

Thermoluminescence Study of Based Materials of Ceramic Tiles

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Abstract

Many flooring materials most of them are in natural form are used to manufacture floor tiles for household flooring purpose. The peoples demand for variety of flooring material Leeds to develop various types of ceramic tiles. In India ceramic industry is fast growing one, more then 500 units of manufacturing ceramic tiles, vitrified tiles and sanitary ware, situated around Morbi, Rajkot, Gujarat, India. Many natural minerals are used as the raw materials required for the manufacturing ceramic ware. The following minerals are used to manufacturing the ceramic tiles i.e. Quartz, Feldspar, Zircon, Talc, Grog, Alumina oxide, etc. Most of the minerals are from Indian mines of Gujarat and Rajasthan states, some of are imported from Russian sub continent. The present paper reports the thermoluminescence characteristics of Feldspar, Alumina and Quartz minerals collected from the ceramic tiles manufacturing unit, Morbi. The as received minerals TL was recorded (NTL), and annealed and quenched from 400°C followed by 15Gy beta dose given from Sr-90 beta source TL was recorded and the comparative TL (Thermoluminescens Study) study of above materials are presented and it represent some special characteristics of the materials.

Keyword: NTL– Natural Thermoluminescence, TL- Thermoluminescence.

Introduction

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 then 200 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. The TL study of minerals commonly used in ceramic tiles industry, such materials gives better understanding about their properties and characteristics. The systematic study of TL of such minerals is helpful to solve the basic raw materials quality problem the ceramic tiles industries.

Experimental method: The natural minerals used in manufacturing ceramic tiles are collected from the ceramic tiles industry. Most of the materials used for the TL analysis were indigenous ones and a few were imported minerals. First make a fine powder of such mineral and then 5mg powder of each

materials are taken and placed this powder between circular ring and then put Sr ⁹⁰ Beta source on it for twenty min. for irradiation. The source capacity is 500rad./min. after irradiation the sample is collected from the circular ring and placed into the TL (Thermoluminescence) reader. TL of these minerals was recorded using TL set-up supplied by Nucleonix Systems, Hyderabad¹. Irradiation was carried using Sr-90 beta source. Equal quantities of samples (5 mg) were used for the analysis.



Figure-1
High temperature Furnace



Figure-2

Taking out the samples from high temperature furnace

Table-1
 Beta-Radiation Source

Strontium-90	
General	
Name, symbol	Strontium-90, ⁹⁰ Sr
Neutrons	52
Protons	38
Nuclide data	
Half-life	28.8 years
Decay products	⁹⁰ Y
Decay mode	Decay energy
Beta decay	0.546 MeV



Figure-3

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”

Results and Discussion

TL Study of Quartz: Figure-4 is the TL of 5mg of weighed powder was taken to record TL glow curve of Quartz (NTL) without any pre heat treatment and irradiation. The glow curve exhibit one hump like glow peak at temperature at 332°C. There is no good TL is observed.

Figure-5 shows TL glow curve of Quartz irradiated with beta dose of 15 Gy using Sr⁹⁰. Here one peak occurs at temperature 110°C and intensity of 1.83 au here little TL is recorded. It is noted that after irradiation one trap developed and released carrier during the TL measurement.

Figure-6 is the TL glow curve of Quartz annealed and quenched from 400°C and given a beta dose of 15 Gy using Sr-90 beta source. TL glow curve of 400°C AQ sample of Quartz exhibits one well resolved and isolated TL peak with high intensity around 100°C. This peak is interesting TL peak in dosimetric point of view.

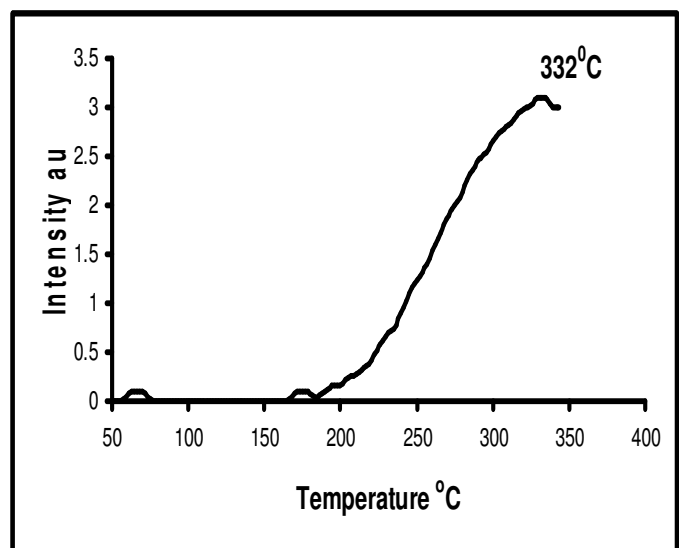


Figure-4

TL of 5mg of weighed powder

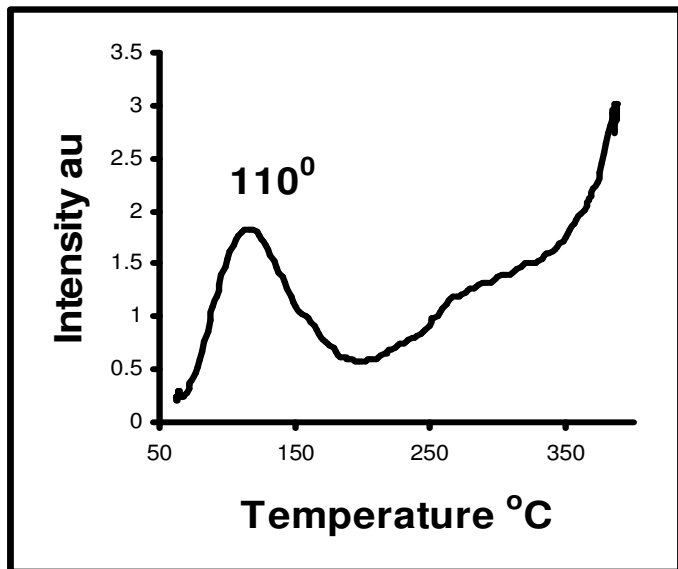


Figure-5
 TL glow curve of Quartz

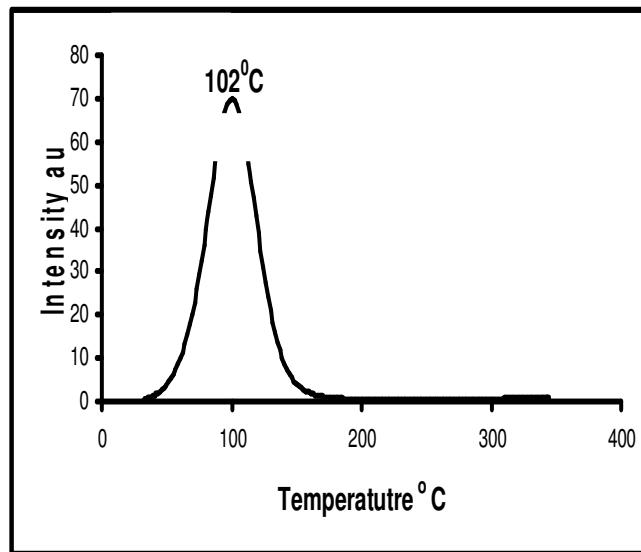


Figure-7
 TL glow curve of Quartz annealed and quenched from 600°C

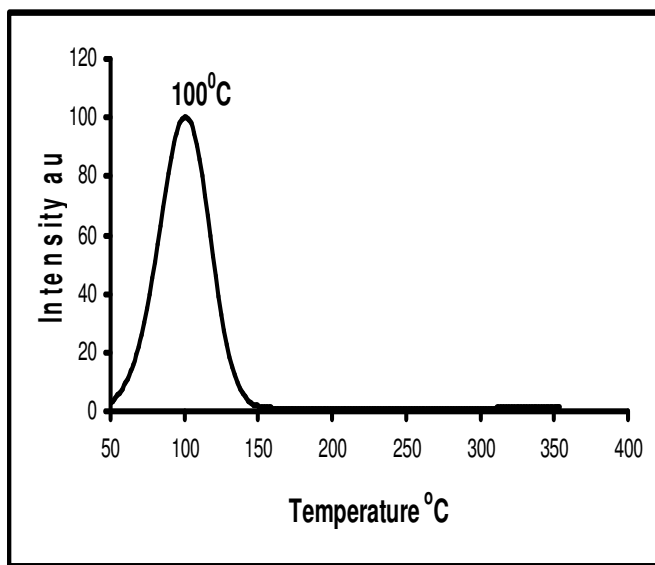


Figure-6
 TL glow curve of Quartz annealed and quenched from 400°C

Figure-7 is the TL glow curve of Quartz annealed and quenched from 600°C and given a beta dose of 15 Gy using Sr-90 beta source. TL glow curve of 600°C AQ sample of Quartz exhibits one well resolved and isolated TL peak with high intensity around 102°C. This peak is interesting TL peak in dosimetric point of view.

Figure-8 shows the TGA of Quartz from the TGA it is clear that variation seen in phase between temperature range 400°C and 800°C. The TL intensity is decreased between this temperature ranges due to phase change

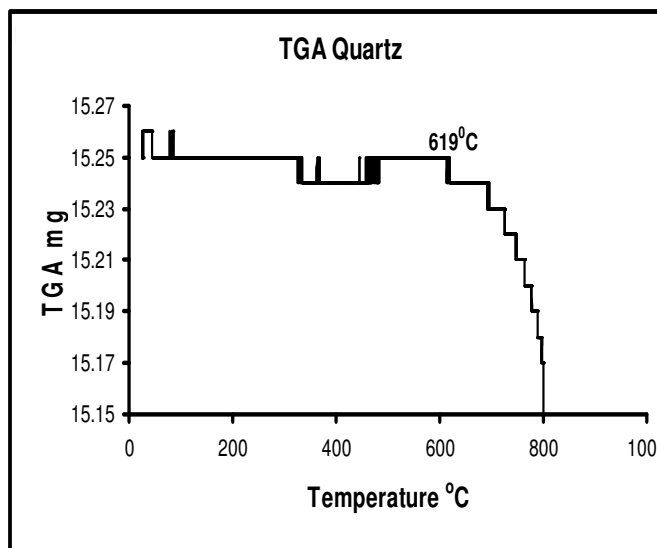


Figure-8
 TGA of Quartz from the TGA

Figure-9 shows the XRD pattern of Quartz it is clearly matches with the standard peaks observed at 26.66, 20.88, 50.18 and 60° are major peaks of standard quartz sample.

Figure-10 shows the TL glow curve of Feldspar mineral with out any pre heat treatment and irradiation .The glow curve exhibits one well resolved peak at 308°C temperature ,here heating rate is 4°C/sec for TL measurement the intensity of peak is 76au noted this intensity is remarkable this sample gives TL without any pre heat treatment this result is interesting here phase changed thrmoluminescence is occurs .some mineral contain water molecule due to this result the phase change TL

produced. Here till temperature 170°C the intensity remain near to zero but then after intensity continuously increasing with temperature. From this result it is noted that one trap with large numbers of carriers generated with peak 308°C.

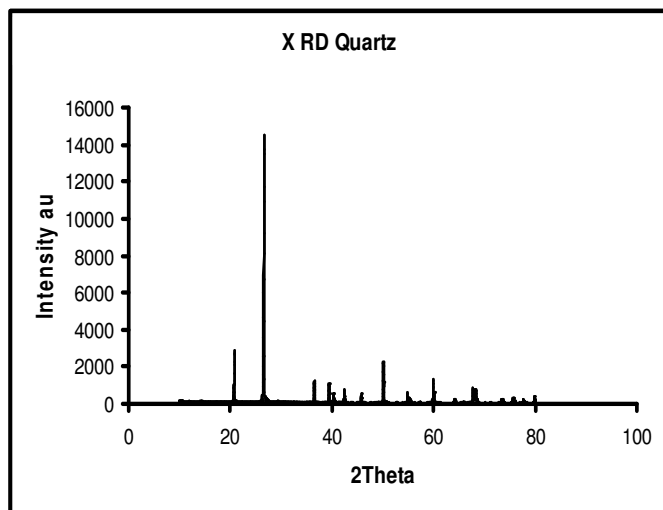


Figure-9
 X RD pattern of Quartz

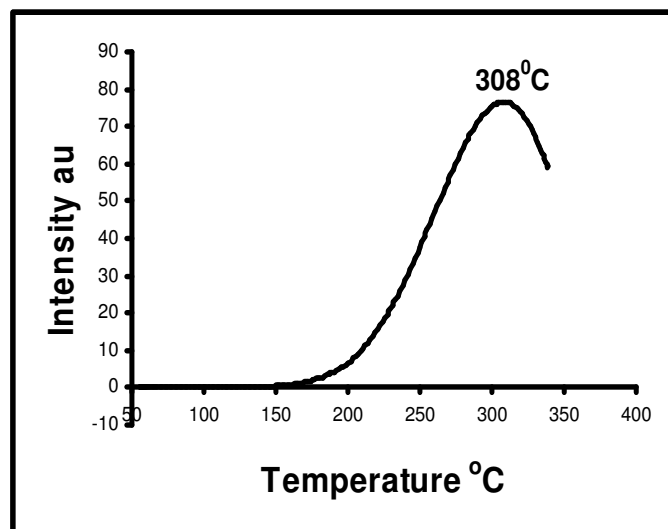


Figure-10
 TL glow curve of Feldspar mineral

Figure-11 shows the TL glow curve of Feldspar mineral irradiated with beta dose of 15 Gy by Sr⁹⁰ here no any pre heat treatment is given to the sample, here two well resolved glow peak occurs at temperature 141°C and 312°C it is indicate that two traps with large carriers is related with this temperature range here the intensity of peak is 43au and 39au respectively, here it is noted that the intensity of peak 309°C in in Figure-2.1 is decreased in Figure-2.2 and the peak temperature slightly change from 309°C to 312°C it shows fading effect but one remarkable result is that one new peak occurs at temperature

141°C with intensity 43au this peak is well resolved and stable so it is considered as dosimetric peak.

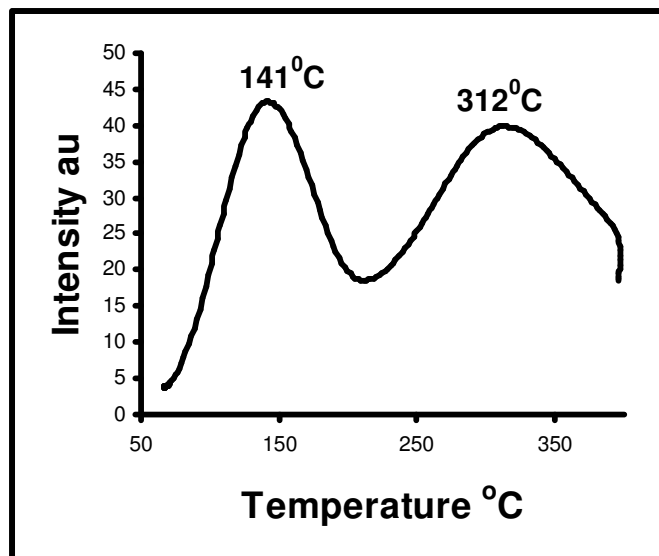


Figure-11
 TL glow curve of Feldspar mineral

Figure-12 shows the TL glow curve of Feldspar mineral with pre heated at annealing and quenching temperature at 400°C and irradiated with beta radiation dose of 15Gy by Sr⁹⁰, here heating rate is 4°C/s for TL measurement, here one well resolved glow peak occurs at temperature 123°C and peak intensity of 39au is recorded, with comparison of Figure- 2.3 it is clear that peak temperature almost remain same but the peak intensity is decreased about 40%, this interesting this shows the fading effect occurs between temperature range of 200°C TO 400°C into the material also broad hump is produced in the glow curve.

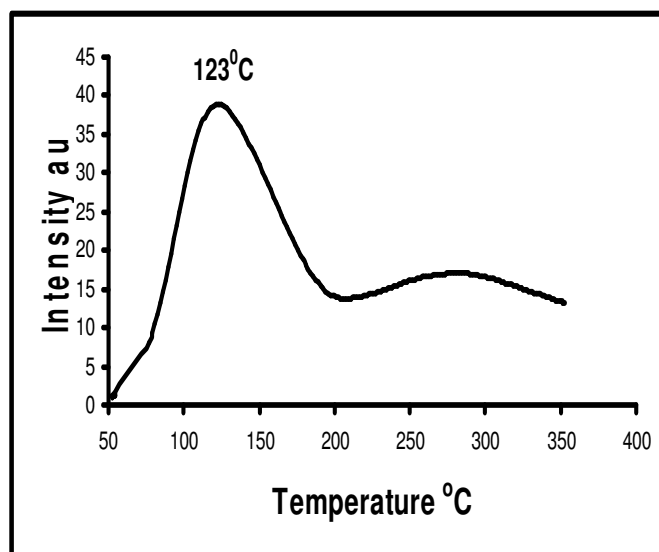


Figure-12
 TL glow curve of Feldspar mineral

Figure-13 shows the TL glow curve of Feldspar mineral with pre heated at annealing and quenching temperature at 600°C and irradiated with beta radiation dose of 15 Gy by Sr⁹⁰, here heating rate is 4°C/s for TL measurement, here one well resolved glow peak occurs at temperature 114°C and peak intensity of 51 au is recorded, with comparison of Figure- 2.4 it is clear that no major occurs into the result except peak temperature slightly change from 123°C to 114°C and intensity decreased from 34 au to 51 au so it is noted that after 400°C temperature treatment more carrier oriented trap is formed that's why TL intensity is increased but minor variation occurs in peak temperature it shows the stability of peak.

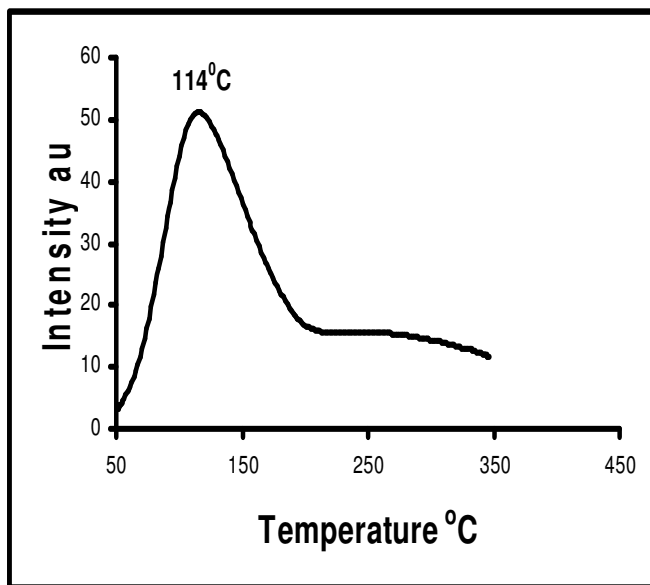


Figure-13
 TL glow curve of Feldspar mineral

Figure-18 shows the glow curve of Alumina treated with annealing and quenching temperature of 400°C and irradiated with beta source of 15 Gy. Here glow curve exhibits one well resolved peak at temperature 275°C and intensity of 48 au also one broad hump is developed. It compare with Figure- 4.3 the intensity is increased from 19 au to 48 au it is noted that after the treatment of AQ400°C more carriers oriented trap is formed and it released it when it heated for TL measurement. The heating rate for TL is 4°C/s. The peak 275°C is considered as stable peak it indicate stability of material also this peak is interesting for dosimetry point of view.

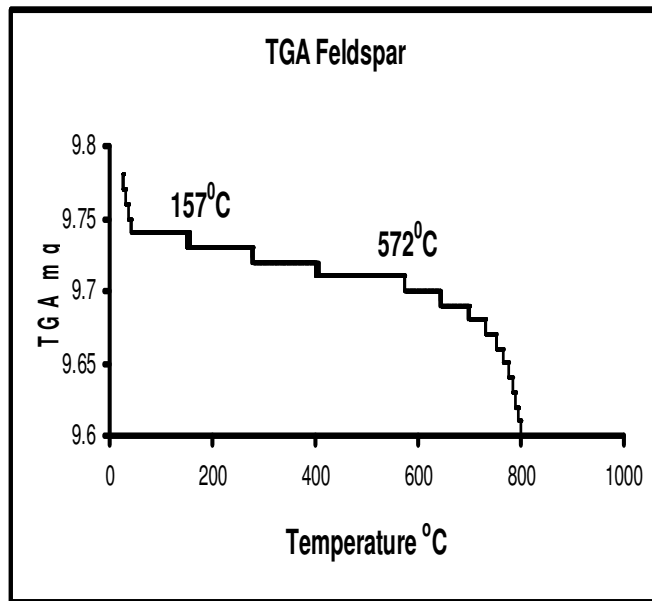


Figure-14
 TGA of Feldspar

Figure-14 shows the TGA of Feldspar it indicate variation in phase at different temperature. The variation in TL intensity due to phase change in to the material at particular temperature it is co related with TL result .

Figure-15 shows the X RD pattern of Feldspar it is clearly matches with the standard peaks observed at 13, 27.48, and 41.86° are major peaks of standard Feldspar sample.

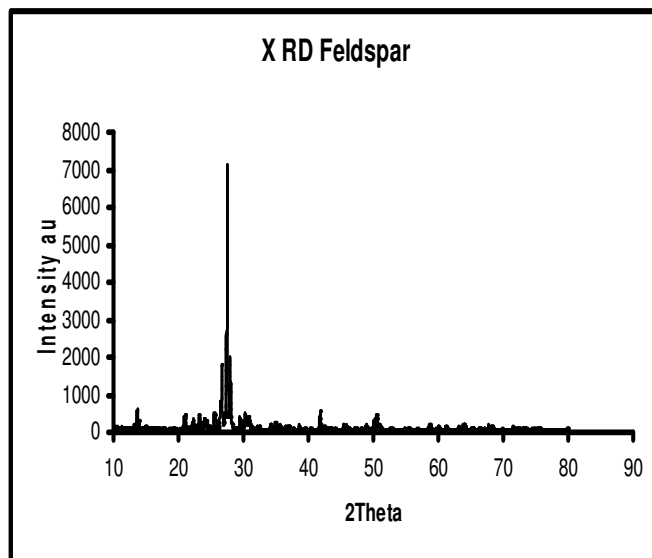


Figure-15
 X RD pattern of Feldspar

TL Study of Alumina: Figure-16 shows TL glow curve of Alumina with out treatment of heat and irradiation dose. This glow curve exhibits one peak at temperature 159°C and intensity of 0.11 au here no significant TL is recorded, the material exhibits low TL sensitivity in natural form.

Figure-17 shows TL glow curve of Alumina with irradiated with beta dose of 15 Gy by Sr⁹⁰. The glow curve exhibits one peak at temperature 257°C and with intensity of 34 au, here it is noted that after irradiation the intensity of TL is increased it is means that that large carriers oriented trap is generated.

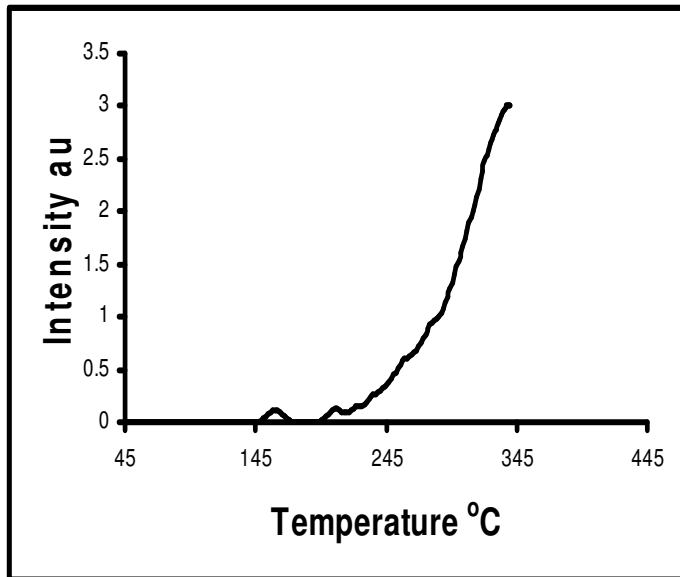


Figure-16

TL glow curve of Alumina with out treatment of heat and irradiation

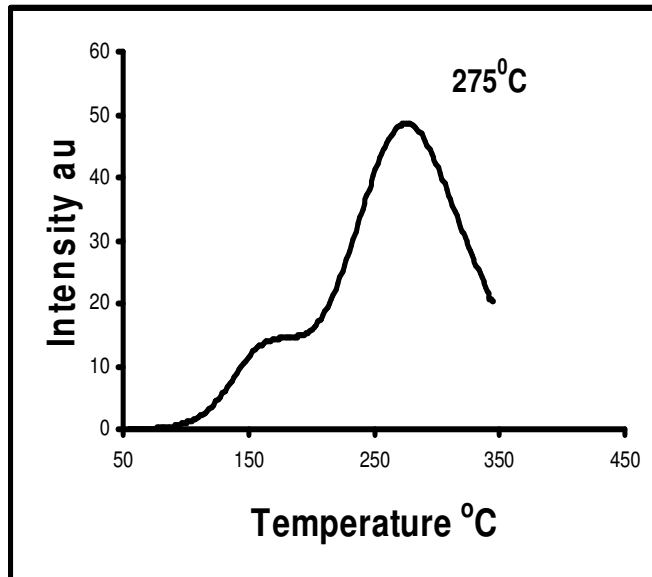


Figure-18

Glow curve of Alumina

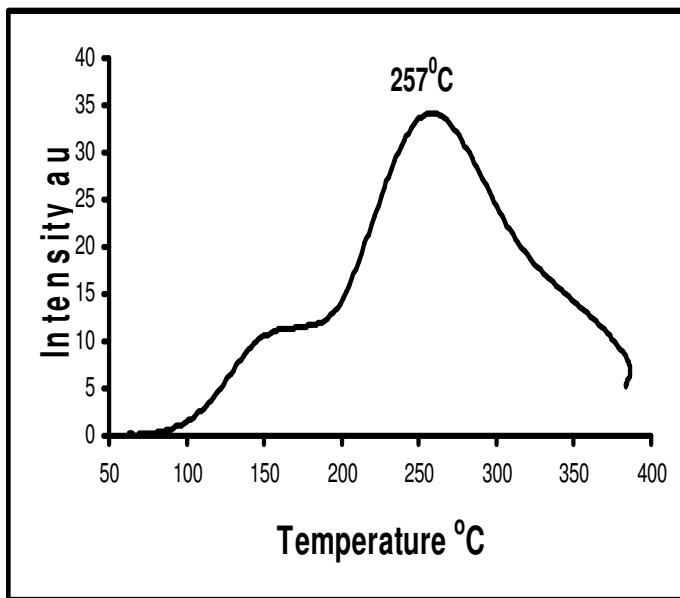


Figure-17

TL glow curve of Alumina with irradiated with beta dose of 15

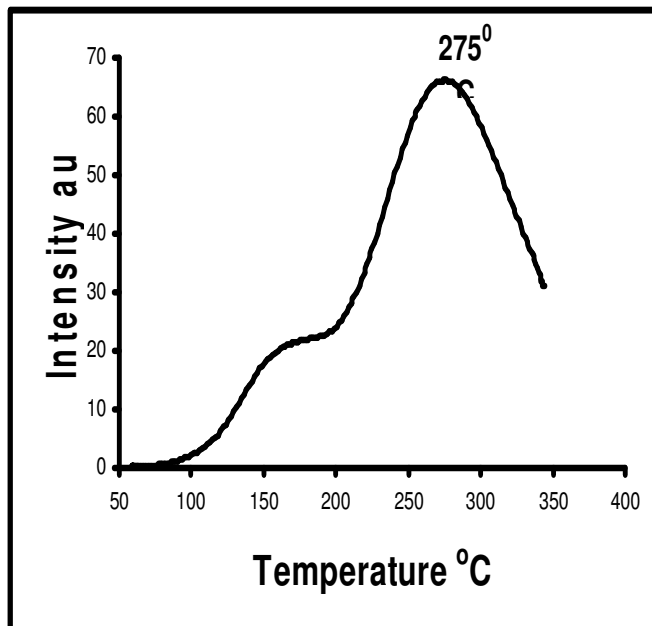


Figure-19

Glow curve of Alumina

Figure-19 shows the glow curve of Alumina treated with annealing and quenching temperature of 600°C and irradiated with beta source of 15 Gy. The heating rate for TL is 4°C/s. Here the glow curve exhibits one well-resolved peak at temperature 275°C and intensity of 66 au. Also one broad hump is developed. It compares with Figure-4.4 the intensity is increased from 48 au to 66 au, but the peak temperature remains constant. Increasing intensity exhibits that more carriers are involved with traps after this heat treatment.

Figure-20 shows the TGA of Alumina, it indicates small variation in phase at different two temperatures at 171°C and 518°C. Also it shows the stability of the material against temperature.

Figure-21 shows the XRD pattern of Alumina, it clearly matches with the standard peaks observed at 25.72°, 35.28°, and 57.62°. These are major peaks of standard Alumina sample.

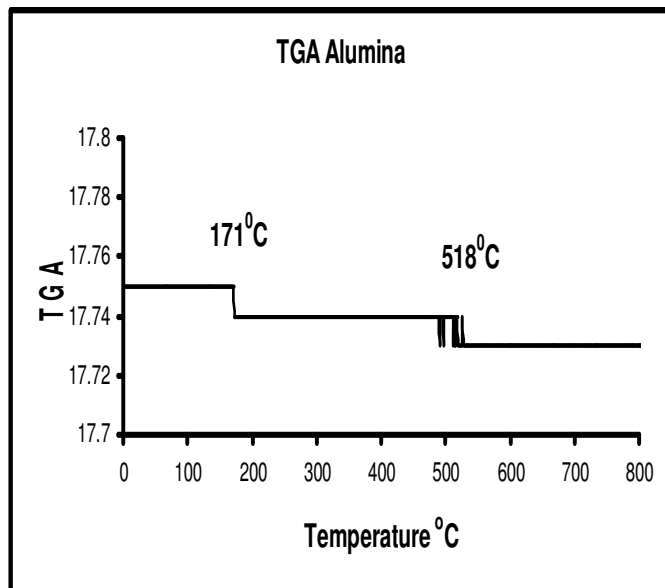


Figure-20
TGA of Alumina

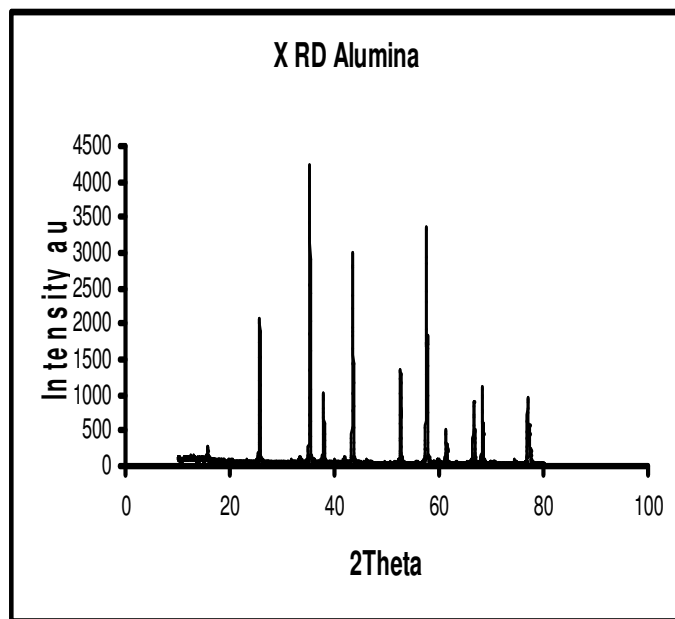


Figure-21
RD pattern of Alumina it

Conclusion

The natural TL [NTL] observed in Above minerals under study as well as NTL+ATL followed by the TL observed from annealed and quenched form 400°C and 600°C followed by beta irradiation leads to the conclusions the results are due to the traps formed by irradiation as well as heat treatment to the subjected mineral.

The systemic study may be more useful in checking the purity of the raw materials which in turn leads to improving the quality of ceramic tiles in ceramic industries. Further studies are in progress.

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