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TL Study of Amethyst with α, β and γ Irradiations

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ABSTRACT

The present paper reports the thermoluminescence characteristics of Amethyst mineral collected from Bhor Ghats near Sangamner, Nasik District, Maharashtra. The TL of as received minerals at varies heat treatment was recorded and also 5Gy beta dose was given to each sample prior to TL recording. TL of as received specimen (NTL) annealed for 1 hour and quenched from 200, 400, 600 and 800°C. The Amethyst mineral displayed a well resolved isolated peak around 140°Cfor AQ from 800°C. However annealing and quenching from 400 and 600°C TL peak temperature changes to 100°C and 105°C. TL peak temperatures of corresponding TL peak intensities of Amethyst mineral of gamma irradiation and X-ray irradiation are reported. XRD and TGA of Amethyst mineral were reported.

INTRODUCTION

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

The mineralAmethysthas the capability of thermoluminescence (TL), which is manifested by emission of light during heating of the mineral, before the temperature of red heat [4]. During the TL process, the energy of ionized radiation accumulated in Amethyst is transformed into heat and optical radiation [5]. Depending on the optical properties of the mineral and the conditions under which the light is emitted, a part of the light energy is always transformed into heat, because of absorption in the mineral itself. It must be borne in mind, too, that the heating of Amethyst mineral leads in certain cases to changes in the position and the structure of trapping centers, which may also be followed by liberation of heat [3, 4]. The present paper reports thermoluminescence characteristics of Amethyst mineral collected from Bhor Ghats near Sangamner, Nasik District, Maharashtra.

MATERIALS AND METHODS

The as-received minerals were weighed carefully by using Citizen Model electronic weighing balance and grinded thoroughly about ~1 hour using agate mortar and pestle in order to get a powder size of 60 micron and TL was recorded by giving varies heat treatment. All the specimens are given 5Gy of beta dose prior to TL recording.For recording of TL curves, an Nucleonix thermoluminescence (TL) glow curve recorded was used in the present study [6-15]. The thermoluminescence glow curve reader consists of a specimen holder along with heater, a temperature programmer, a photomultiplier tube as detector, a high voltage unit, a DC amplifier and a suitable displaying or recording device. Every time 5mg of weighed irradiated sample using Sr-90 beta source was taken for TL measurement. The reproducibility of the system was found within 3%[1-2].

RESULTS AND DISCUSSION

Fig-1is the TL ofAmethyst mineral as received (AR), annealed and quenched (AQ) from 200, 400,600 and 800°C. The TL was recorded for 5mg weighed powder by giving 15 Gy beta dose from Sr-90 beta source. Curve-1 is the TL of 15 Gy beta irradiated as receivedAmethyst. It shows a broad peak around 141°C and followed by a small hump. Curve-2 is the TLof 15 Gy beta irradiated Amethyst annealed and quenched from200°C. It displays a hump and a small peak around 155°C followed by hump with less intensity when compared to curve-1. Curve-3 is the TL of 15 Gy beta irradiated Amethyst annealed and quenched from 400°C.From curve-3 it is observed a good peak around 100°C and a small hump with little high intensity when compared to curve-2. Curve-4 is the TL of 15 Gy beta irradiated Amethyst annealed and quenched from 600°C. It shows a small peak at 105°Cfollowed by a hump with little high intensity when compared to curve-3.Curve-5 is the TL of 15 Gy beta irradiated Amethyst annealed and quenched from 800°C.It displays a good peak at 140°C followed by few humps with increased intensity when compared to curve-4. From the figure, it is also observed that as the annealing temperature increases from 200 to 800°C entire TL pattern changes and finally a good peak with increased intensity is obtained. This may be due to various phase changes occurred while annealing the mineral from 200-800°C temperatures.

Fig-2is the TL of Amethyst mineral annealed and quenched (AQ) from 800°C. The TL was recorded for 5mg weighed powder by giving gamma irradiation. It shows a broad peak around 120°C followed by a small hump and a broad peak at 190°C followed by few humps and another small peak around 237°C. From the figure it is observed that three peaks are obtained with few humps with less intensity. This may be due to various phase changes occurred while annealing the mineral from 800°C temperature.

Fig-3is the TL of Amethyst mineral annealed and quenched (AQ) from 800°C. The TL was recorded for 5mg weighed powder by giving X-ray irradiation. It shows a small peak around 126°C followed by a small hump and a broad peak at 184°C followed by few humps and another small peak around 249°C. From the figure, it is observed that three peaks are obtained with few humps with less intensity. This may be due to various phase changes occurred while annealing the mineral from 800°C temperature. However, the X-ray andγ-rayirradiations did not yield any significant TL.

Fig-4is the XRD pattern ofAmethyst; it is clearly observed that the maximum peak obtained at 27°. The Crystallite size of Amethyst is calculated using Scherrer's formula and is found around **85 nm**. The XRD is plain and all the planer reflections are seen.

Fig-5is the TGA ofAmethyst. From figure it is found that there are many phase changes in the temperature range of 50°C - 800°C. It is interesting to note there is a sudden phase change in between 600-735°C. This may be due to structural collapse of the mineral.

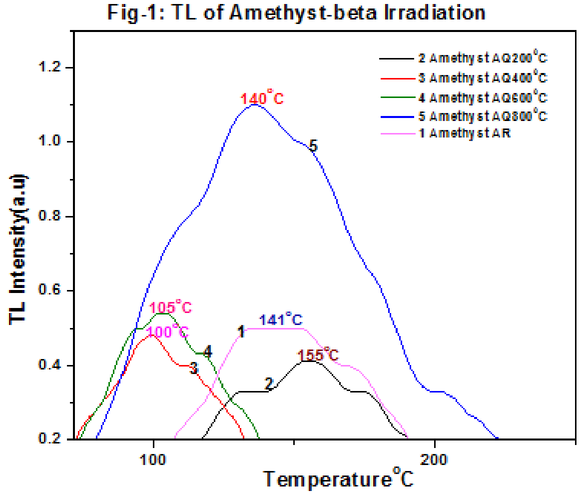


Fig-1: TL of Amethyst-beta Irradiation

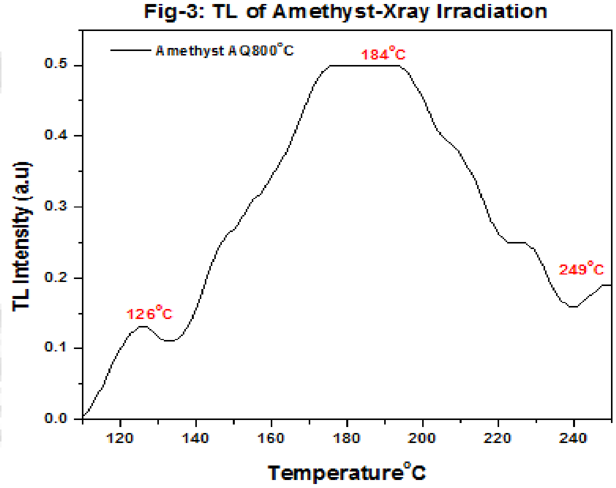


Fig-3: TL of Amethyst-Xray Irradiation

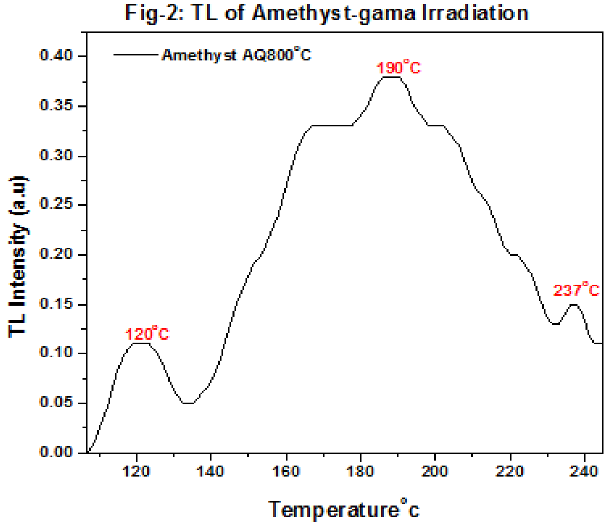


Fig-2: TL of Amethyst-gama Irradiation

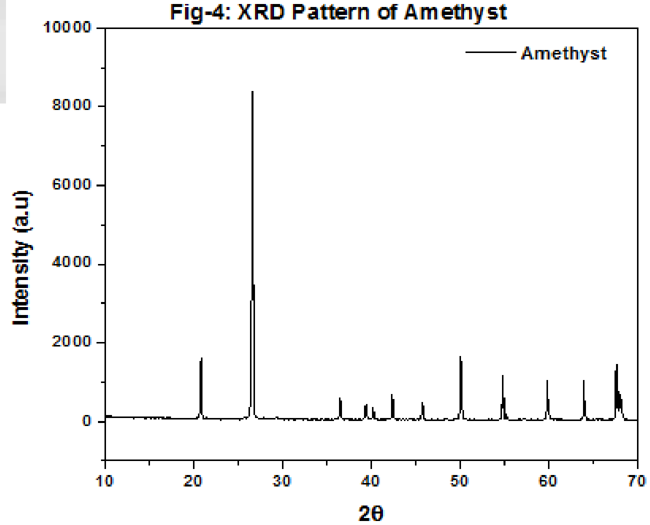
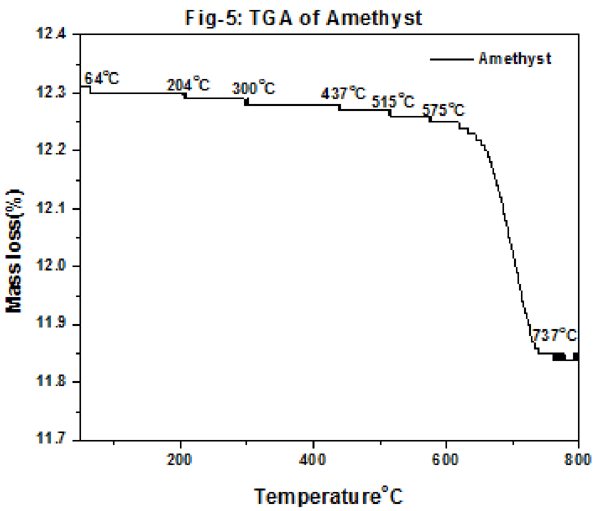


Fig-4: XRD Pattern of Amethyst



CONCLUSIONS:

1. From TL of Amethyst given a beta dose of 15Gy it is found so many variations in peak temperatures for different annealing and quenched temperatures with very less intensity.

2. From the TL of γ- irradiated and X-ray irradiated of Amethyst, It is seen that very humps and kinks with very less intensity is observed.This may be due to good crystallite formation which is confirmed XRD of Amethyst whose crystallite size is **85nm**.

3. The XRD pattern of Amethyst is very plain and all the planar reflections are seen.

4. From TGA It is interesting to note there is a sudden phase change in between 600-735^{o}C. This may be due to structural collapse of the mineral.

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