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Thermoluminescence Characterisation of Ceramic Mineral China Clay

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ABSTRACT

Many natural minerals are used as the raw materials required for the manufacturing ceramic ware. 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 mineral China Clay collected from Morbi, Rajkot, Gujarat, India. The TL of mineral at various heat treatments was recorded and also 5Gy beta dose was given to each sample prior to TL recording. The mineral is annealed for 1 hour and quenched from 600 and 800^{o}C. It displayed a well resolved peak around 132^{o}C annealing and quenching from 600 and for annealing and quenching from 800^{o}C the TL peak temperature is found around 138^{o}C and 161^{o}C. XRD and TGA of China Clay mineral were reported.

Keywords: China Clay, Thermoluminescence, minerals, TGA XRD

Introduction:

Geology is the earliest disciplines to accept the TL technique in dating of mineralization, igneous activities, sedimentation and evaluation of growth rate of beaches and sand dunes. The TL technique is useful in dating of geological specimens where all conventional methods fail. TL can provide a perfect passive measurement i.e. integrated irradiation levels over extended periods of the order of three years. In a geological specimen, the TL would starts building up from the time of its crystallization and normally continue throughout its existence due to the radioactivity present in the minerals and in the surrounding materials, till it saturates.

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 present paper reports the thermo luminescence characteristics of transparent China Clay mineral collected from Morbi, Rajkot, Gujarat, India. The TL was recorded for mineral was annealed and quenched from 600 and 800^{o}C followed by 15Gy beta dose given to each 5mg weighed sample from Sr-90 beta source.

Experimental Method:

The as-received mineral China Clay was weighed carefully by using Citizen Model electronic weighing balance. Grinded thoroughly about ~1 hour using a mortar and pestle in order to get a powder size of 60 micron and TL was recorded by giving varies heat treatment.

In the present paper the TL set-up manufactured by Nucleonix Systems, Hyderabad was used [3-9]. The reproducibility of the system was found within 3% [1-2].

Results & Discussion

Fig.1 is the TL of China clay mineral annealed and quenched (AQ) from 600 and 800^{o}C. The TL was recorded for 5mg weighed powder by giving 25 Gy beta dose from Sr-90 beta source. In Fig.1 curve-1 is the TL of 25 Gy beta irradiated China clay annealed and quenched from 600^{o}C. It is observed from curve-1, a well resolved peak around 132^{o}C followed by many humps. Curve-2 is the TL of 25 Gy beta irradiated China clay annealed and quenched from 800^{o}C. It shows small peaks around 138^{o}C and161^{o}C followed by number of humps with a little high intensity when compared to curve-1. From the it is understand that as annealing temperature increases well resolved peak splits into small peaks with little high intensity. This may be due to various phase changes occurred while annealing the mineral from 600^{o}C to 800^{o}C temperatures. It is found from the table that more Nickel and Iron are present in the mineral. This leads to less TL because Ni and Fe are luminescence killers [9-15].

Fig.2 is the XRD pattern of China clay, it is clearly observed that the maximum peak obtained at 26.8^{o}.

Fig.3 is the TGA of China clay. From figure it is found that there are many phase changes in the temperature range of 87°C - 626°C.

Fig.4 is the TL growth of China clay 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 is linear from 5Gy to 300Gy.

Fig-1: TL of Chinaclay-Beta Irradiation

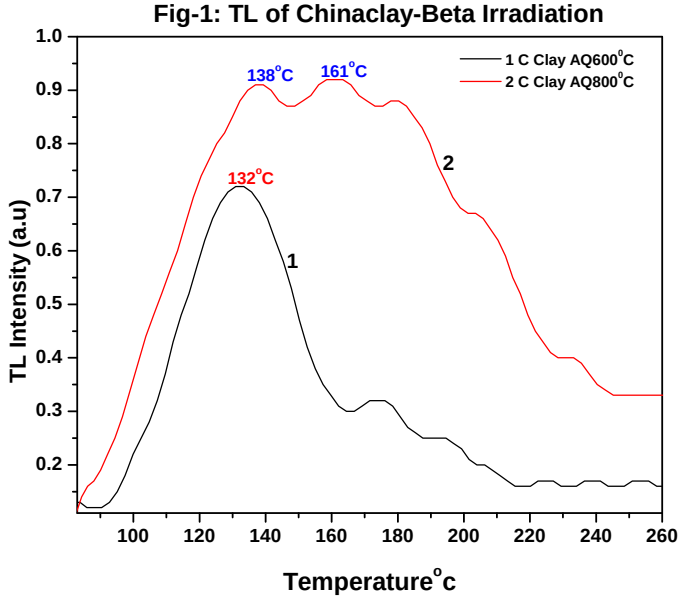


Fig-2: XRD pattern of China Clay

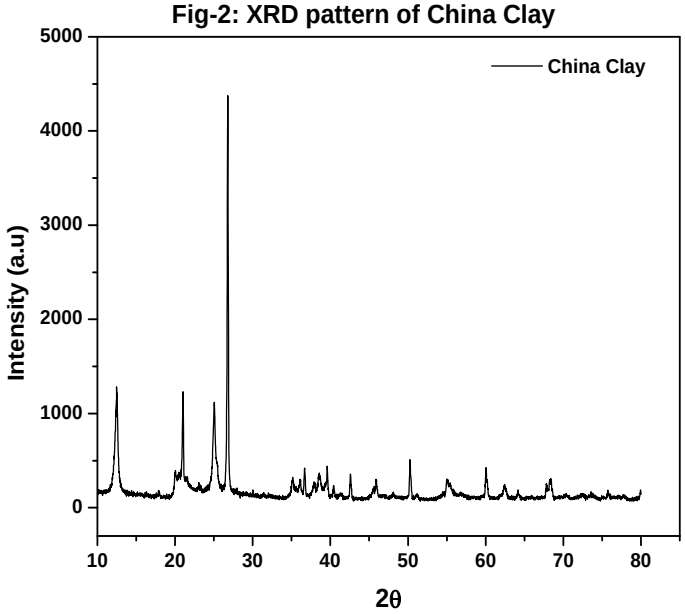


Fig-3: TGA of Chinaclay

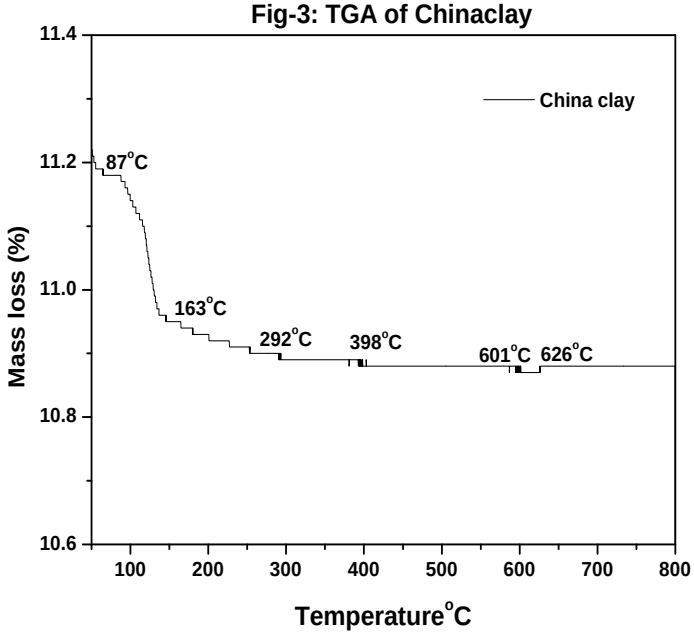
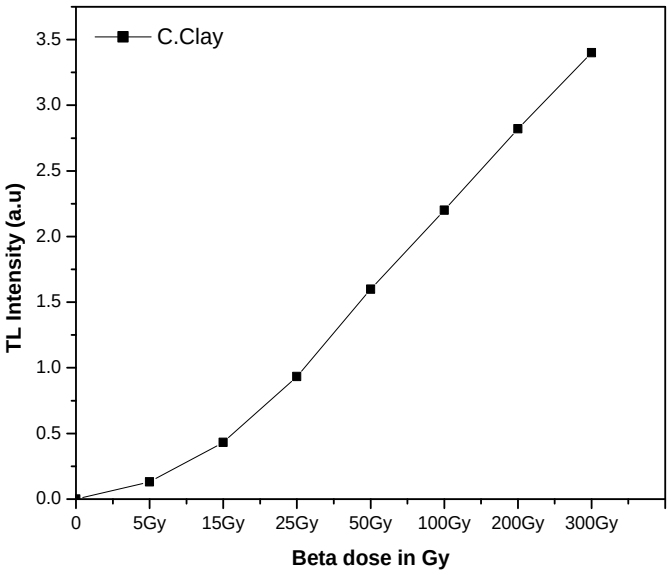


Fig-4 : TL Growth of China Clay (AQ800°c)



Conclusion:

1. From TL Study of China Clay It is found from the table that more Nickel and Iron are present in the mineral. This leads to less TL because Ni and Fe are luminescence killers.
2. From XRD of China Clay the Crystallite size of China clay is calculated using Scherrer's formula and is found around 53.26 nm.
3. From TGA of China Clay there is a constant weight loss in the temperature region 50^{o}C-120^{o}C observed. This is due to loss of water molecules present in the China clay mineral.
4. From TL growth study of China Clay it is observed that the growth is linear as beta dose is increases.

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