Thermoluminescence Study of Base 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 400 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 (TL) characteristics of Feldspar, Alumina and Quartz minerals collected from the ceramic tiles manufacturing unit, Morbi. The as received minerals Natural TL was recorded (NTL), and annealed and quenched from 400°C and 800°C followed by 15Gy beta dose given from Sr-90 beta source TL was recorded and the comparative TL (Thermoluminescence) study of above materials are presented. The characterization of the minerals is done using TGA and XRD studies.

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 major 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, Aluminum 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 as feldspar and Zircon 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 [1,2].

Experimental method

The natural minerals used in manufacturing ceramic tiles are collected from the industry. Most of the materials used for the TL analysis were indigenous minerals and a few were imported minerals. TL of these minerals was recorded using TL set-up supplied by Nucleonix Systems, Hyderabad [3,4]. Irradiation was carried using Sr-90 beta source. Equal quantities of weighed samples (5 mg) were used for the analysis. Heating rate used for all the TL measurements was 4°C/Sec.

Results and discussion

Fig.1 curves 1,2,3 are the TL of 5 mg of weighed powder of Quartz annealed and quenched from 200, 400 and 800°C. There is not much NTL was observed and alsos with 15 Gy beta irradiation. Fig.1 curves 1,2,3 are the TL glow curve of quartz irradiated with beta dose of 15 Gy using Sr^{90}. Here one broad peak occurs at temperature 110°C and

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 Printed in Kazakhstan

intensity of 1.83 au for 200 AQ. 40 au for 400 AQ and 100 au for 800AQ.

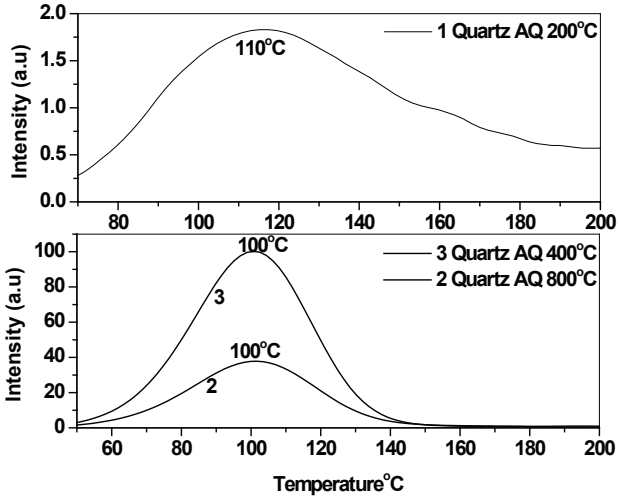


Fig.1. Curve 1 is the TL of 15Gy beta dose natural quartz annealed and quenched form 200°C.

Curve 2 is the TL of 15Gy beta dose natural quartz annealed and quenched form 400°C.
Curve 3 is the TL of 15Gy beta dose natural quartz annealed and quenched form 800°C.

TL glow curve of 400°C and 800°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.

Fig. 2 shows the NTL 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 thermoluminescence may 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 peak at 308°C.

Fig. 2 curve 2 is the TL glow curve of Feldspar mineral irradiated with beta dose of 15 Gy using Sr^{90} 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 which indicates that two different traps with large number of carriers are present leads to related traps when heating in the temperature range from 50-350°C with intensity of peaks 43au and 39au respectively.

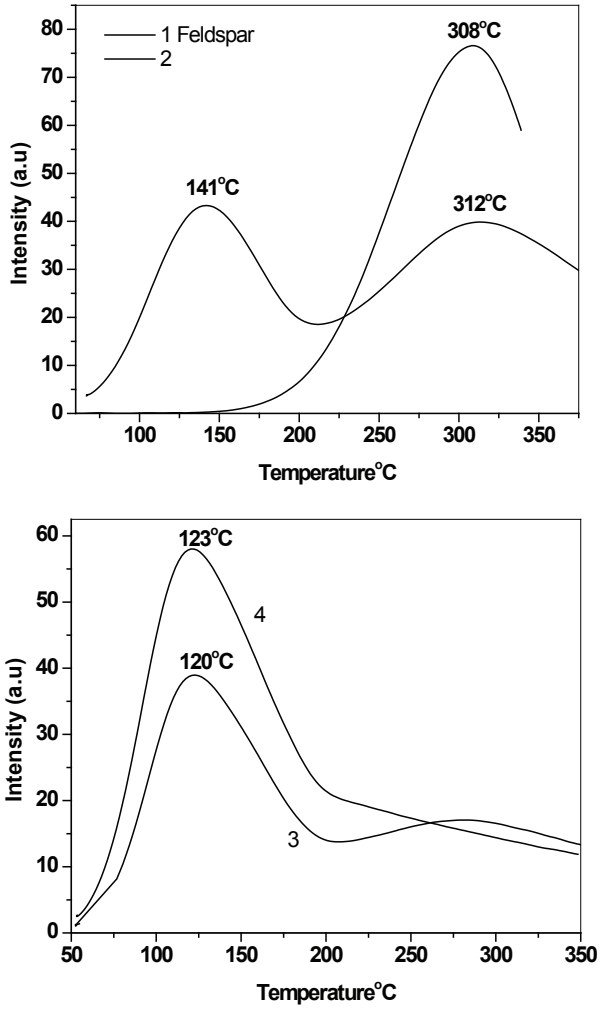


Fig. 2. Curves 1,2, 3 and 4 are the NTL, 200, 400 and 800AQ of Feldspar.

Fig. 2 curve 3 and 4 are the TL glow curve of Feldspar mineral with pre heated at annealing and quenching temperature from 400 and 800°C. One well resolved glow peak occurs around 123°C with peak intensity 39au for 400AQ and 60au intensity for 800AQ sample.

Fig. 3 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.

TL glow curve of Alumina with out any treatment of heat and irradiation did not yield any NTL. Fig.3 curves 1,2,3 are the TL glow curve of

alumina annealed and quenched from 200°C, 400°C and 800°C and irradiated with beta dose of 15 Gy from Sr^{90}. The glow curve exhibits one peak at temperature 265°C and with intensity of 34au for 200 °C AQ, 50au for 400AQ and 70au for 800°C AQ specimens of alumina. It is noted that after annealing and quenching followed by irradiation the intensity of TL is increased which s means that that large carriers oriented traps are generated. It is also observed a low intensity broad hump is observed around 150°C in all three curves.

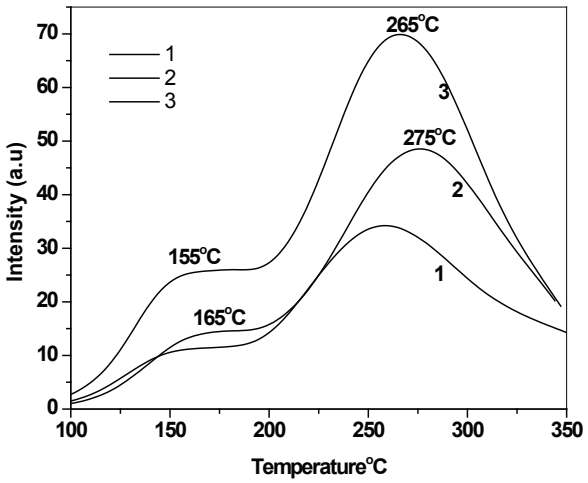
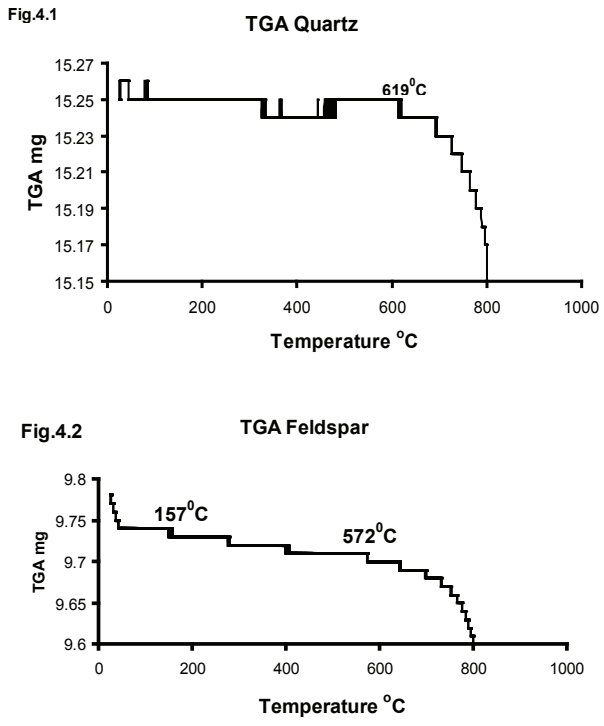


Fig. 3. Curves 1,2, and 3 are the TL of 200, 400 and 800AQ of alumina (Al_2O_3).



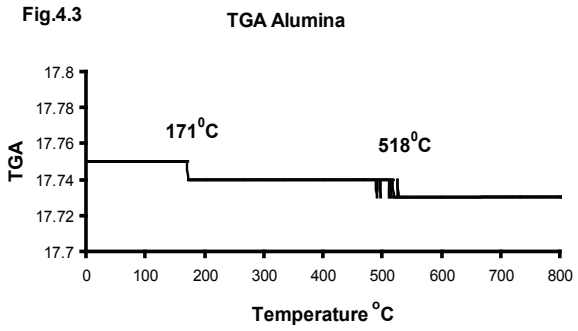


Fig. 4. 1,2 and 3 are the TGA of Quartz, Feldspar and Alumina.

Fig.4.1 is the TGA of Quartz. From the TGA it is clear that variation seen in phase between temperature range 400°C and 800°C. As we observed in TL the TL intensity is decreased between this temperature ranges due to phase change. Fig.4.2 is the TGA of Feldspar which continuously changes its phases by releasing the water molecules and dissociating. Fig.4.3 is the TGA of alumina which changes its phases by releasing the water molecules around 170°C and not much change observed in TGA. However the TL intensity increase when annealed and quenching from 800°C because of heat treatment causes many defects creation in the crystal lattice.

Fig.5 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.

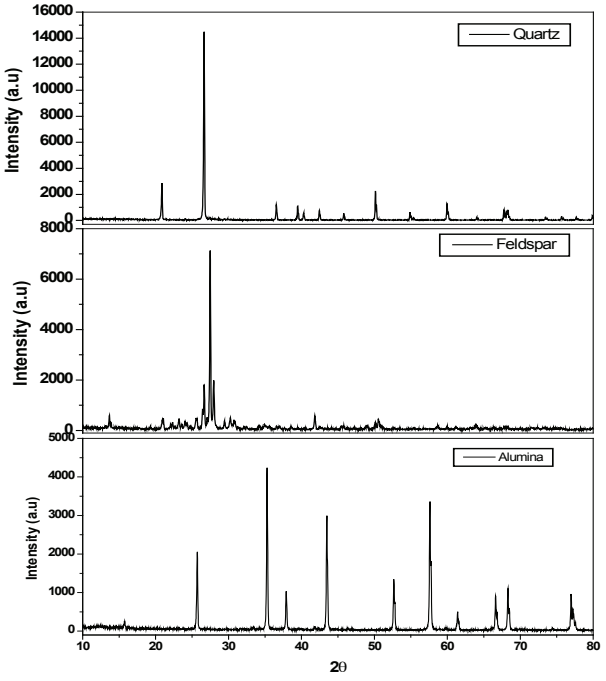


Fig. 5. XRD of Natural quartz, Feldspar and Alumina.

From the observed XRD pattern of Natural Quartz, Feldspar and Alumina it is clearly seen the peaks are very isolated and intense and matches with the standard peaks. This indicates the minerals are mostly pure with out any inclusions. The results are mostly matching with observations of earlier workers [5-12]. These minerals can be used fro TL dosimetry studies.

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 400oC and 8000C followed by beta irritation leads to the conclusions that the results are due to the traps formed due to irradiation as well as heat treatment subjected to the 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 on TL dosimetry are in progress.

Acknowledgment

The author (H.C. Mandavia) is thankful to U.G.C., New Delhi, for the awarded of Teacher Fellowship and thankful to Shri C.M.Shanghavi (Hons.secretary Sarvodaya Education Society) , Shri S.M.Vadia (Executive Secretary Sarvodaya Education Society) and Dr. P. K. Patel (Principal Shri M. M. Science College, Morbi) to promote this research.

References

1. K.V.R. Murthy, IOP Conference Series, 012024, July, 2009
2. S.Kumar, Source Book of Ceramic, 1998.
3. K.V.R. Murthy and J.N. Reddy Thermoluminescence basic theory application and experiment, Feb.2008, Pub. Nucleonix, Hyderabad.
4. K.V.R. Murthy, Y.S. Patel, A.S. Sai Prasad, V Natarajan, A G Page, 2003 Radiation Measurements 36 483.
5. S.W.S. Mckeever, 1985 Thermoluminescence of Solids, Cambridge University Press, Cambridge, 205.
6. M J Aitken, 1974 Physics and Archaeology Oxford, U.K.: Oxford Univ. Press.
7. S.W.S. McKeever, M.S. Akselrod and B.G. Markey, 1996 Radiation .Prot. Dosim. 65 267.
8. Compact Fluorescent Lamp Phosphors in Accidental Radiation Monitoring, K.V.R. Murthy, S.P. Pallavi, Rahul Ghildiyal, Manish C Parmar, Y.S. Patel, V. Ravi Kumar, A.S. Sai Prasad, V. Natarajan and A.G. Page, Radiation Protection Dosimetry (2006), Vol. 120, No. 1-4, 238-241.
9. Hitesh M. et al, Journal of Science Government of Gujarat, Volume-1,Issue-1/2010,Page no. 72 to 74.
10. Hitesh M. et al, Spark e journal Volume2, Issue3, Feb.2010, Page no.287to 292.ISSN 0975-7929.
11. Hitesh M et al Material science an Indian Journal, Volume-6,Issue-3,.2010,Page no.167 to 169.ISSN 0975-7486.
12. Hitesh M et al Journal of science and Tech. Research, Volume-1,Issue-2,July-Dec 2010ISSN 0974-9780 Page no.33 to 36.

Received 19 June 2010.