CHAPTER - 6

CONCLUSIONS

The synthetic quartz exhibited radiation induced TL peaks at 108°C-140°C, 210°C-230°C and 350°C-375°C. The TL emission of the specimen comes form $(GeO_4)^-$ centers and $(AlO_4)^0$ center. This has been confirmed with ESR studies also. The 110°C TL peak in synthetic quartz specimen varies between 89°C-150°C. This variation in peak position is suggested to be due to various physical treatments like pre-thermal treatment, duration of pre-heat treatment and irradiation etc. The changes in TL glow curve pattern are attributed to the influence of the physical treatments on defects and relevant color centers. High temperature TL (>250°C) peaks of quartz, is explained on the basis of the recombination of electrons with the hole at Al^{+3}-h^+ centers.

Annealing the material at various elevated temperature creates effect on internal structure of quartz material. The present work revealed the stability of quartz is upto 573°C under normal pressure. The low quartz can convert itself to a high-quartz (beta-quartz) on heating beyond 573°C. The alpha-beta transition is a displacive phase changes. Beyond 573°C of annealing temperature the quartz transforms into beta phase and beyond 870°C of annealing temperature, the specimen transforms into beta to tridymite phase. Such phase transformations are responsible for the significant changes in TL glow pattern of pre-heat treated specimen.

The TL with different pre-heat treatments and doses seem to be due to E_1' (an oxygen vacancy having an unpaired electrons) centers. These finding are also correlated for pattern investigation with the OSL studies. The shape of OSL decay curve is non-exponential either for low pre-thermal treatment (~400°C) or lower beta dose of 25.2Gy. The material exposed to lower dose even with higher pre-thermal treatment as well as the material when given higher dose but lower pre-thermal treatment showed non-exponential OSL decay curve. Changes in any of these conditions give rise to exponential

OSL decay. This shows that the decay shape is dependent upon the sample condition such as the absorbed dose, the illumination intensity, pre-thermal treatment and temperature of sample etc.

It is observed that not only non-multiple component OSL decay nature but the clear increase in OSL as a function of illumination time upto a maximum, before the decay starts for the specimens having implemented below critical protocols such as high dose for lower pre-thermal treatment and/or low dose for higher pre-thermal treatment. Such type of decay nature is attributed to the contribution of shallow traps during OSL measurements at room temperature.

These shallow traps seem to play an important role whenever the OSL process involves stimulation into the delocalized band. It is explained that for lower temperature of annealing the lifetime of the charge in the shallow traps is much longer than the decay time giving rise to small OSL signal due to trapping in the low temperature traps, but re-trapping into deeper, competing traps, re-trapping into optically active traps and non-radiative recombination produces non-exponential decay curve, which is discernible. On raising the temperature of annealing for any dose the OSL increases and also the area under the OSL curve increases. These observations are interpreted on the premise of changes in concentration of luminescence center.

As the duration of pre-thermal treatment increases, OSL also enhances. This is more predominant at certain temperature of annealing such as 600°C and 1000°C. These are also in accordance with the alteration in number of recombination centers. The changes are also due to the phase transformation at these temperatures in quartz, which is in line with explanation given for TL studies.

The TL glow curves after OSL at room temperature exhibited three well-defined peaks 110°C, 230°C and 375°C. But the significant growth of 110°C TL peak is observed compared to 230°C and 375°C. This seems to be due to charge distribution occurred during optical stimulation at room temperature. It is concluded that the 110°C TL peak is responsible for slower and non-exponential OSL decay along with reduction in OSL intensity.

To study this further, the OSL studies were carried out at an elevated temperature of 160°C, which presumably eliminates the contribution of 110°C TL traps. It was found that no significant changes are observed in OSL decay pattern for the specimens given below critical doses and critical pre-heat treatments. However, for the specimens when given higher doses and pre-heat treatments showed the changes in OSL decay pattern. Above critical dose and critical pre-thermal treatment to the specimen gives rise to faster decay. It is attributed to concepts of "thermally assisted process" "thermal quenching process" and "half life" of changes in the shallow trap.

Subsequent TL after OSL at 160°C showed the absence of 110°C TL peak and exhibited two strong peaks at 230°C and 375°C. The higher growth of 230°C TL peak compared to that of 375°C TL peak with rise in either dose or temperature of annealing is attributed to the redistribution of charges taking place during optical stimulation. The redistribution seems to be more probable for the traps corresponding to 230°C. This process finds support of "recuperation process". Redistribution of electrons among the ascribed traps may also be linked with the same luminescence centers responsible for the emission of the TL peaks.

The literature revealed that Post Irradiation Heat Treatment (PIHT) at 290°C might transfer the charges from shallow traps to the OSL traps; so, the PIHT was given for different durations at 290°C. The observations revealed that the PIHT influences the phenomenon of charge transfer in two ways,

(i) Electron transferred from easily bleachable shallow traps to optically active OSL trap, which in turn improves OSL efficiency.

(ii) Transfer of electrons from shallow traps to deep traps at 375°C.

The decrease in OSL level with repeated cycles of record under identical physical conditions can be explained on the basis of rapidly bleachable peak (~325°C). It is suggested that the traps corresponding to 325°C TL peak is continuously emptied during repeated optical stimulation process, which causes the decrease in OSL level. Further, TL after cyclic succession of OSL at 160°C showed that a significant growth of ~230°C TL peak with the rise in temperature of annealing as compared to 375°C. This is clearly due to pre-heat treatments and transferring of electrons during optical stimulation.

Electron Spin Resonance (ESR) studies reveal the results very well in agreement with the findings of TL-OSL studies. ESR signals for the present studies are corroborated to E_I' centers and Ge centers. It grows either with rise in pre-heat treatment or given dose. It was noticed that ESR signal corresponding to E_I' reduces when specimens were given above critical pre-thermal treatment. Further, it was noticed that for such specimen (i.e. specimens with high temperature of annealing) ESR signal corresponding to Ge center starts growing. This significant finding is linked with high temperature (>230°C) TL peaks of the specimen.

Another remarkable observation of changes in ESR signal before UV illumination for specimens pre-heat treated at high temperature is that the signal of E_I' center is weaker compared to Ge center. However, after UV exposure signatures of E_I' center disappears and only signal of Ge center grows.