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Research Article

THERMOLUMINESCENCE DOSIMETRY STUDY OF MINERAL POTASH

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ABSTRACT

In India ceramic industry is fast growing one, more than 450 units of manufacturing ceramic tiles, vitrified tiles and sanitary ware, situated around Morbi, Rajkot, and Gujarat, India having an annual turnover of around Rs.5000 Cores. 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, Potash, Snow white, Ivory soda, China clay, Ukraine clay, 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 dosimetry study of mineral Potash collected from the ceramic tiles manufacturing unit, Morbi. The as received minerals TL was recorded (NTL) and also 25Gy beta dose was given to each 5mg weighed sample and ATL was recorded. Annealed and quenched from 200, 400, 600, and 800^{o}C followed by 25Gy beta dose given from Sr-90 beta source. Further the ceramic tile may be used as accidental thermoluminescence dosimeter (TLD) for high doses also studied.

Keywords: Thermoluminescence dosimeter (TLD), Ceramics; X-ray diffraction; Mineral, Potash.

INTRODUCTION

Thermoluminescence (TSL), an established technique, is utilized in a variety of applied sciences. The major applications are in the fields of geology and dosimetry. Developments concerning the use of thermoluminescence (TL) techniques are retrospectively assessing the radiation dose in areas of accidental radioactive contamination. However, most natural materials are not highly sensitive. If these techniques are to be used to their maximum potential is necessary to gain knowledge of why and how sensitivity variations and changes occur from sample to sample. Naturally occurring minerals commonly exhibit TSL emission. Among these, quartz, calcite and fluorite are the well-studied minerals because of their excellent TSL sensitivity [1-6]. In the present study, the thermoluminescence property of potash mineral collected from the ceramic tiles manufacturing unit, Morbi, has been studied.

Experimental:

The natural potash mineral used in manufacturing of ceramic tiles are collected from the industry. Nucleonix PC **C**ontrolled Thermoluminescence Reader [Type:TL1009] was employed for the thermoluminescence property analysis of Potash mineral [7,8]. Every time 5mg of weighed irradiated samples were taken. The heating rate was set as 1°C/sec and sample was annealed and quenched from 200, 400, 600, and 800^{o}C followed by 25Gy beta dose given from Sr-90 beta source. The dose response of 25 Gy shows well defined high intensity peaks and hence the further analysis. The TSL glow curves were recorded immediately after irradiation.

RESULTS AND DISCUSIONS

Figure-1 is the TL of Potash mineral as received (AR), annealed and quenched (AQ) from 200, 400,600 and 800^{o}C. The TL was recorded for 5mg weighed powder by giving 25 Gy beta dose from Sr-90 beta source. Curve-1 is the TL of 25 Gy beta irradiated as received Potash. It shows a well resolved peak around 154^{o}C and followed by another well resolved peak at 330^{o}C with TL intensities 38, 54a.u respectively. Curve-2 is the TL of 25 Gy beta irradiated Potash annealed and quenched from 200^{o}C. It displays a well resolved peak around 156^{o}C followed by a hump with less intensity when compared to curve-1. Curve-3 is the TL of 25 Gy beta irradiated Potash annealed and quenched from 400^{o}C. It is observed from curve-3, a well resolved peak around 152^{o}C followed by hump with less intensity when compared to curve-2. Curves 4 and 5 are the TL of 25 Gy beta irradiated Potash annealed and quenched from 600 and 800^{o}C. It shows a sharp well resolved peak around 145^{o}C followed by hump and curve-5 has a broad peak around 288^{o}C with nearly equal intensities. From the figure it is also observed that as the annealing temperature increases from 200 to 800^{o}C entire TL pattern changes and finally resolved as two peaks with slight variation in intensity. This may be due to various phase changes occurred while annealing the mineral from 200-800^{o}C temperatures.

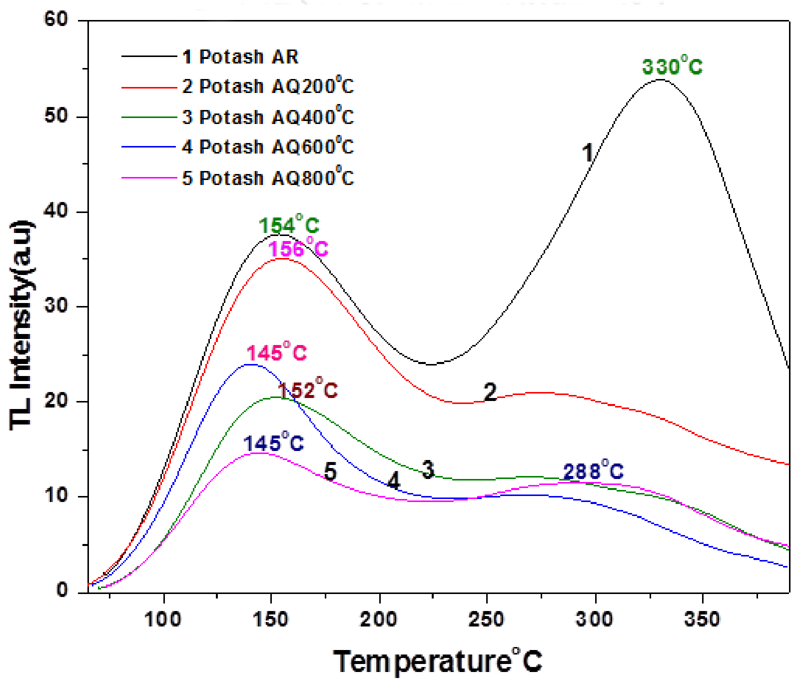

Figure 1: TL of Potash-Beta Irradiation

Figure-2 is the XRD pattern of Potash; it is clearly observed that the maximum peak obtained at 43.5. The Crystallite size of Potash is calculated using Scherer's formula and is found around **89.37**nm.

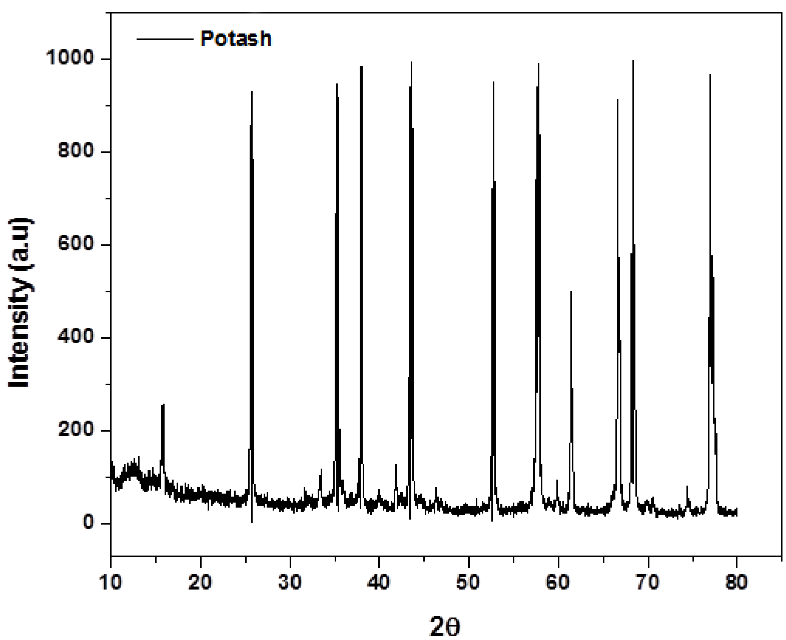

Figure 2: XRD Pattern of Potash

Figure-3 is the TGA of Potash. From figure it is found that there are many phase changes in the temperature range of 54°C - 700°C. It reveals that there is continuous dissociation between 54°C – 700°C. This is due to structural collapse of the mineral.

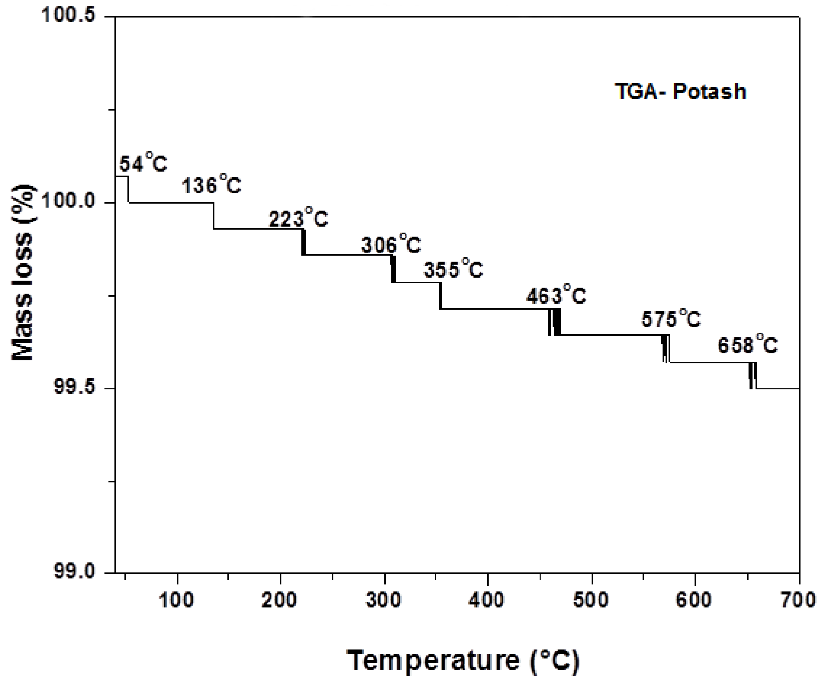

Figure 3: TGA of Potash

Figure-4 A & B are the particle size histograms of as received Potash and annealed and quenched from 800°C Potash.

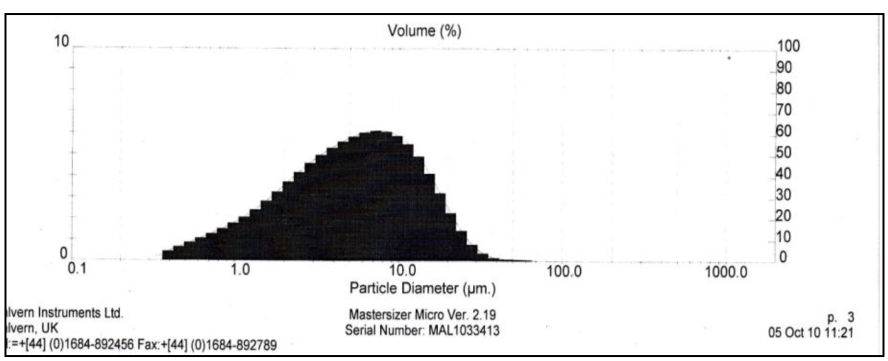

Figure 4-A: Particle size histogram of as received (AR) Potash

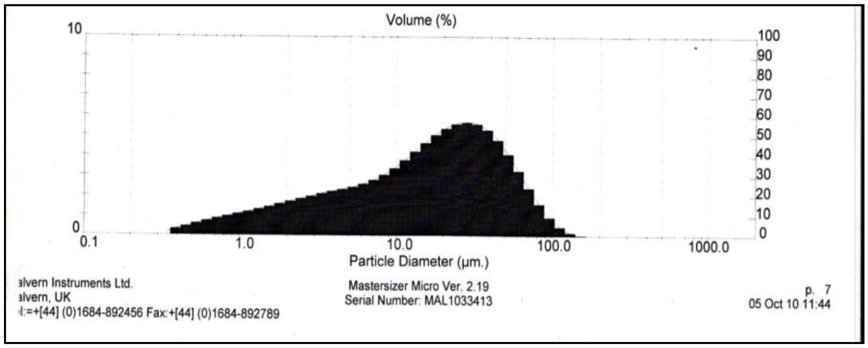

Figure 4-B: Particle size histogram of annealed & quenched (AQ) 800°C Potash

Figure-5 is the TL growth curve of Potash mineral annealed and quenched from 800°C. The mineral was given the following beta doses 5, 15, 25, 50, 100, 200 and 300Gy using Sr-90 beta source. The 5 mg weighed beta irradiated powdered sample was used for TL measurement. From the figure it is noted the growth increases up to 50Gy after 50Gy up to 300Gy it is a linear growth.

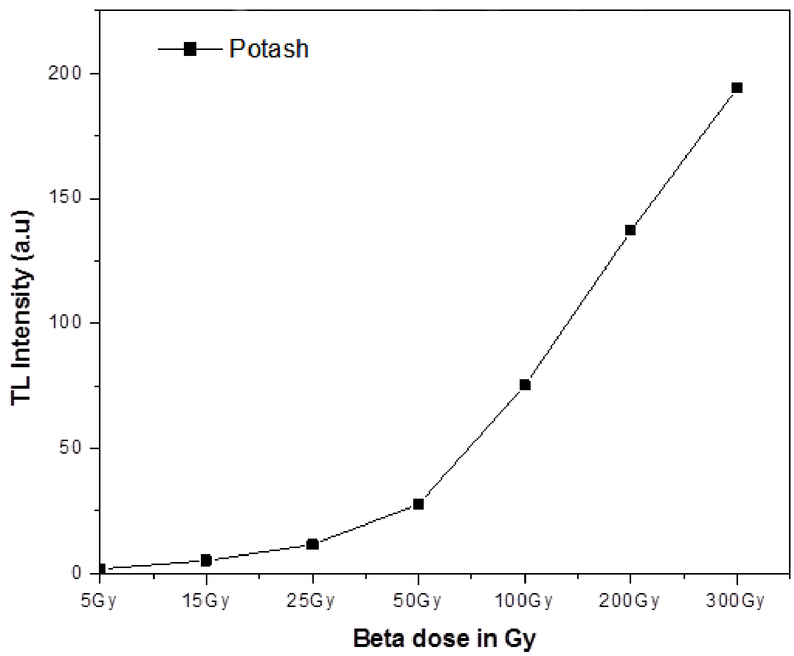

Figure 5: TL Growth of Potash (AQ800°C)

Figure-6 is the TL decay of Potash mineral annealed and quenched from 800°C. TL was recorded after 24, 48, 100, 170, 210, 280 hours of beta irradiation initially irradiated with beta dose of 25Gy using Sr-90 beta source. The 5 mg weighed beta irradiated powdered sample was used for TL measurement. From the figure it is noted the TL Intensity is gradually decreased with increasing the time of storage after beta irradiation. The TL decay percentage of Potash is about 68%.

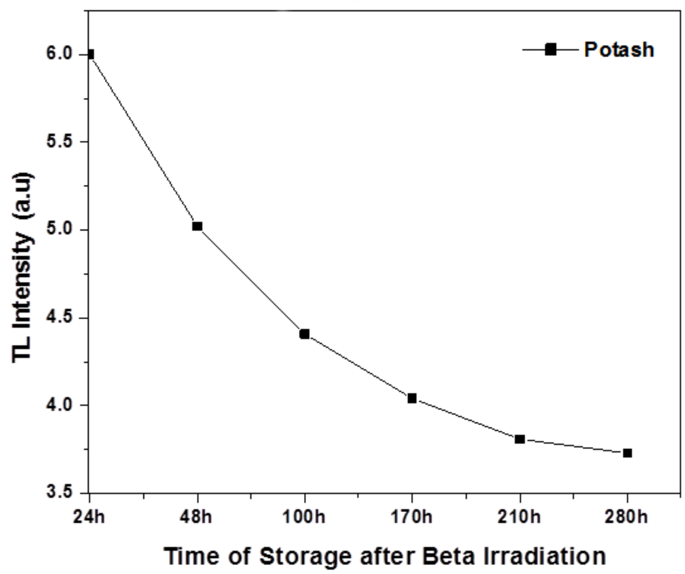

Figure 6: TL Decay of Potash (AQ800^{0}C)

CONCLUSIOON

1. The Potash minerals under study were subjected to natural Thermoluminescence (NTL), annealed and quenched from 200,400,600 and 800^{o}C followed by a 25 Gy beta dose. XRD pattern confirm the mineral under study are mostly pure in form. It is interesting to note the crystallite size calculated using Scherer's formula (t = K λ/B Cosθ) reveals the mineral under study is in nano form.

2. From TGA of Potash It reveals that there is continuous dissociation between 54^{o}C – 700^{o}C. This is due to structural collapse of the mineral.

3. From the result obtained from the laser diffraction particle size analyzer, the average particle diameter of as received Potash mineral is 23.03 μm, and that of annealed and quenched at 800^{o}C Potash mineral is 7.20 μm. Here eglamoration is more than 300%.

4. From the TL growth studies all the minerals under study, most of the minerals showed linear growth in the dose range 5Gy to 300Gy.

5. The TL decay studies of the above minerals mentioned reveals that most of the minerals TL decay is 50% when stored up to 280 hours (two weeks).

Potash can be considered as good TL dosimeter.

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