International Journal of Luminescence and its applications
Vol 3, No. 1, Jan 2013, Article ID: 022, pages 87 – 90

Non-exponential shape of OSL decay curve and their correlation with thermoluminescence

Y. D. Kale[#], Y.H. Gandhi[**] and D.R. Joshi[**]

[#]A D Patel Institute of Technology, New Vallabh Vidyanagar, Anand-388121, Gujarat, India
[**]Luminescence Research Laboratory, Applied Physics Department, Faculty of Technology & Engineering, The M. S. University of Baroda, Vadodara-390001, Gujarat, India.

Abstract
The Optically Stimulated Luminescence (OSL) decay curves are recorded near room temperature under different physical conditions to the specimen. The shapes of OSL decay curves are non-exponential in nature with loss of OSL signal at definite level of the physical treatments. Optically released electrons might have re-trapped either into same level or different localities other than well known 110°C TL level are attributed to the observed changes in OSL decay curves. The initial stimulation peak time for the OSL decay curve and TL glow curve followed by OSL are also recorded to confirm the present suggestion based on the correlation work.
Keywords: annealing treatment, dose, OSL TL,

1. INTRODUCTION

The Optically Stimulated Luminescence (OSL) is well-known method for dating and dosimetry applications and advantageous tool over the TL (Thermoluminescence) technique **[1]**. It has established the definite correlation between OSL output and TL traps in quartz. To resolve this correlation for better luminescence efficiency, the significant works have been carried out on the OSL of quartz at elevated temperatures rather than near room temperature **[2-3]**. The usual exponential shape of decay curves have suggested a faster OSL response corresponding to traditional rapidly bleachable TL traps **[4]**. An earlier part of the OSL curve, the decay is observed quite slowly in nature which corresponds to non-exponential shape of OSL decay. However, researchers have not paid enough attention over such part of OSL decay. To enhance the luminescence efficiency they involved in suggesting suitable elevated temperature OSL protocols **[2]**.

The present works have interest to throw the light on non-exponential shape of decay and corresponding responsible TL traps. To understand this OSL decay curves are recorded near room temperature under different physical treatments to synthetic quartz material. The non-exponential shape is controlled by the definite level of the physical treatments is observed. It is attributed to optically released electrons but not from well known traditional rapidly bleachable traps which have re-trapped either into same level or different localities other than 110°C TL level. The initial stimulation peak time (time taken by the curve before decay initiates) (ISPT) for the OSL decay curve and TL glow curve followed by OSL are also recorded to support the present results.

2. EXPERIMENTAL DETAILS

Sample:

- Laboratory grown Synthetic Quartz Crystal **[5]**,
- Grains: 0.063-0.053mm

Protocol-1:

- Un annealed sample + 5.04Gy beta dose + TL at RT (25°C).
- AQ at 600°C and 1000°C, 1hr + 5.04Gy beta dose + TL at RT (25°C).

Protocol-2:

- AQ at 400°C, 600°C and 1000°C, 1hr + 0.42-302.4Gy beta dose + OSL at RT + TL at RT.

Instruments:

- Mortar and pestle for grinding the sample

* Corresponding author: Email: ydkale1@rediffmail.com
Journal ISSN No: ISSN 2277 – 6362

- Muffle Furnace for annealing treatment (1200^{o}C ± 1^{o}C accuracy).
- Beta (Sr90) Irradiation source (dose rate of 0.084Gy/sec).
- RISO (TL/OSL-DA-15) TL/OSL Reader; 470nm wavelength for stimulation.

3. RESULTS AND DISCUSSION

To understand the correlation between TL traps and non-exponential shape of OSL decay pattern, it is essential to record the thermoluminescence glow curves near room temperature followed by different physical treatments to the sample prior to OSL.

The sample, annealed at 1000^{o}C for 1hour duration followed by 5.04Gy beta dose, is more sensitized compared to un-annealed and 600^{o}C annealed sample. Significant enhancement in TL signals to the order of 10^{6} counts is observed. It also helped to grow new stable TL peak near 220^{o}C even though sample was annealed for higher durations. Such significant observations are not displayed in the 600^{o}C treated samples of identical dose and annealing duration **[Fig.1]**.

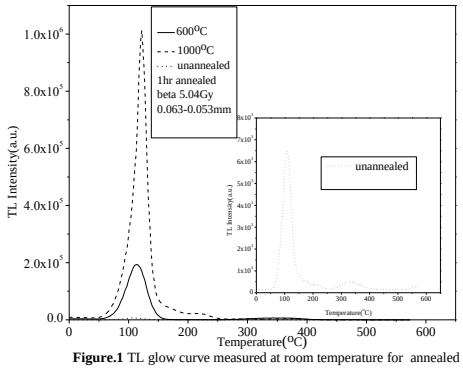

Figure.1 TL glow curve measured at room temperature for annealed

In order to investigate, the non-exponential shape of decay and corresponding responsible TL traps the OSL decay curves are also recorded for 400^{o}C, 600^{o}C and 1000^{o}C annealed sample for one hour duration followed by different beta doses. The 400^{o}C treated sample exhibits the non-exponential pattern for each dose compared to 600^{o}C and 1000^{o}C annealed samples. Such pattern has started disappearing from 5.04Gy beta irradiated sample or higher doses of 600^{o}C annealed specimen. However, it is eliminated for 1000^{o}C annealed sample **[Fig.2-4]**.

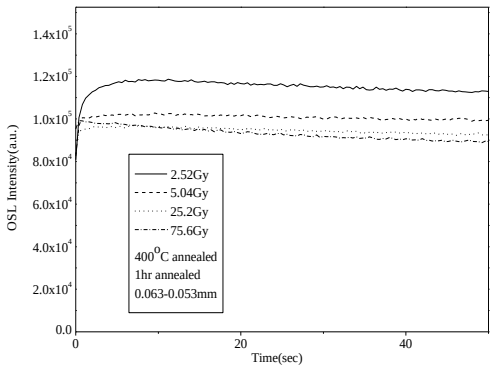

Figure.2 OSL measured at room temperature of 400^{o}C annealed sample for 1hr duration at different doses.

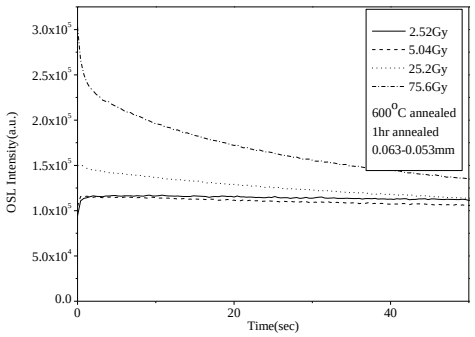

Figure.3 OSL measured at room temperature of 600^{o}C annealed sample for 1hr duration at different doses.

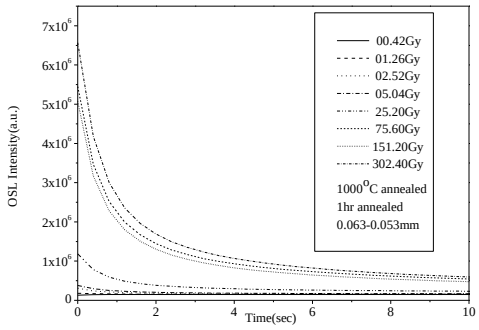

Figure.4 OSL measured at room temperature of 1000^{o}C annealed sample for 1hr duration at different doses.

Researchers have reported that an exponential shape of decay curve is responsible to fast components of the OSL which gives lower initial stimulation peak time and non-exponential shape is correlated to the slow components of the OSL which exhibits higher initial stimulation peak time **[6]**. In present study the slow OSL decay is observed for each exposed to 400^{o}C and partially

to 600°C annealed samples. But the pattern of decay is shifted toward faster decay in nature by reducing the initial stimulation peak time **[Table.1]**.

Table-1. The OSL and ISPT are recorded for under different physical treatments.

Grain Size	AQ (°C)	AQ (Hr)	Beta Dose (Gy)	ISPT (sec)	OSL Intensity (a.u.)
0.063-0.053mm	400°C	1	2.52	11.2	118641
			5.04	9.6	102797
			25.2	6.8	96922
			75.6	0.4	99198
	600°C	1	2.52	10.8	117115
			5.04	1.2	115922
			25.2	0.4	150807
			75.6	0.0	302812

It can also be explained with changes in OSL intensity. The OSL intensity did not increase with the dose even though pattern of decay is diverted to exponential shape of decay curve. It is clearly suggested that electrons from optically sensitive traps did not released much during stimulation. Further, it is resolvable clearly that, electrons which are de-trapped; it might be re-trapped either into same location or in other level. It is justified by the recording TL glow curves followed by optical stimulation for identical annealed samples **[Fig.5-7]**.

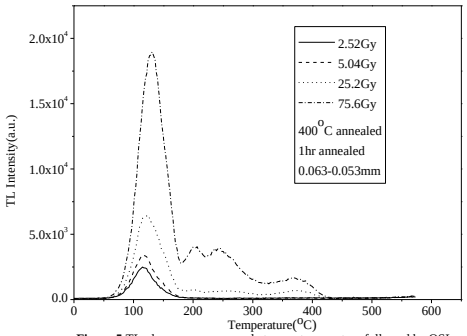

Figure.5 TL glow curve measured at room temperature followed by OSL for 400°C annealed sample.

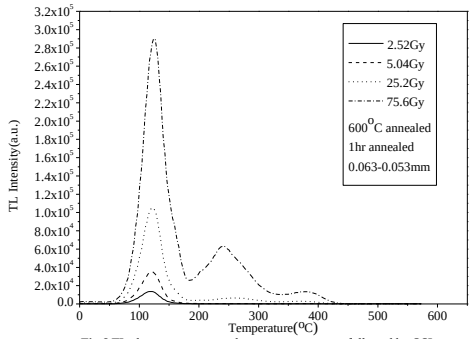

Fig.6 TL glow curve measured at room temperature followed by OSL for 600°C annealed sample.

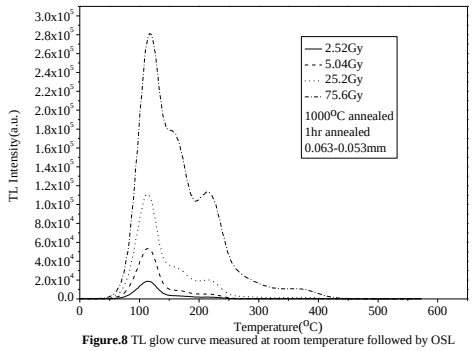

Figure.8 TL glow curve measured at room temperature followed by OSL for 1000°C annealed sample.

TL results followed by stimulation have reported the little growth of 375°C TL peak along with 210°C TL peak during higher exposures for lower annealed samples. It is also noticed that the non-exponential pattern of decays are absent either for higher exposed sample (> 25Gy) even for low annealing treatment (400°C) or lower exposed sample (5.04Gy) for 1000°C annealed material. This may be attributed to particular growth of new TL traps corresponding to 210°C peak followed by implemented protocol.

4.0 CONCLUSION

Either at lower dose or lower annealing temperature, the non-exponential shape of decay curves is responsible to re-trapped the optically released electrons into same trap, deep trap and different levels. It is confirmed by the growth of TL glow peaks at 210°C and 375°C followed by OSL under identical physical conditions. to the sample.

ACKNOWLEDGEMENT

The authors are greatly thankful to Prof .R K Gartia, Department of Physics, Manipur University, Imphal, Manipur for experimental support.

References:

1. Huntley et al., Nature. 313 (1985) 105.
2. S. W. S. Mckeever et al., Radiation Measurements. 27 (1997) 161.
3. Y. D. Kale and Y. H. Gandhi, Indian Journal of Pure and Applied Physics 47 (2009) 413.
4. R. M. Bailey et al., Radiation Measurements. 27 (1997) 123.
5. P. Saha et al., Trans. Indian Ceram. Soc. 50(5) (1991) 129.
6. R. M. Bailey, Radiation Measurements. 32 (2000) 233.