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Thermoluminescence Dosimetry study of Feldspar Mineral Used as Base Material of Ceramic Tiles

H.C.Mandavia[1],K.V.R.Murthy[2],
M. M. Science college,Morbi, Gujarat,India[1], M.S. University of Baroda[2],
email : himaphysics@yahoo.com

Abstract

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. The better use 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.

This paper deals with the Thermoluminescence (TL) dosimetry work. This paper represents the growth studies of natural Feldspar mineral used as raw material in ceramic tiles. The comparative TL study and discussion of glow curve of Feldspar minerals as received and treated with annealing and quenching at 500^{0}C, by applying different beta radiation dose as 2.5Gy, 5Gy, 10Gy, 25Gy, 50Gy, 75Gy, 150Gy, 300Gy, 600Gy,The tables indicating peak temperature and peak intensity is also furnished. The results shows excellent dosimetric behavior of the material.

1.0 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. The better use 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.

In TSL dosimetry the relationship between the TSL signal and the absorbed dose to be measured must be determined by an appropriate calibration. Thermoluminescent Dosimeters (TLDs) have found increasing application with the progress made in the development of solid thermoluminescent dosimeters and instrumentation for reading them. Many TLD based systems are now commercially available, and are widely used in routine personal dosimetry, environmental monitoring and clinical radiation dosimetry. The extreme sensitivity of TSL for detecting the presence of defects, as few as 10^9 within a specimen is beneficial for detecting low radiation levels which are encountered in personal and environmental monitoring.

The application potential of TL-dosimeter is very high. They have been found very useful in many fields on account of several favorable characteristics such as high sensitivity, small size, ability to cover wide range of exposure / dose, reusability, insensitive to environmental conditions . In the past professionals had used the film budge technique in real practice. Later on they found that TLD technique is better for many reasons. And hence during last three to four decades they have developed and established the TLD technique. This is became popular now-a-days prominent applications of thermoluminescence dosimetry and radiation protection. The dosimeters have been widely used for in-phantom and in-vivo dosimetry, in medical applications. Another area, where thermoluminescence dosimeters have found use is personal monitoring of radiation workers.

Feldspar is the most important group of rocks forming silicate (tectosilicate) minerals. The acid intrusive rocks (pegmatite) are the chief source of Feldspars.

Uses : Feldspar is a common flux and is used in various types of ceramic bodies, the fluxing action depending on the amount and type of alkalies present. Unlike pegmatites and nepheline syenites, feldspar has a rather slow fluxing action due to the high viscosity of the melt. Potash feldspar is generally preferred in ceramic glazes. Potash spar fuses at cone 8 to 9 as compared to cone 4 for some high soda spars. In a fired body it increases the strength, hardness and coefficient of expansion and improves the transluscency and vitrification.

Feldspars are also used in glazes, enamels and glass as a cheap source of alkalies. For use in glass, the ferric oxide content should be less than 0.2%, silica not more than 67% and alumina not less than 17%. Potash spars are more commonly used in glass since pure varieties are more abundantly available.

1.1 Experimental:

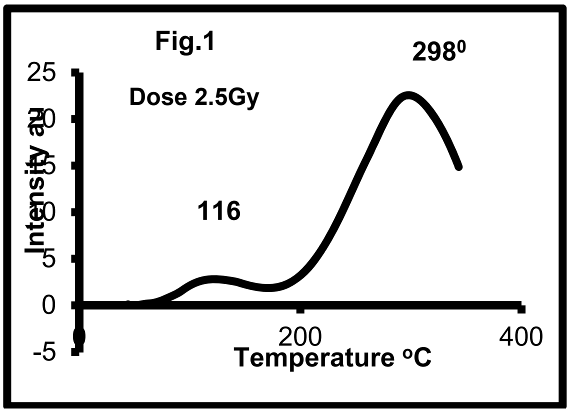
The natural Feldspar minerals used in manufacturing ceramic tiles are collected from the ceramic tiles industry. First make a fine powder of such mineral and then 5mg powder of mineral are taken and placed this powder for irradiation of Beta source Sr ^{90} . The source capacity is 500rad./min, after irradiation the sample is placed into the TL(Thermoluminescence)reader. TL of these minerals 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.

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 silica crucible on to a ceramic block. Such material or specimens are called "annealed and quenched" or "thermally pre-treated specimen".

After the heat treatment all the samples are recollected into the particular zip bag indicating their code

Result and Discussion :



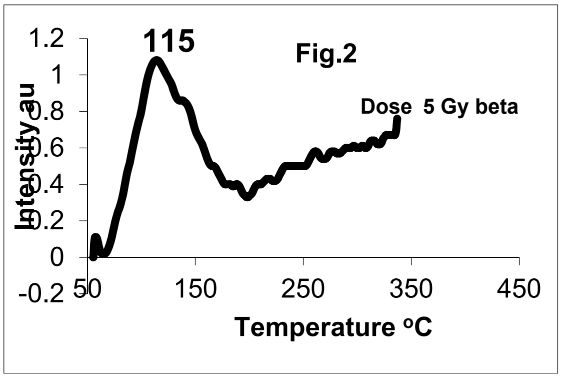
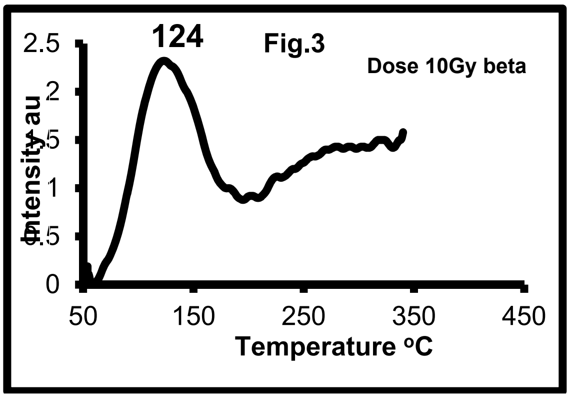
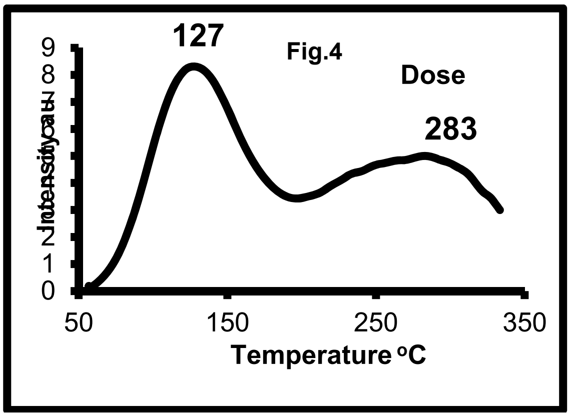


Fig. 1 shows the glow curve of Feldspar sample treated with AQ500^{0}C and irradiated with beta dose of 2.5Gy by Sr^{90}.Here glow curve exhibits one kink at temperature 55^{0}C and one broad peak at temperature109^{0}C and intensity 1.0au. also humps are developed in to the glow curve.

Fig. 2 shows the glow curve of Feldspar sample treated with AQ500^{0}C and irradiated with beta dose of 5Gy by Sr^{90}.Here glow curve exhibits one kink at temperature 58^{0}C and one peak at temperature115^{0}C and intensity 1.08au. also humps are developed in to the glow curve.





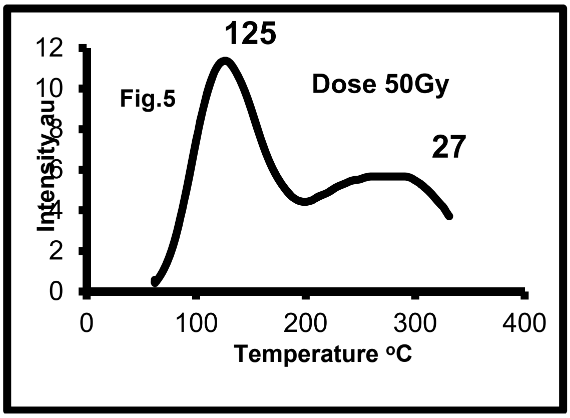
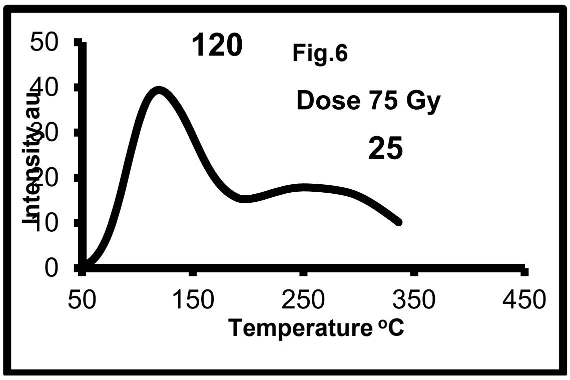


Fig.3 shows the glow curve of Feldspar sample treated with AQ4500^{0}C and irradiated with beta dose of 10Gy by Sr^{90}.Here glow curve exhibits one kink at temperature 52^{0}C and one peak at temperature124^{0}C and intensity 2.32au. also humps are developed in to the glow curve.

Fig. 4 shows the glow curve of Feldspar sample treated with AQ500^{0}C and irradiated with beta dose of 25Gy by Sr^{90}.Here glow curve exhibits one well resolved glow peak at temperature 127^{0}C and intensity of 8.31 and one broad peak at temperature 283^{0}Cand intensity 5au .



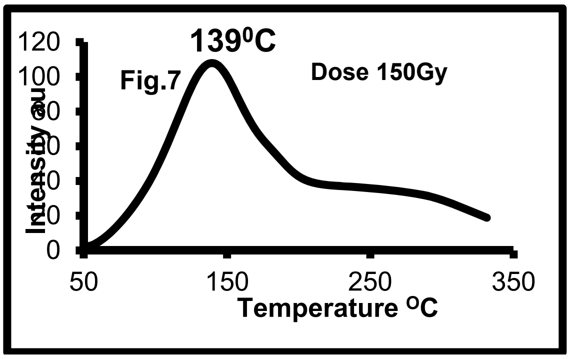


Fig.5 shows the glow curve of Feldspar sample treated with AQ500^{0}C and irradiated with beta dose of 50Gy by Sr^{90}.Here glow curve exhibits one well resolved glow peak at temperature 125^{0}C and intensity of 11.37 and one broad peak at temperature 271^{0}C and intensity 5.67au .

Fig.6 shows the glow curve of Feldspar sample treated with AQ500^{0}C and irradiated with beta dose of 75Gy by Sr^{90}.Here glow curve exhibits one well resolved glow peak at temperature 120^{0}Cand intensity of 39.4

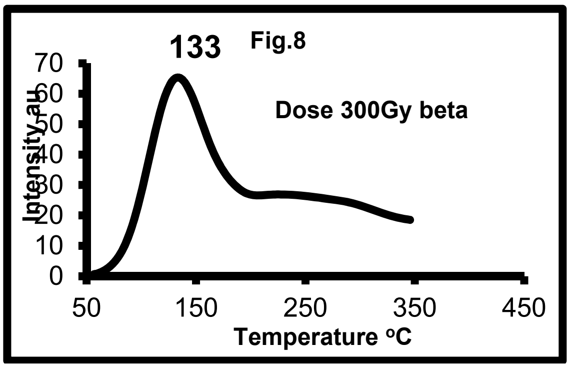
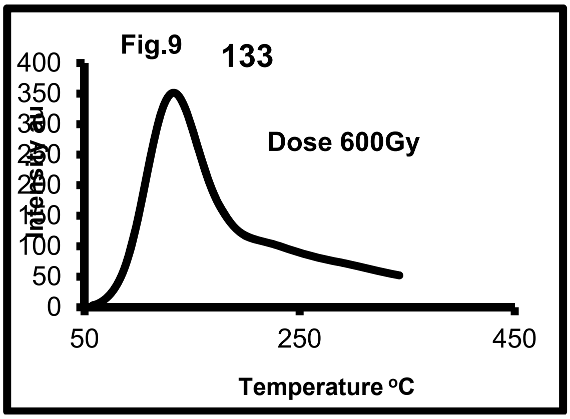


Fig.7 shows the glow curve of Feldspar sample treated with AQ500^{0}C and irradiated with beta dose of 150Gy by Sr^{90}.Her glow curve exhibits one well resolved glow peak at temperature 139^{0}C and intensity of 108au, here second peak is vanished and the intensity of first peak is increased high level.

Fig.8 shows the glow curve of Feldspar sample treated with AQ500^{0}C and irradiated with beta dose of 300Gy by Sr^{90}.Here glow curve exhibits one well resolved glow peak at temperature 133^{0}C and intensity of 65au .here intensity is decreased it exhibits fading effect.

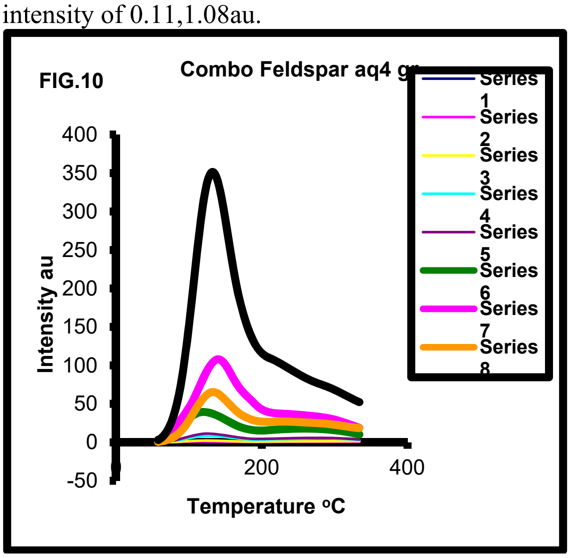
Fig. 9 shows the TL glow curve of Feldspar sample treated with AQ500^{0}C and irradiated with beta dose of 600Gy by Sr^{90}.Here glow curve exhibits one well resolved glow peak at temperature 133^{0}C and intensity of 351.36au .here intensity is increased but peak temperature remain constant.



From the results of above TL growth study of Feldspar sample treated with AQ500^{0}C shows that irradiated sample of 2.5Gy, 5Gy, and 10Gy, dose exhibits one kink and one peak also some humps are formed into the glow curve .irradiated sample of 25Gy, 50Gy,and 75Gy, dose exhibits one well resolved peak and one broad peak with increasing in intensity ,irradiated sample of 300Gy exhibits one peak at temperature 139^{0}C and intensity of 65au.here intensity is decreased, at irradiation dose of 600Gy highest intensity 351.36au is recorded .

Fig.10 shows combined TL glow curve of Feldspar sample treated with AQ500^{0}C and irradiated with different dose of beta radiation by Sr^{90} .Curve S1 shows the TL glow curve of the material irradiated with dose of 2.5Gy, the glow curve exhibits one peaks at temperature 109^{0}C with intensity of 0.13au.

Curve S2 shows the TL glow curve of the material irradiated with dose of 5Gy, the glow curve exhibits two peaks at temperature 58^{0}C, 115^{0}C with intensity of 0.11,1.08au.

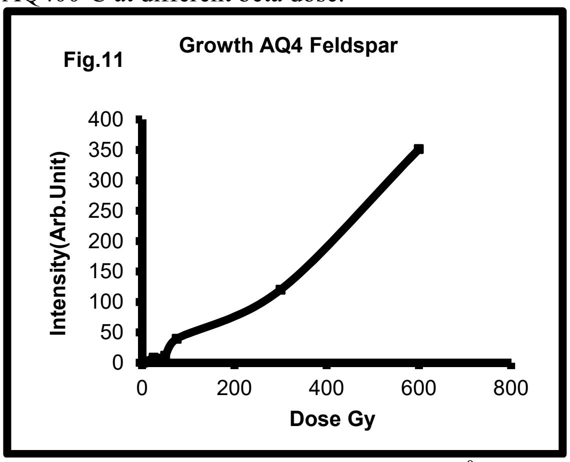


Curve S3 shows the TL glow curve of the material irradiated with dose of 10Gy, the glow curve exhibits one peaks at temperature 124^{0}C with intensity of 2.32au. Curve S4 shows the TL glow curve of the material irradiated with dose of 25Gy, the glow curve exhibits one peak at temperature 127^{0}C with intensity of 8.31.Curve S5 shows the TL glow curve of the material irradiated with dose of 50Gy, the glow curve exhibits one peak at temperature 125^{0}C with intensity of 11.37au. Curve S6 shows the TL glow curve of the material irradiated with dose of 75Gy, the glow curve exhibits one peak at temperature 120^{0}C with intensity of 39.4au. Curve S7 shows the TL glow curve of the material irradiated with dose of 150Gy, the glow curve exhibits one well resolved peak at temperature 139^{0}C with intensity of 108au. Curve S8 shows the TL glow curve of the material irradiated with dose of 3000Gy, the glow curve exhibits one well resolved peak at temperature 133^{0}C with intensity of 65au. Curve S9 shows the TL glow curve of the material irradiated with dose of 600^{0}Gy, the glow curve exhibits one well resolved peak at temperature 133^{0}C with intensity of 351.36au.

Table-1

Sr.No.	Dose Gy	Peak Temperature °C	Peak Intensity(Arb.Unit)
1	2.5	109	0.13
2	5.0	58, 115	0.11, 1.08
3	10	124	2.32
4	25	127	8.31
5	50	125	11.37
6	75	120	39.4
7	150	139	108
8	300	133	65
9	600	133	351.36

Table-1 shows the peak temperature and peak intensity of Feldspar treated with temperature AQ400^{0}C at different beta dose.



(Growth graph of Feldspar AQ500^{0}C)

Fig. 11 shows the growth graph of Feldspar sample treated with temperature AQ500^{0}C at different beta dose.

Conclusions:

- The TL growth study of as received Feldspar sample shows interesting results. From the result it is noted that the TLpeak Intensity is increased with increased in radiation dose it indicate the excellent dosimetric behavior of the material.
- The results are also useful in Geological research and forensic point of view.
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