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Thermoluminescence Dosimetry Study of Natural Quarts Mineral Used as Base Material of Ceramic Tiles

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Abstract

This paper deals with the Thermoluminescence (TL) dosimetry work. This paper represents the growth studies of natural quarts mineral used as raw material in ceramic tiles. A comparative TL study of Quartz minerals as received and treated with annealing and quenching at 400^0C, was carried out by applying different beta radiation dose as 2.5Gy, 5Gy, 10Gy, 25Gy, 50Gy, 75Gy, 150Gy, 300Gy, 600Gy., The results indicate that the material shows excellent dosimetric behavior.

Introduction:

In the present scientific world, ionizing radiations have been found very useful in engineering, medicine, science and technology. Professionals used them at every walk of life. In all the applications, the exact amount of absorption of radiation energy in the exposed material is important factor to get the desired results. Better use of radiation can be achieved mostly by accurate determination of energy absorbed from the radiation field and it possible the distribution of this absorbed energy within the material. Measurements of these quantities form the basis of radiation dosimetry and systems used for this purpose are referred as dosimeters. In TSL dosimetry the relationship between the TSL signal and the absorbed dose to be measured must be determined by an appropriate calibration [1] .

Many natural mineral are used to manufacture floor tiles for household floorings. The demand of a variety of flooring materials has lead to develop various types of ceramic tiles. In India the ceramic industry is one of the fastest growing industries, more than 500 manufacturing units of ceramic tiles, vitrified tiles and sanitary wares are situated at Morbi (Rajkot District, Gujarat state, India). Many natural minerals are used as the raw materials for the manufacturing ceramic wares. The minerals used in manufacturing the ceramic tiles are Quartz, Feldspar, Zircon, Talc, Frit-O, Frit-T, Aluminium oxide, Sodium trypoly phosphate China clay, Bikaner clay, etc. Most of the minerals are from mines in Gujarat and few are from Rajasthan state and imported from Russia. The phenomenon of TL has been studied by many investigators. The thermoluminescence (TL) study in geology, particularly for natural minerals, is an important research tool [2]. The TL study of minerals commonly used in ceramic tiles industry, such as Quartz gives better understanding about their properties. The systematic study of TL of such minerals is helpful to solve the basic raw materials quality problem the ceramic tiles industries. [3].

Quartz:

The purest natural crystalline form of silica is quartz, containing more than 99.95% SiO_2. The other abundant sources of silica are the acid igneous rocks, sands, sandstones and quartzite containing varying amounts of impurities. In all these raw materials SiO_2 exists in the form of ∝-quartz. Flint, which is a mixture of chalcedony and quartz, is also used as a source of silica in some countries. [4].

Under optical microscope, quartz is identified by its colorless, nonpleochroic habit in plane polarized light; shape is commonly anhedral, often found as perfect euhedral crystal. It does not show any cleavage, but some conchoidal fractures are observed within the grains. Anisotropic under cross polarized light, quartz shows first order interference color which is highly variable (grey, yellow etc.). It gives adulatory or patchy extinction which is one of the most characteristic features of Quartz especially in metamorphic rocks. Refractive index is low, slightly higher than Canada balsam (1.55), the outline being feebly visible in plane polarized light. Quartz grains often show numerous tiny vitreous inclusions of other minerals. Quartz is distinguished from alkali Feldspar by its positive relief in balsam, lack of alteration and cleavage. Quartz lacks the multiple twinning of most Feldspar and differs from the untwined oligoclase by uniaxial figure and lack of cleavage.

Uses : Quartz is widely used in the manufacture of soda-lime-silica glass and white wares. Quartzite containing about 98% SiO_2 are used for the manufacture of silica bricks, used in steel making furnaces, specially at the roof of an acid open-hearth, checkers, converter etc. They are also used in coke-ovens and the roof of glass tank furnace. For refractory use, the combined Al_2O_3 and TiO_2 should be < 2.5% and for superior qualities < 1%. With Na_2O and K_2O < 0.1% CaO < 0.3% and MgO < 0.1%, quartzite are considered to be of suitable quality.

The pure, untwined, clear and transparent quartz crystals possess piezo-electric properties and are used in telecommunication. Quartz is also the source of element silicon, used in the manufacture of non-oxide ceramics (e.g. SiC, Si_3N_4) and ferro-silicon..

Experimental method:

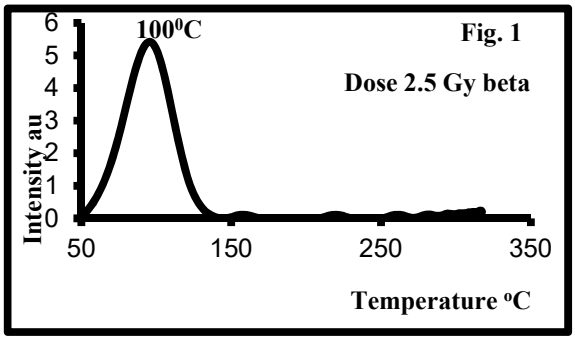
Thermal Annealing Treatment:

Thermal annealing for the specimen was carried out in the muffle furnace. The laboratory muffle furnace has temperature range up to 1200°C and the size of chamber for sample heating was 22cm × 10cm × 10cm. The temperature was maintained with ±1°C accuracy using a temperature controller, which supplied required current to the furnace. Power supply of 230V was provided to the furnace. A silica crucible containing a powdered form of virgin specimens was kept in the furnace at required annealing temperature for desired time. After completion of annealing duration the specimens were rapidly air-quenched to room temperature by withdrawing the Alumina crucible on to a ceramic block. Such material or specimens are called

"annealed and quenched" or "thermally pre-treated specimen"[5].

The natural Quartz minerals used in manufacturing ceramic tiles were collected from the industry. Most of the materials used for the TL analysis were indigenous ones and a few were imported minerals. TL of Quartz mineral was recorded using TL set-up supplied by Nucleonix Systems, Hyderabad. Irradiation was carried using Sr-90 beta source. Equal quantities of samples (5 mg) were used for the analysis. The heating rate was maintained as 1^0 C /Second.

TL growth study of Quartz sample treated with AQ 400^{0}C



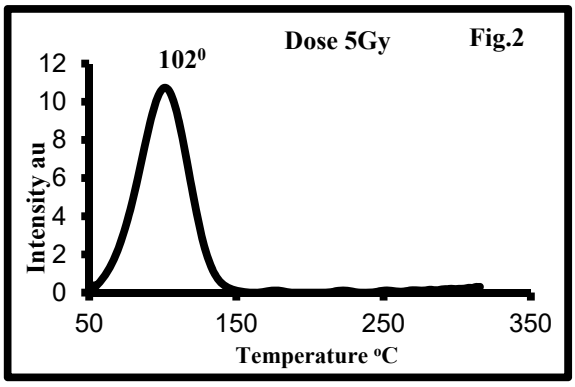
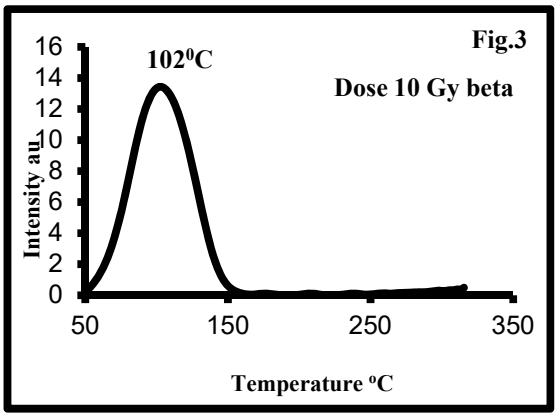


Fig.1 shows the TL Glow curve of sample treated with annealing and quenching temperature at 400^{0}C and irradiated with beta dose of 2.5Gy by Sr^{90}.here glow curve exhibits one well resolved glow peak at temperature 100^{0}C with intensity of 5.42au. [6].

Fig.2 shows the TL Glow curve of sample treated with annealing and quenching temperature at 400^{0}C and irradiated with beta dose of 5Gy by Sr^{90}.here glow curve exhibits one well resolved glow peak at temperature 102^{0}C with intensity of 10.72au.



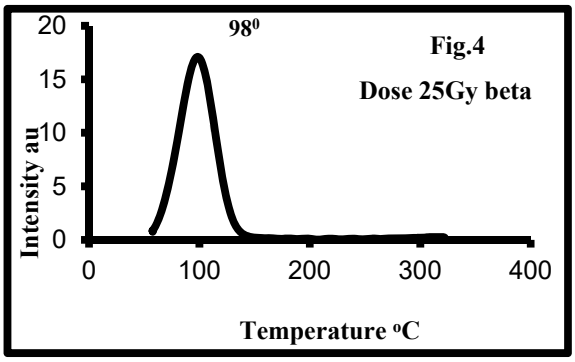
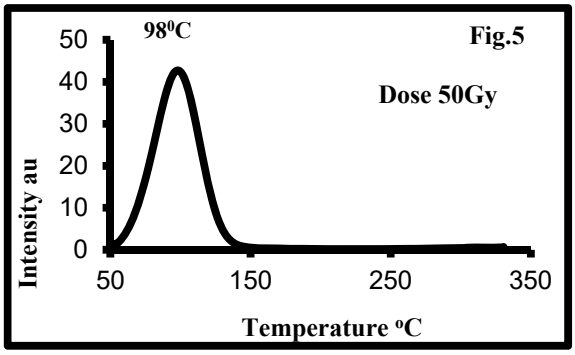


Fig.3 shows the TL Glow curve of sample treated with annealing and quenching temperature at 400^{0}C and irradiated with beta dose of 10Gy by Sr^{90}.here glow curve exhibits one well resolved glow peak at temperature 101^{0}C with intensity of 13.42au. [7].

Fig.4 shows the TL Glow curve of sample treated with annealing and quenching temperature at 400^{0}C and irradiated with beta dose of 25Gy by Sr^{90}.here glow curve exhibits one well resolved glow peak at temperature 98^{0}C with intensity of 17.08au. [8].



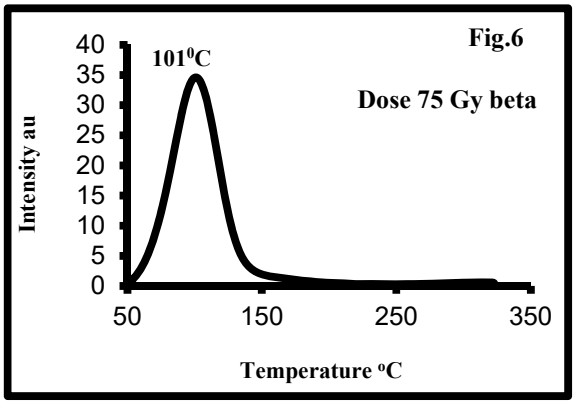
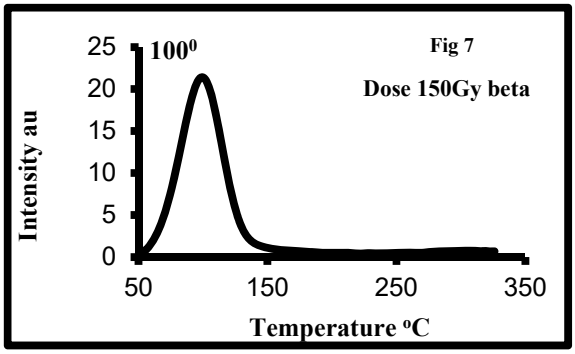


Fig.5 shows the TL Glow curve of sample treated with annealing and quenching temperature at 400^0C and irradiated with beta dose of 50Gy by Sr^{90}.here glow curve exhibits one well resolved glow peak at temperature 98^0C with intensity of 42.72au[9].

Fig.6 shows the TL Glow curve of sample treated with annealing and quenching temperature at 400^0C and irradiated with beta dose of 75Gy by Sr^{90}.here glow curve exhibits one well resolved glow peak at temperature 101^0C with intensity of 34.52au. [10].



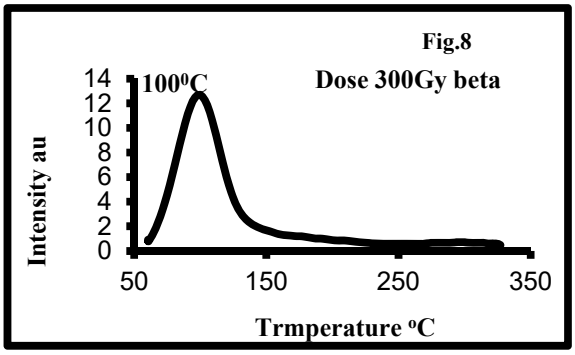


Fig.7 shows the TL Glow curve of sample treated with annealing and quenching temperature at 400^0C and irradiated with beta dose of 150Gy by Sr^{90}.here glow curve exhibits one well resolved glow peak at temperature 100^0C with intensity of 21.41au.

Fig.8 shows the TL Glow curve of sample treated with annealing and quenching temperature at 400^0C and irradiated with beta dose of 300Gy by Sr^{90}.here glow curve exhibits one well resolved glow peak at temperature 100^0C with intensity of 12.69au .

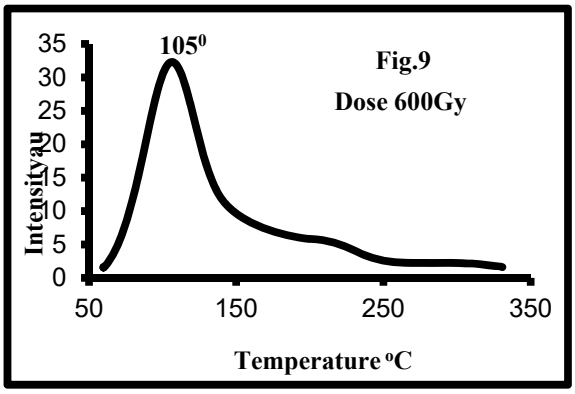
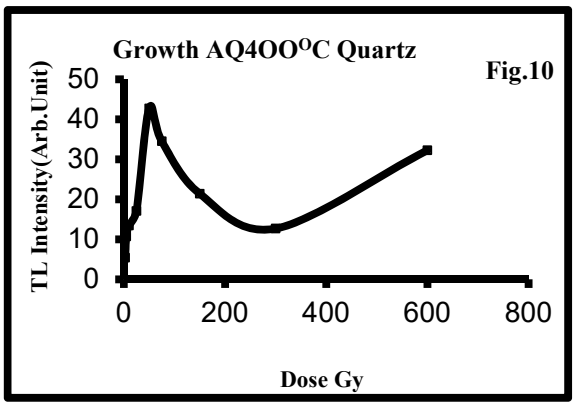


Fig.9 shows the TL Glow curve of sample treated with annealing and quenching temperature at 400^0C and irradiated with beta dose of 600Gy by Sr^{90}.here glow curve exhibits one well resolved glow peak at temperature 105^0C with intensity of 32.27au. It can be noted that after irradiation beyond 150Gy, another weak glow peak around 215ºC is observed.

The results indicate that after heat treatment of AQ 400^0C, the material shows significant TL and the

intensity of the TL increases with dose, except dose at 75Gy, 150Gy, and 300Gy; this is either due to partial recombination of radiation induced defect centres or depletion of luminescent centres.



Conclusions:

- The TL growth study of Quartz sample treated with AQ 400^{0}C shows interesting result. From the result, it is noted that the after heat treatment of AQ 400^{0}C the material shows significant TL result and the intensity of the TL is increased with dose, except at doses 75Gy,150Gy, and 300Gy. TL shows saturation effect .i.e. .intensity is decreased with radiation dose.
- The result shows good dosimetric behavior of the Quartz mineral.

Fig.10 shows the growth graph of Quartz sample treated with annealing and quenching temperature at 400^{0}C and irradiated with different beta dose by Sr^{90}.

Sr.No.	Dose Gy	Peak Temp.^{o}C	Peak Intensity au
1	2.5	95	5.42
2	5.0	102	10.72
3	10	101	13.42
4	25	98	17.08
5	50	98	42.72
6	75	101	34.52
7	150	100	21.41
8	300	100	12.69
9	600	105	32.27

Above table shows the peak temperature and peak intensity of the Quartz sample treated with annealing and quenching temperature at 400^{0}C and irradiated with different beta dose by Sr^{90}.

References:

1. K.V.R. Murthy and J.N. Reddy Thermoluminescence basic theory application and experiment , Feb.2008, Pub. Nucleonix, Hyderabad.
2. K V R Murthy , Y S Patel , A S Sai Prasad, V Natarajan , A G Page , 2003 *Radiation Measurements* **36** 483.
3. S.Kumar, Source Book of Ceramic, 19
4. K.V.R Murthy , V. Natarojan, M.D Shastri- Lumilnscence & it ‘s Applications February, 2009
5. R. Debnath , H.K. Kundu , M.D. Shastri, K.V.RMurthy – Luminscence & it ‘s Applications February -21-2009
6. K. Mahesh, P.S Weng – C. Furetta – Thermmo. Luni. India Solids And It ‘s Application , 1971
7. Y.H Gandhi, “Thermoluminescence and allied studies of synthetic quartz and its application”, Ph.D. Thesis, pp83, 1995
8. H.C.Mandavia,K.V.R.Murthy, Euration Chemico technical Journal, Volume-13,November 1-2,2012,ISSN-1502-3920
9. H.C.Mandavia,K.V.R.Murthy ,International Journal of Luminescence and Application,Volume-1(11),ISSN2277-6362,p129 to 132 ,8/6/2012
10. H.C.Mandavia,K.V.R.Murthy International Journal of Luminescence and Applications, Volume-2(1),ISSN-2277-6362,pp-15- 18,9/8/1