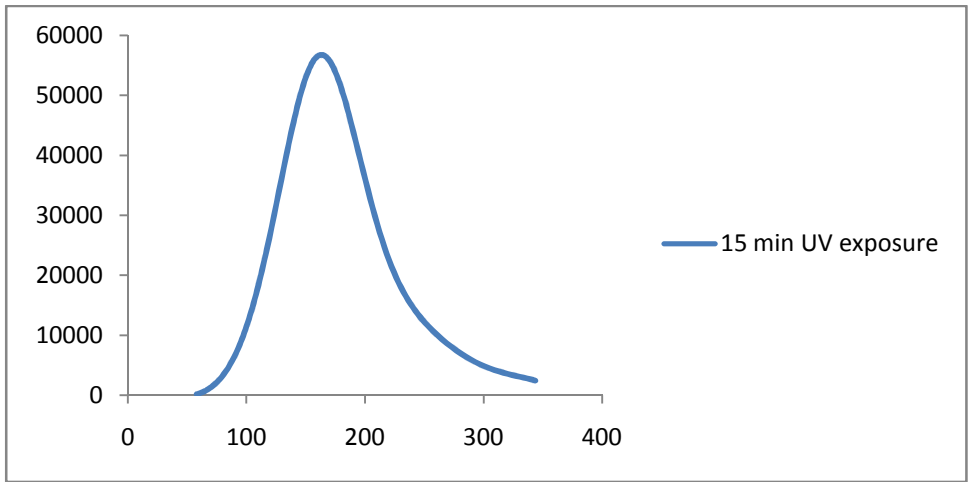

Figure-3
TL glow curve of $SrY_2O_4:Eu^{3+}$ 15 min UV exposure

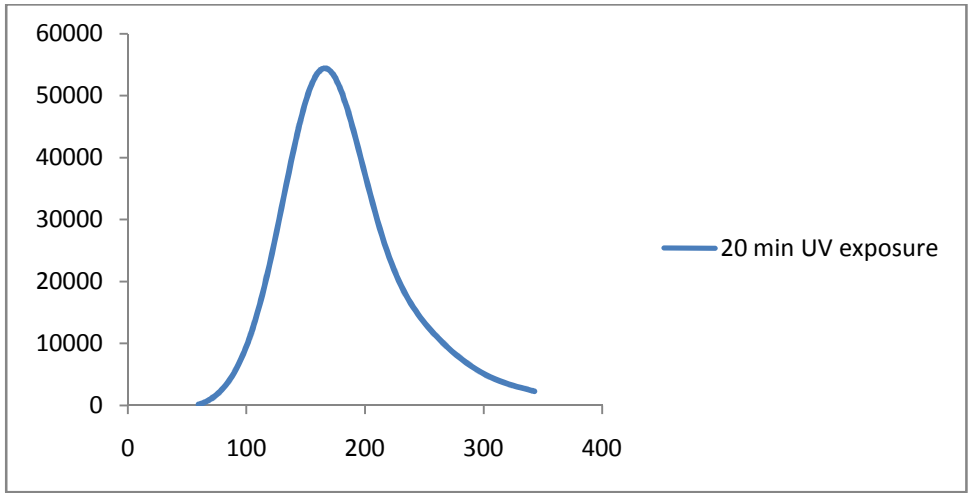

Figure-4
TL glow curve of $SrY_2O_4:Eu^{3+}$ 20 min UV exposure

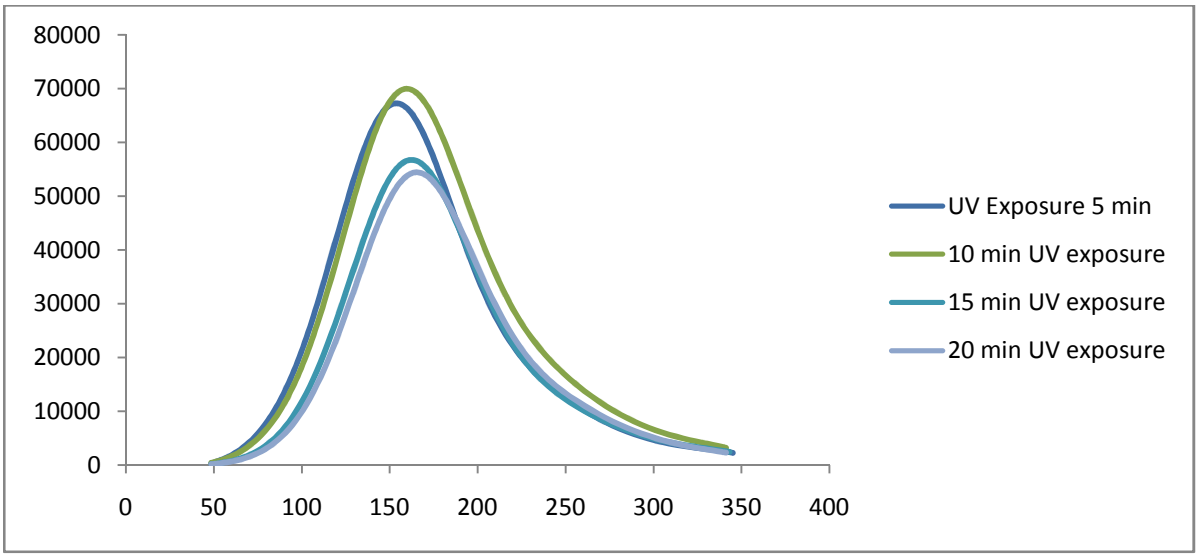

Figure-5
Variation with UV exposure time

Table-1
Shape factors (μ), Activation Energy E and Order of Kinetics b of UV irradiated $SrY_2O_4:Eu^{3+}$ doped phosphor

UV min	T_1	T_m	T_2	τ	δ	ω	μ = δ / ω	Activation energy	Frequency factor
5	114.7	155	199.7	40.27	44.67	84.94	0.526	0.592	$1X10^8$
10	115.4	160	210.1	44.6	50.1	94.7	0.529	0.547	$2X10^7$
15	119.2	164	213.4	44.76	49.39	94.15	0.525	0.555	$2X10^7$
20	123.5	168	216.5	44.49	48.47	92.96	0.521	0.568	$3X10^7$

It is interesting to note the effect of single dopant displays a good TL peak having good shape intensity and temperatures the overall TL pattern observed is interesting. Since the phosphor has to be coated in the CFL of fluroscent lamp the same is also can used as a dosimeter the position of the glow peak is at 155^0C in both the phosphors indicating that the electron traps involved are deep enough and high energy is required to release the trapped electrons; hence long storage of trapped charge carriers at normal working temperature is achieved and thus the thermal stability is ensured.

Table-2
The trap depth for the prominent glow peaks of the studied $SrY_2O_4:Eu^{3+}$, evaluated from second order kinetics

Methods	5 min UV	10 min UV	15 min UV	20 min UV
E (eV) = T_m(K)/500	0.31	0.32	0.32	0.33
$E(eV) = 23KT_m$	0.30	0.31	0.32	0.33
$E(eV) = 38KT_m$	0.50	0.52	0.53	0.55
$E\ (eV) = \frac{2KT_m^2}{\delta}$	9.26	8.80	9.38	0.10
$E_\omega = C_\omega \frac{KT_m^2}{\omega} - b_\omega(2KT_m)$	4.76	4.32	4.58	4.95
$E_\tau = C_\tau \frac{KT_m^2}{\tau} - b_\tau(2KT_m)$	0.02	2.0	2.31	0.02
$E_\delta = C_\delta \frac{KT_m^2}{\delta} - b_\delta(2KT_m)$	6.76	6.42	6.74	7.16

Conclusion

Followings are the main conclusions drawn from the studies of TL in Eu dope SrY_2O_4 phosphors irradiated by UV source: The glow curves are found to be a second order kinetics. Trap depth calculated by different methods are found to be 0.31 eV to 7.16eV.

The frequency factor was calculated and its numerical value lies between $2X10^7$ to $1X10^8$

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