Recent Research in Science and Technology 2012, 4(8): 58-60
ISSN: 2076-5061
Available Online: http://recent-science.com/

TL glow curve and kinetic of gamma irradiated quartz collected from Rasmada mines of C.G. basin

***Jagjeet Kaur, *Suryanarayana N.S, *Vikas Dubey, *Rahul Shrivas; **K.V.R.Murthy and S.J. Dhoble**

Department of Physics, Govt. Vishwanath Yadav Tamaskar Post Graduate Autonomous College, Durg (C.G.), India, 491001
**Applied Physics Department, Faculty of Technology and Engineering, M.S. University of Baroda, Baroda 390001, India
Department of Physics, RTM University, Nagpur, India.

Abstract
Present paper reports the TL glow curve and kinetic parameter of Quartz. The sample of natural quartz collected from Rasmada mines of C.G. basin is irradiated with gamma source. For gamma exposure Co^{60} gamma source was used and the exposure of 1 hour to 4 hour was given to the sample with dose 0.5kGy to 2 kGy. TL glow for quartz crystal shows the peaks at temperature 242, 256, 250 and 252^0C for doses 2kGy to 0.5 kGy respectively. The powder sample shows TL glow peak at 236, 251, 254 and 253^0C respectively. The corresponding activation energy and frequency factor is calculated by peak shape method. The activation energy found to be 0.79 eV for powder and 1.26 eV for quartz crystal, frequency factor is found to be $4X10^8$ to $3X10^{13}sec^{-1}$. The maximum activation energy is found for quartz crystal with gamma exposure of 2kGy. The sample shows first and second order kinetics. The sample was characterized by XRD. The Induction coupled plasma activated emission spectra (ICP - AES) analysis was done to find out the percentage of elements in the quartz mineral.

Keywords: Gamma irradiated; quartz; thermoluminescence; kinetics, ICP – AES.

INTRODUCTION

Quartz is abundant in nature and can be found in archaeological artifacts as well as geological materials [1]. Quartz exposed to ionizing radiation exhibits both thermoluminescence (TL) and optically stimulated luminescence (OSL) when heated or stimulated with light respectively. The usefulness of quartz as a radiation dosimeter, in both archaeological and geological dating applications, and for assessment of dose following artificial-radiation exposure using luminescence has been reviewed by several authors [2, 3]. In particular, luminescence characteristics of quartz have been discussed either from experiments to monitor the change in the relative number of luminescence centres and electron traps or by use of models involving interactions among the recombinations centres or electron traps [2, 3].

EXPERIMENTAL

Samples of quartz were obtained from rasmada mines of Durg district of Chhattisgarh state (INDIA). TL measurements were taken from a TLD unit supplied by M/S Nuclionix Systems Hyderabad. During TL measurements heating rate was used 6.7^oC / sec. The Co^{60} gamma source was used for irradiating the specimen. Every time 2 mg weighed powder and crystal is taken for TL measurement. The sample was characterized by XRD. The XRD measurements were carried out using Bruker D8 Advance X-ray diffractometer. The x-rays were produced using a sealed tube and the wavelength of x-ray was 0.154 nm (Cu K-alpha). The x-rays were detected using a fast counting detector based on Silicon strip technology (Bruker LynxEye detector). The ICP – AES chemical analysis was done by ELAN DRC II at NGRI – Hyderabad.

Results and Discussion

The XRD pattern of the sample is shown in figure 1. From the XRD pattern analysis it was found that the prominent phase formed is quartz, by well indexed based on the JCPDS No.89-8934. Eight different peaks are obtained at 2θ values of 21.22^0, 26.84^0, 28.08^0, 39.74^0, 50.37^0, 54.96^0, 60.16^0 and 68.08^0. This shows that the sample have hexagonal structure. The XRD peaks corresponds to Bragg diffraction at (100), (011), (102), (112), (022), (121) and (203) planes of hexagonal quartz. The sharp peaks indicate microcrystalline behavior of the sample.

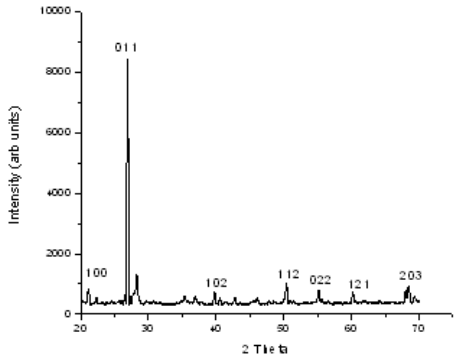

Fig 1. XRD pattern of quartz collected from Rasmada mines of C.G.Basin

Fig. 2 – 5 shows the TL glow curve of quartz collected from Rasmada mines of C.G. basin. The mineral was irradiated with gamma (γ) source given dose of 0.5 kGy to 2kGy for powder and crystal of quartz. The heating rate used for TL measurements is 6.7^0C/sec. The sample displayed well resolved peak at 242, 256, 250 and 252^0C for crystal with gamma exposure 2kGy to 0.5 kGy respectively and the powder quartz sample shows TL glow peak at 236, 251, 254 and 253^0C respectively. Corresponding activation energy (E) values are calculated using the formulas modified by Chen and others [4-7]. The shape factor (μ), activation energy (E),

order of kinetic (b) and the trap depth for the prominent glow peaks of the Quartz, under study were calculated and are shown in Table 1 and 2.

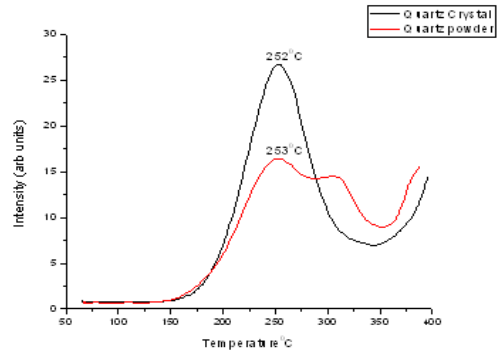

Fig 2. TL glow curve of quartz for crystal and powder with gamma exposure 0.5 kGy

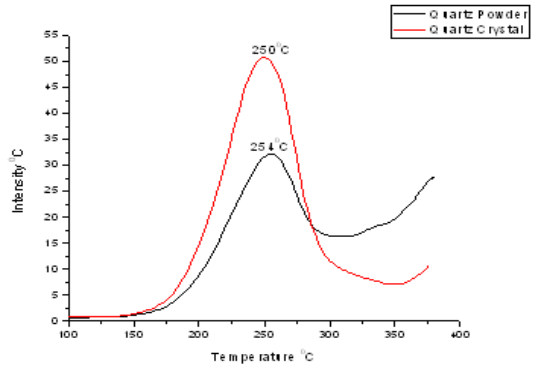

Fig 3. TL glow curve of quartz for crystal and powder with gamma exposure 1 kGy

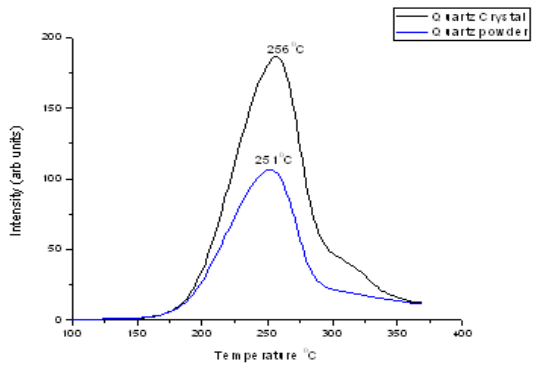

Fig 4. TL glow curve of quartz for crystal and powder with gamma exposure 1.5 kGy

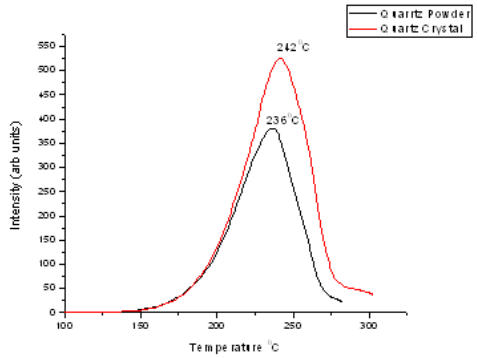

Fig. 5 TL glow curve of quartz for crystal and powder with gamma exposure 2 kGy

Table 1. Shape factor (μ), Activation energy (E) and frequency factor (s) of gamma irradiated natural quartz collected from Rasmada mines of C.G. basin

Gamma dose in kGy (kilo Grey)	T_1	T_m	T_2	τ	δ	ω	μ = δ / ω	Activation energy E	Frequency factor s
Quartz crystal 2 kGy	214	242	284	28	42	70	0.6	1.26	$3X10^{13}$
Quartz powder 2 kGy	208	236	255	28	19	47	0.40	1.18	$7X10^{12}$
Quartz crystal 1.5kGy	221	256	278	35	22	57	0.38	1.01	$5X10^{10}$
Quartz powder 1.5kGy	212	251	274	39	23	62	0.37	0.88	$3X10^{9}$
Quartz crystal 1 kGy	214	250	277	36	27	63	0.42	0.96	$2X10^{10}$
Quartz powder 1 kGy	213	254	284	41	30	71	0.42	0.85	$2X10^{9}$
Quartz crystal 0.5 kGy	212	252	282	40	30	70	0.42	0.87	$3X10^{9}$
Quartz powder 0.5 kGy	208	253	300	45	47	92	0.51	0.79	$4X10^{8}$

Table 2. The trap depth for the prominent glow peaks of the studied Quartz, evaluated from first and second order kinetics

Methods	References	0.5 kGy	1 kGy	1.5 kGy	2 kGy	0.5 kGy	1 kGy	1.5 kGy	2 kGy
		For Quartz Crystal				For quartz powder			
$E\ (eV) = T_m(K)/500$	[4]	0.50	0.5	0.51	0.48	0.50	0.50	0.50	0.47
$E(eV) = 23KT_m$	[5]	0.49	0.49	0.50	0.47	0.50	0.50	0.49	0.46
$E(eV) = 38KT_m$	[6]	0.82	0.81	0.83	0.79	0.82	0.83	0.82	0.77
$E\ (eV) = \frac{2KT_m^2}{\delta}$	[7]	0.36	0.39	0.51	0.24	0.23	0.37	0.47	0.50
$E_\omega = C_\omega \frac{KT_m^2}{\omega} - b_\omega(2KT_m)$	[7]	0.13	0.15	0.14	0.23	0.11	0.13	0.11	0.17
$E_\tau = C_\tau \frac{KT_m^2}{\tau} - b_\tau(2KT_m)$	[7]	0.11	0.13	0.14	0.23	0.89	0.11	0.10	0.16
$E_\delta = C_\delta \frac{KT_m^2}{\delta} - b_\delta(2KT_m$	[7]	0.16	0.18	0.16	0.23	0.14	0.16	0.12	0.19

The peak shape factor of 242^{0}C TL peak in quartz crystal was found to be ~0.6 which follows second order of kinetics similar behavior have been shown by the quartz powder sample irradiated with gamma 0.5kGy dose. The value E and s derived from different Chen's peak shape method tabulated in Table 1 & 2. The TL kinetics, the activation energy and the frequency factor is found associated with 242^{0}C were found to be second order with value 1.26eV, $3X10^{13}$ sec^{-1} respectively. The trap depth is found to be 0.14 to 0.83eV.

Table 3 is the result of induction coupled plasma activated emission spectra (ICP - AES) analysis. It is interesting to note that the major oxide is CaO and SiO_2 and some percentage of Al_2O_3 is also present in natural quartz sample.

Table 3. ICP – AES analysis of Quartz sample

Sample name	Ca (as CaO) %	Mg (as MgO) %	L.O.I. (in %)	SiO2 (Silica) %	Fe (as Fe_2O_3) %	Al (as Al_2O_3) %	Mn (as)MnO %	Other Trace Elements	Total (in %)
Quartz	48.22	0.16	0.96	23.52	1.00	25.23	0.53	0.38	100

CONCLUSION

The value of activation energy E and frequency factor s of quartz by gamma irradiation collected from Rasmada mines of Durg district is highest using peak shape methods. The activation energy E, frequency factor s of the both crystal and powder sample of natural quartz are found in between 0.79 to 1.26 eV, $4X10^8$ to $3X10^{13}$ s^{-1}. The sample shows first and second order of kinetics.

ACKNOWLEDGEMENT

We are grateful to UGC New Delhi for funding through a Major Research Project. Also very thankful to NGRI (National

Geophysics Research Institute), Hyderabad for Chemical Analysis of our sample. Department of Physics, RTM, University Nagpur for providing facility for irradiating the sample.

REFERENCES

[1] G.O. Sawakuchi, E. Okuno, Nucl. Instrum. Methods *Phys. Res.* B 218 (2004) 217.
[2] A.G. Wintle, A.S. Murray, *Radiat. Meas*. 41 (2006) 369.
[3] L. Botter-Jensen, S.W.S. Mckeever, A.G. Wintle, Optically Stimulated Luminescence Dosimetry, Elsevier, 2003.
[4] Randall J.T. and Wilkins M.H.F., (1945) Proc. Roy. Soc. A 184 366.
[5] Urbach F., (1930) Winer Ber. IIa 139 363.
[6] Lushihik L.I., (1956) *Soviet Phys.* JEPT 3 390
[7] Chen R. (1969) *J.Electrochem.Soc.* 116: 1254.