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Studies on thermoluminescence parameters of erbium doped Y_2O_3 nanophosphors

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Abstract
The thermoluminescence (TL) glow curve of Y_2O_3:Er^{3+} with different radiation time has been studied. The experimental glow curve shows the presence of two peaks at linear heating rate 10°C/min. The activation Energy and frequency factor are determined by thermoluminescence glow curve.

Keywords: Thermoluminescence, Trapping Parameters, combustion synthesis.

INTRODUCTION

Nanocrystalline materials have been recognized as having tremendous potential in the field of luminescence and thus are on the brink of revolutionizing the display and imaging industry. Many commercially available technological devices employ inorganic polycrystalline materials doped with lanthanide or transition metal ions as their main emissive components. Once preparation methods were available to synthesize these phosphors in the nanometer regime, researchers compared the properties of these new luminescing materials versus already established commercially available materials and produced some very positive findings.[1]

Yttrium oxide (Y_2O_3) is the most attractive doping host for rare earth metals because they are close in ionic radius to yttrium (0.881 Å for Er^{3+} and 0.892Å for Yb^{3+}) and, can therefore, be incorporated in large amount without significant lattice distortions[2]. Y_2O_3 was chosen as host due to its high refractory properties with a melting point of about 2450°C, a very high thermal conductivity of 33 W/m/K, and a density of 5.03 g cm^3. Y_2O_3 is a suitable material for photonic waveguide due to its high energy band gap of 5.8 eV [3].

EXPERIMENTAL DETAILS

The powder nanophosphors Y_2O_3:Er^{3+} were prepared by combustion reaction. Erbium nitrate (99.99% sigma Aldrich), yttrium nitrate (99.99% sigma Aldrich), and Urea (99%, CDH) were used as starting raw materials to prepare Y_2O_3:Er^{3+}.The synthesis reaction is [4]

$$(2-2x)Y(NO_3)_3 + 2x\,Re(NO_3) + 5\,(NH_2)_2\,CO \longrightarrow (Y_{1-x}RE_x)_2O_3 + 5CO + 8N_2 + 10H_2O$$

Where Re = Rare earth nitrates.

The Thermoluminescence recording system Nucleonix TL 10091 was used for recording TL glow curves. The system is capable of providing linear heating at any desired rate.

RESULTS AND DISCUSSION

Thermoluminescence(TL) characteristics

The experimental thermoluminescence glow curve of UV irradiation Y_2O_3:Er^{3+}nanophosphors was recorded at different UV radiation time 5,10,15,20 min with a linear heating rate 10˚C/min. The variation in the TL intensity with temperature was shown in fig 1 for 20 min UV radiated Y_2O_3:Er^{3+} sample and similarly fig 2 shows the comparison glow curves of Y_2O_3:Er^{3+} after irradiation with different time 20, 15,10,5 min for 10°C/min heating rate.

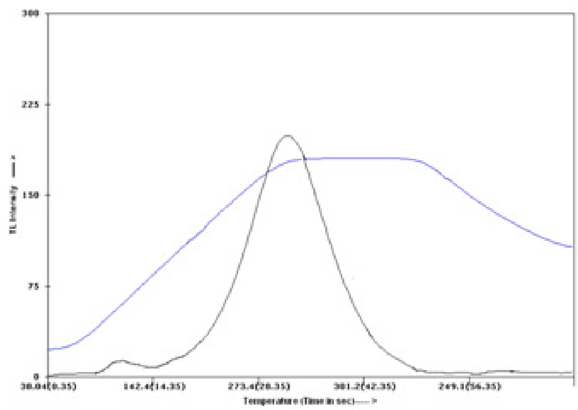

Fig 1. Glow curve of Y_2O_3:Er^{3+} UV irradiation time 20 min at heating rate 10°C/min.

In TL glow curve two peak were observed, one prominent peak is observed at around 280.75°C with another peak at around 135.52°C. The TL intensity of both peak increases with increasing UV irradiation time. The TL glow curve symmetry factor (μ_g) is calculated. The peak parameters, peak temperature, full width , shape factors are shown in Table I. The TL parameters activation energy for first and second peak was calculated by using the half width method and are found to be 0.761, 0.796 , 0.808 and 0.698eV for first peak. Similarly the activation energy for second peak are found to be 1.50eV, 1.65 eV, 1.66eV and 2.11eV for 5min, 10min, 15min, 20min radiation time respectively. The frequency factor(S) is of the order of between 10^{10} to 10^{20} s^{-1} for first peak and second peak and was calculated by half width method, using the expression (i) and is shown in table II

$$S = \beta^*E / K^*T_m{}^2 * e^{(E/KTm)} \quad \text{------(i)}$$

Where β = Heating Rate.
E = Activation Energy.
K = Boltzmann Constant
T_m= Peak Temperature.

Table I. Shape factor (μ_g) for second peak of $Y_2O_3:Er^{3+}$ irradiated by UV-rays for different time with 10°C/min heating rate.

Dose	T_m	$\tau = (T_m - T_1)$	$\delta = (T_2 - T_m)$	$\omega = (T_2 - T_1)$	$\mu_g = \delta/\omega$
20	280.75	26.23	9.5	30.24	0.31
15	278.80	9.79	10.87	20.42	0.53
10	278	24.01	15	39	0.38
5	274.37	22.38	18.65	41.03	0.45

Fig 2 shows the comparison glow curves of $Y_2O_3:Er^{3+}$ after irradiation with different time (20, 15,10,5 min) for 10°C/min. This shows that as we go on increasing the radiation time TL intensity increases. The maximum intensity was shown for 20 min for 10°C/min heating rate. This due to the fact that as the temperature rises the electrons are released from the trap and recombination takes place reducing the concentration of trapped holes and increasing the thermoluminescence intensity. As the electron traps are progressively emptied the rate of recombination decreases and thus the thermoluminescence intensity decreases accordingly. This produces the characteristic thermoluminescence peak [4-6].

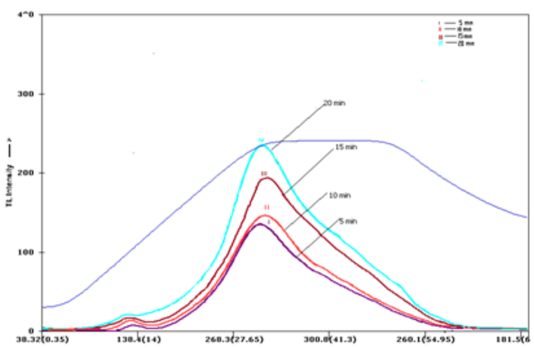

Fig 2. TL glow curve of $Y_2O_3:Er^{3+}$ for different UV radiation time.

Table II. showing the values of frequency factor and activation energy of UV radiated $Y_2O_3:Er.^{3+}$ samples for 10°C/min.

S. no	Different irradiation time of UV light	TL Glow Curves		Frequency Factor		Activation Energy	
		First glow peak *Temp* (°C)	*Second glow peak* *Temp* (°C)	*First Glow Peak* (s^{-1})	*Second Glow Peak* (s^{-1})	*First Glow peak* (eV)	*Second Glow peak* (eV)
1.	5 min	121.27	274.37	$8.99*10^{10}$	$1.135*10^{15}$	0.761	1.50
2.	10 min	134.63	278	$1.14*10^{11}$	$2.36*10^{16}$	0.796	1.65
3.	15 min	135.77	289	$1.52*10^{11}$	$1.42*10^{16}$	0.808	1.66
4.	20 min	137.52	280.75	$0.54*10^{10}$	$3.93*10^{20}$	0.698	2.11

CONCLUSION

Er^{3+} doped Y_2O_3 phosphors, has been successfully prepared via combustion method using urea as an oxidizer. The TL property of $Y_2O_3:Er^{3+}$ has been investigated for different UV radiations at 10°C/min and it was found the TL glow curve is maximum for 20 min radiation.

REFERENCES

[1] Vetrone F, Christopher J, Capobianco J. A, *J of Applied Physics, 96 (2004) 661.*

[2] Polman A, *J. Applied Phys*, 82(1997),1-37.

[3] Anh T, Benalloul P, Barthou C, Giang L T, Vu N, Minh L, *J of nanomaterials*, 48247(2007)10.

[4] Mckeever, S. W. S., *Thermoluminescence of Solids*, Cambridge solid state science series, Oklahoma state university 396, 1-100 (1988).

[5] Anh T.K, Minh Q, Vu N, *J of luminescence*, 102-103 (2003) 391-394.

[6] Choubey A.K, Bhramhe N , Bisen D.P, *The Open Nanoscience Journal,* 2011, *5,* (Suppl 1-M3) 41-44.