

## EFFECT OF DURATION OF POST IRRADIATION HEAT TREATMENT (PIHT) ON OSL OF ANNEALED SYNTHETIC QUARTZ

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Keywords: synthetic quartz, annealing treatment, beta dose, thermal transfer effect, optically stimulated luminescence

Abstract

The optically stimulated luminescence (OSL) decay curves were recorded at 160°C followed by post irradiation heat treatment at 290°C for 0sec, 5sec, 10sec and 30sec to annealed synthetic quartz. The 400°C and 1000°C annealed samples showed increase in OSL intensity with rise in duration of post irradiation heat treatments up to 10seconds. This is due to growth of 210°C TL peak along with 375°C TL peak. The decrease in OSL intensity with further rise in duration of post irradiation heat treatments to 30seconds is attributed to existence of  $375^{\circ}C$  TL peak only.

#### 1. Introduction

From dating application aspect, thermal sensitivity, dose response, fading and bleaching properties are studied for quartz material [1]. In case of fading; the loss of signals during the storage of the material. the charges may escape from thermoluminescence (TL) traps, which reduce the efficiency of the substance. Several workers [2] have suggested the new protocol of thermal treatment followed by irradiation, in which, the trapped charges can be transferred to fast component of optically stimulated luminescence(OSL) by selecting suitable heat treatment.

In the present investigation, annealed samples followed by 25.2Gy beta dose, are heated to 290°C for different durations. The OSL decay curves are recorded at 160°C followed by post irradiation heat treatment. Remarkable changes in OSL signals are observed in 1000°C annealed sample compared to lower temperature annealed samples. It is attributed to the significant growth of 210°C TL peak along with 375°C TL peak. The initial stimulation peak time (time is taken by curve before decay start) is recorded to resolve the shape of decay curves under influence of identical physical conditions. In order to support to these studies, TL glow curves are recorded at room temperature followed by optical stimulation.

### 2. Experimental Details

Sample: Synthetic Quartz Crystal[3] 0.063-0.053mm grain

# Protocol:

400°C, 600°C and 1000°C annealed, 1hr

23.20y

Preheat 290°C for 0sec, 5sec, 10sec, and 30sec

OSL at 160°C

#### Instruments:

Mortar and pestle for grinding the sample Muffle Furnace for annealing treatment (1200°C ± 1°C accuracy). Beta (Sr90) Irradiation source (dose rate of 0.084Gy/sec). RISO (TL/OSL-DA-15) TL/OSL Reader

#### 3. Results and Discussions

The optically stimulated luminescence (OSL) decay curves of different annealed synthetic quartz.are recorded at 160°C followed by PIHT at 290°C for 0sec, 5sec, 10sec and 30sec. The initial stimulation peak time is recorded for these samples to resolve the behavior of OSL decay curves. Fig.1a-1d show that 400°C annealed sample exhibits non-exponential shape of decay curves at lower duration of PIHT of 0 second. It shifts toward exponential side by changing the initial stimulation peak time to 0.4 seconds from 43.2 second with rise in duration of PIHT. This initial stimulation peak time does not change much for 600°C annealed sample. It is reported that shape of decay is still non-exponential in nature by small fraction of 0.4sec initial stimulation peak time, even though OSL is recorded at elevated temperature followed by post irradiation heat treatment. Noticeable changes are observed in 1000°C annealed sample, in which, the shape of decay is exponential at each duration of PIHT.

<sup>↓</sup> 25.2Gy beta dose





**Figure.1a** OSL measured at 160°C followed by PIHT at 290°C for 0sec for different annealing temperatures.



**Figure.1b** OSL measured at 160°C followed by PIHT at 290°C for 5sec for different annealing temperatures.



**Figure.1c** OSL measured at 160°C followed by PIHT at 290°C for 10sec for different annealing temperatures.



**Figure.1d** OSL measured at 160°C followed by PIHT at 290°C for 30sec for different annealing temperatures.

In further investigations, The OSL intensities are recorded with duration of PIHT for different annealed samples.



**Figure.2** OSL measured at 160°C followed by different duration of PIHT for different annealing temperatures.

**Fig.2** shows that lower temperature annealed sample ( 400°C exhibits the growth of OSL intensity with rise in durations of PIHT at 0sec, 5sec and 10sec. The changes in OSL signal is observed in an identical sample by further rise in duration of PIHT to 30sec, in which, the OSL output is diminished to 107711a.u. form 111219a.u. Similar pattern of decay curve is observed to 1000°C annealed sample of identical exposure. The magnitude of OSL intensity is suddenly enhanced by 30 to 35 times higher than the OSL intensities of 400°C and 600°C annealed samples with the identical durations. The remarkable changes in OSL signal with rise in durations



of post irradiation heat treatment are not seen in 600°C annealed sample.

Murray et al. [4] suggest that the OSL intensity increases by decreasing the initial stimulation peak time which gives exponential shape of OSL decay curve otherwise it is considered as a non-exponential decay curve. In present case, the initial stimulation peak time decreases to 0.4sec with rise in duration of PIHT to the lower annealed samples. It is reported that shape of decay curve is shifted to exponential side, but not so clear to exponential nature. The non-exponential shape of decay suggests the re-trapping of optically released charges still occurs either into deep traps or traps above 160°C.

R Chen [6] is suggested the non-exponential shape of decay curve belongs to non-first order of kinetics. There may be due to lack of available of recombination centers to recombine the electrons. The exponential decay, observed to higher annealed sample, may due to growth of new centers corresponding to Ge center. It is confirmed by the recording of TL glow curve at room temperature to identical annealed samples (Fig.3).



Figure.3 TL measured at room temperature for different annealed samples prior to PIHT protocol.

Zimmerman [7] has reported the higher thermal treatment helps to push the hole from L center from R-center and during stimulation; the concentration of these centers is decreased. It may responsible to the reduction of OSL. For the growth of OSL with duration of PIHT may have two reasons; one during post irradiation heat treatment charges are thermally transferred to TL traps above 290°C. Those transferred to rapidly bleachable traps give noticeable OSL. Secondly, with further rise in duration of PIHT, the charges may transferred to slowly bleachable traps or recombine with holes. It is justified

by the growth of 210°C TL peak along with 375°C (Fig.4).



**Figure.4** TL measured at room temperature after OSL at 160°C followed by different duration of PIHT at 290°C for different annealed samples.

#### Conclusion

The growth of 210°C TL peak (Ge center) along with 375°C TL peak is responsible for rise in OSL with duration of PIHT in higher annealed sample. The PIHT transfers the charges to either into fast component of OSL or slow component of OSL, which are responsible to the changes in shape and intensity of OSL decay curves.

Acknowledgement The authors are thankful to Prof. R.K. Gartia, Department of Physics, Manipur University, Imphal, India for providing experimental facility (sponsored project by DST) and research discussion.

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