

Significance of the computerized techniques in Glow Curve analysis of thermoluminescent materials

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ABSTRACT

The article reports the significance of the Glow Curve Analysis of the irradiated doped phosphors by various techniques with special emphasis on the CGCD(computerized glow curve deconvolution technique).

The need to analyze a glow curve and to know the trapping parameters in principle helps in understanding stability Vs. fading properties of the signal.

The usability of the thermoluminescent material is based on its kinetic parameters i.e Order of kinetics (shape factor),activation energy and frequency factor. As an example, for a prepared sample of erbium doped Calcium Zirconate, CGCD has been used as an advanced tool to analyse its thermoluminescence behaviour showing its possibility of being a potential candidate for application where more stability and less fading is principally desired.

Keywords

CGCD,Glow curve, kinetic parameters, thermoluminescence,phosphor

I. INTRODUCTION

Recently, luminescent properties of rare earth doped perovskite-type compounds have received considerable attention due to their potential advantages i.e. chemically stable and environment-friendly material system and free from hazardous elements such as sulfur and cadmium [1]. Perovskite-type alkaline earth zirconates ($MZrO_3$, $M = Ca, Sr$ and Ba) are also attractive as the host material [2]. Eu^{3+} -doped $CaZrO_3$ exhibits intense red luminescence under UV excitation [3-5]

Calcium zirconate, $CaZrO_3$, also known as lakargiite is a refractory compound, which congruently melts at $2340^\circ C$ [6]. In terms of crystalline structure, $CaZrO_3$ is an orthorhombic perovskite consisting of slightly deformed $[ZrO_6]$ octahedral and $[CaO_8]$ [7, 8]. At $1750^\circ C$ $CaZrO_3$ undergoes polymorph transformation where orthorhombic $CaZrO_3$ to cubic $CaZrO_3$ [9].

The kinetic parameters one may get may be considered as empirical magnitudes characterizing the TL components but noting the large variations of parameters reported in the literature for the same TL peaks, such results should be accepted with a pinch of salt.

RESULTS AND DISCUSSION:

The TL glow curve is related to the trap levels lying at different depths in the band gap between the conduction and valence bands of the solid. These trap levels are characterized by different trapping parameters such as trap depth, order of kinetics and frequency factor. Thus liable dosimetry study of the thermoluminescent material is based on trapping parameters.

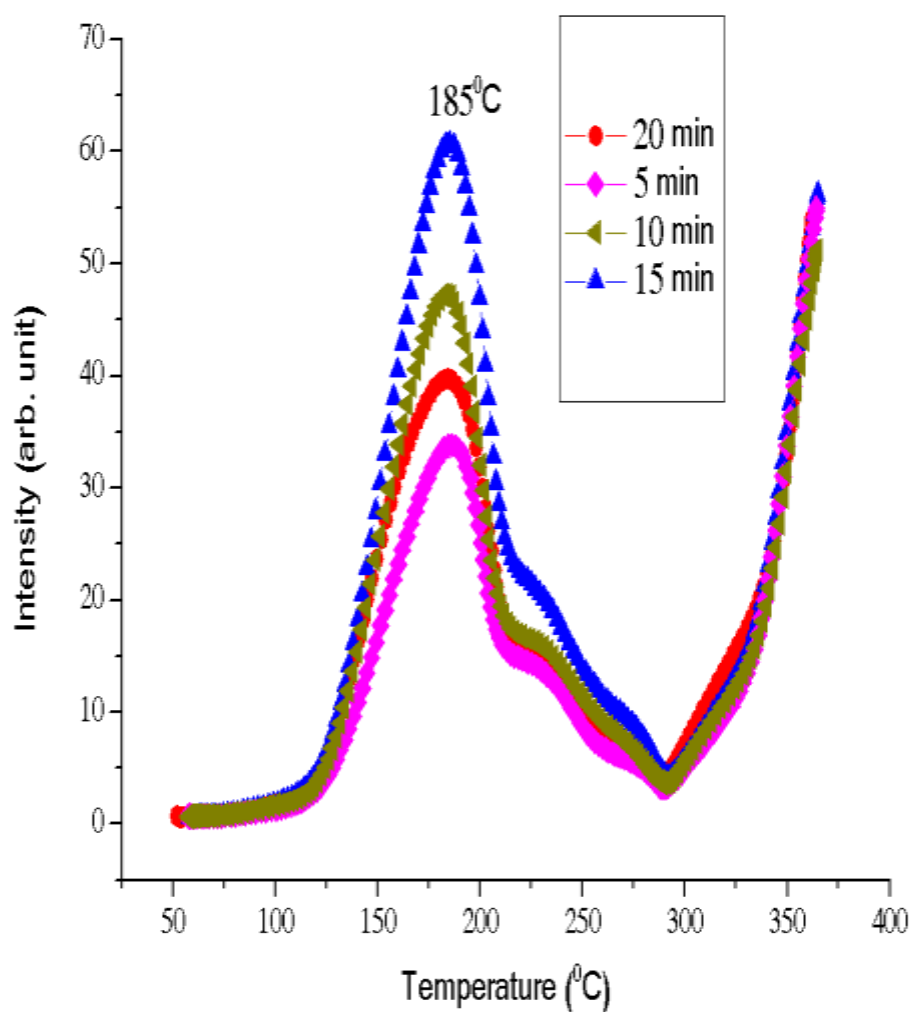


Figure1: TL glow curve for $\text{CaZrO}_3:\text{Er}^{3+}$ (1%) for Variable UV exposure time

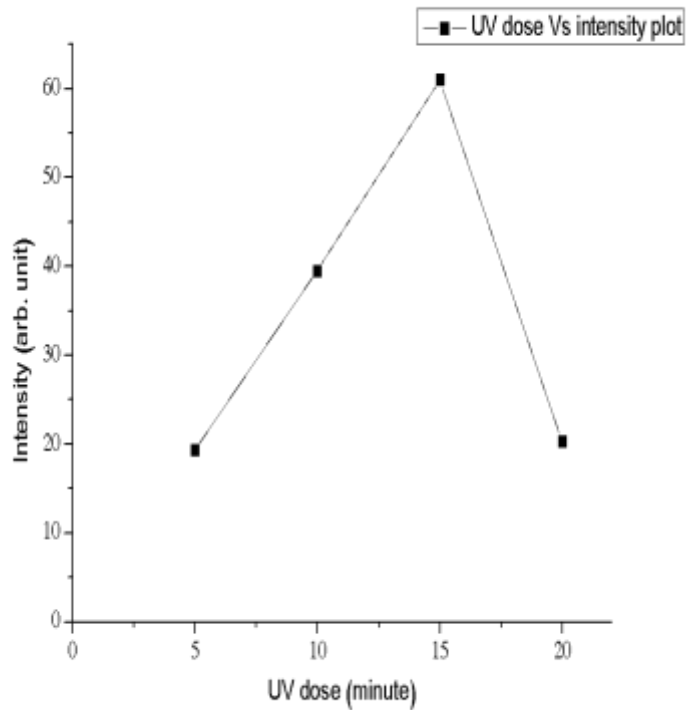


Figure 2:UV dose Vs Intensity plot for $\text{CaZrO}_3:\text{Er}^{3+}$

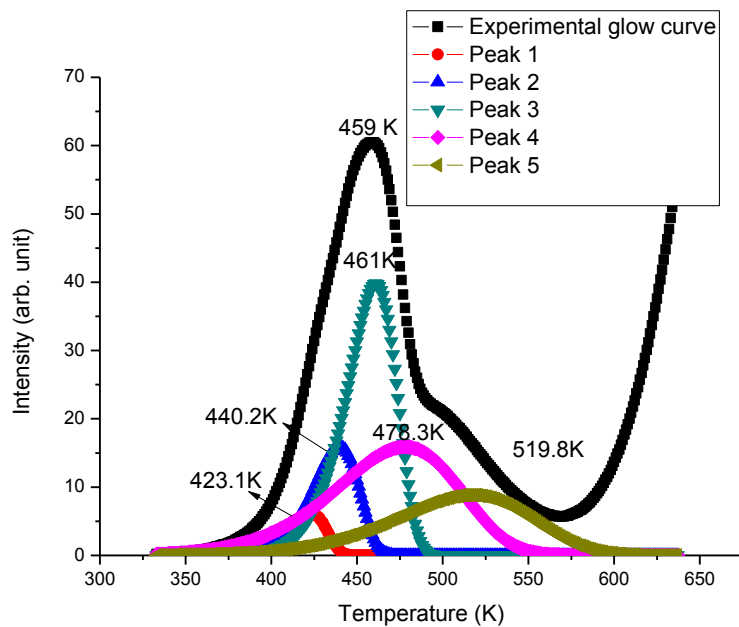


Figure 3: CGCD curve of $\text{CaZrO}_3:\text{Er}^{3+}$ (1%) for 15 minute UV exposure time

The TL glow curve obtained may be analyzed using software that fits the curve by some predefined function – Gaussian's or Poisson's. CGCD. is used to analyse the glow curve. Depending upon the equation used in the fitting process the following parameters could be obtained:- Activation Energy E (eV), Frequency factor or escaping factor S (/s), the initial no. of trapped electrons, the concentration of the trapping states, the order of kinetics b and the ratio of retrapping and recombination probabilities ($R_n = A_n/A_m$).

II. CONCLUSION

It is concluded that from the above study that erbium doped phosphor shows high temperature TL glow curve centered at 185°C for CaZrO_3 host. It gives information that more stability and less fading found in the sample. The trap parameters such as order of kinetics, activation energy or trap depth and frequency factors are calculated using peak shape method by CGCD technique. It gives more information about trap centers in broad TL glow curve. The estimated kinetic parameters for $\text{CaZrO}_3:\text{Er}^{3+}$ phosphor is calculated by curve fitting techniques CGCD curve of experimental data and the peak shape method proposed by Chen and others. The activation energy is found in between 0.52 to 1.34 eV and the frequency factor is range of 1×10^5 to 5×10^{15} for UV irradiated phosphor.

To analyse the glow curve of the phosphor sample using computerized glow curve deconvolution technique and need to develop optimum TL model and optimum method to analyze and extract all the information from the glow curve with quite accepted accuracy and precision.[10]

III. RESEARCH METHODOLOGY

Phosphor of CaZrO_3 doped with Er^{3+} ions with fixed molar concentration of Er^{3+} (1 mol%) was prepared by solid state reaction method. The precursors were CaCO_3 , ZrO_2 , Eu_2O_3 and H_3BO_3 (as flux) used for synthesis of $\text{CaZrO}_3:\text{Er}^{3+}$ doped phosphor. The composition of each chemical weighed in proper stoichiometric ratio then mixed thoroughly for 45 minutes using mortar and pestle. The grinded sample was placed in an alumina crucible and subsequently fired at 1000°C for 1 hour for calcinations and then at 1250°C for 3 hours for sintering in a muffle furnace. Every heating was followed by intermediate grinding. The obtained phosphor under the TL examination is given UV radiation using 254 nm UV source Thermoluminescence glow curves were recorded at room temperature by using TLD reader I1009 supplied by Nucleonix Sys. Pvt. Ltd. Hyderabad.

Table 1: Shape factor, Activation energy, and frequency factor for 15 minute UV irradiated $\text{CaZrO}_3:\text{Er}^{3+}$ (1%)

Peak	T_1	T_m	T_2	τ	δ	ω	$\mu = \frac{\delta}{\omega}$	Activation energy (E)	Frequency factor(s)
Peak1	407.6	423.10	434.90	15.50	11.80	27.30	0.43	1.34	3×10^{15}
Peak2	421.2	440.20	452.90	19.00	12.70	31.70	0.40	1.24	5×10^{13}
Peak3	440.2	461.00	475.50	20.80	14.50	35.30	0.41	1.22	7×10^{12}
Peak4	433.0	478.30	512.60	45.30	34.30	79.60	0.43	0.58	1×10^5
Peak 5	463.7	519.8	558.7	56.10	38.90	95.00	0.41	0.52	1×10^5

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Table 1: Shape factor (μ), activation energy (E), and frequency factor (s) for 15 minute UV irradiated $\text{CaZrO}_3:\text{Er}^{3+}$ (1%) phosphor [11].