CHAPTER I

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Though the crystalline structure and defect equilibria of the Alkali halides have been investigated extensively, silicon dioxide crystal also have been subjected to the curiosity of a scientific mind long back. It is the major part of the earth's crust. It is available in various forms, its crystalline form is known as quartz. Single crystals of quartz are widely used in electronic and optical applications and in Metal Oxide Semiconductor (MOS) devices as a thermal Oxide film (1). Point defects play an important role in many of the optical and precision frequency control applications of quartz crystals (2). Therefore, it is necessary to identify and characterise point defects present in the material. The related defect dynamics, under different physical conditions is also important to know. These information provide the interpretations about stability of the material in thermal and radiation background and help to design the devices accordingly. A crystalline variety of silicon dioxide; stable at room temperature, is known as alpha quartz. In nature, alpha quartz is available in the form of sand and rocks like sand stone, quartzite and vain quartz. These imperfections, degrade its electronic properties, while the laboratory grown synthetic quartz single crystals have the reduced levels of twins and imperfections; therefore, natural quartz crystals have
been replaced by such crystals in above mentioned applications (3).

Many workers have developed different techniques to judge defect pattern and related defect dynamics under different physical conditions on this material (4-7). Among these, the thermally stimulated luminescence (TSL) is a highly sensitive technique for the investigation of defects in insulating materials (8).

Thermally stimulated luminescence (TSL) is the emission of light from the pre-excited material, when it is warmed with uniform heating rate. It is also known as thermoluminescence (TL). It has been established that during irradiation the material absorbs the energy, stores it for a long time and reemits it in the form of visible photon, as one desire at any time by supply of heat. It is believed that all varieties of crystalline solids contain varieties structural of imperfections and impurities. Some of them constitute regions of localized positive or negative charges, which are able to attract and bind the charges of opposite signs; such defects are therefore called as "Traps". Analysing TL characteristics one may know about the trap and hence corresponding defect present in it. Probably, it is the most direct evidence available for the existence of electronic trap levels.

Many workers have studied TSL characteristics using natural quartz specimen; this work includes the variation
of physical conditions and other allied studies(9-11). However it could not correlate defect pattern present in this material and TSL characteristics clearly. This is because natural quartz crystal can not provide necessary prior information of the degree and density of the defects present in the material, as these vary from sample to sample. This problem could be solved by taking laboratory grown synthetic quartz crystal, as the exact information of concentration and types of the defects present in the material is known.

The thermoluminescence (TL) of synthetic quartz crystal have been explored recently by several workers(12-16). The attempts have been made to investigate luminescence centres associated with the observed TL. Their interest centred around 110 °C glow peak. Its position varies from 98 °C to 150 °C, the position of this peak depends upon many factors such as growth condition, heating rate, type of pre-treatment etc(17). Some of the people tried to understand defect dynamics of this technologically important crystals, under different physical conditions. Some others have made attempts to study the predose effect and effect of pre-heat-treatment on this specimen. Jani et.al.(18) have correlated TSL results of synthetic quartz with ESR (electron spin resonance) studies. Different authors have suggested responsible mechanism of TL and they also tried to characterize luminescent centres associated with the emission, very few people have attempted to characterize the trapping levels in this
It is believed that defect present in the material is associated with the trapping level. Hence, there is a direct correlation between defect state and trapping state. The change in defect level under the influence of any physical condition presumably brings change in corresponding trapping level. Kinetics of corresponding trapping state has great influence on shape and size of the glow curve which in turns, also affects the trap spectroscopic information. Thus, the change in defect state under different physical conditions affect the trap spectroscopic information. In order to understand defect dynamics, under different physical conditions clearly, the trapping level characterisation is highly essential.

In the present work, special attention has been paid to characterise the trapping levels of this material under different physical conditions. The effect of different physical conditions on these levels have been investigated systematically. In order to do this special computerised curve fitting dilute approximation method is used. The extracted trap spectroscopic information have been interpreted in terms of suggestions made, based on TL studies of this specimen; carried out under different physical conditions. In studies of pre-heat treatment, the duration of pre-thermal treatment is also varied in addition to the temperature of anneal which nobody paid that much attention.
Therefore, the thermoluminescence glow curves and trap level characteristics have been examined in detail for synthetic quartz crystal under three different physical conditions namely—annealing the specimen at different elevated temperature followed by sudden air-cooling, annealing them for different duration and different incident beta-doses. The experimental results obtained are presented in the thesis; indicated interesting changes in the TL behaviours and trap spectroscopic data. The observed changes have been explained on the basis of present understanding of TL in synthetic quartz. The optical absorption and X-ray diffraction studies exhibited in the thesis have also strengthened the interpretation offered, for TL in synthetic quartz crystal. It is inferred that the present results will facilitate the professionals to select the synthetic quartz for suitable application.
REFERENCES


