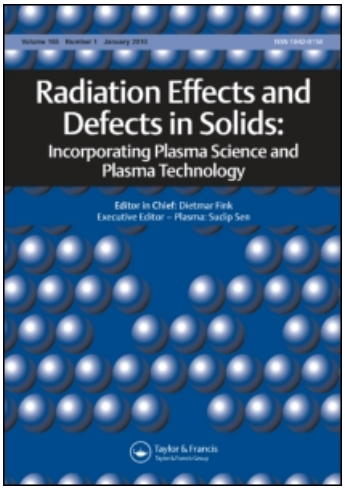

Radiation Effects and Defects in Solids
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713648881

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To cite this Article Souza, Divanizia N. , Valerio, Mário Ernesto G. , de Lima, José F. and Caldas, Linda V. E.(2001) 'The use of pellets of brazilian natural topaz as radiation dosimeters', Radiation Effects and Defects in Solids, 156: 1, 325 — 330
To link to this Article: DOI: 10.1080/10420150108216913
URL: http://dx.doi.org/10.1080/10420150108216913

Radiation Effects & Defects in Solids, Vol. 156, pp. 325–330
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THE USE OF PELLETS OF BRAZILIAN NATURAL TOPAZ AS RADIATION DOSIMETERS

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(Received 7 April 2000; In final form 24 September 2000)

The properties of the thermoluminescent emission (TL) and thermally stimulated exoelectron emission (TSEE) of pellets of colourless natural topaz samples from Santo Antonio do Jacinto, Minas Gerais, Brazil, were studied with the aim of use as solid state dosimeters. Standardized fields of ^{60}Co, ^{137}Cs, ^{241}Am, $^{90}Sr/^{90}Y$ and X-rays were used for the tests. The TSEE and TL responses were studied as a function of the radiation energy (photons and particles) and as a function of the absorbed dose. The results indicate that colourless topaz from Minas Gerais, Brazil, is a promising material for dosimetric purposes.

Keywords: Topaz; TL; TSEE; Dosimeters

1. INTRODUCTION

Mineral topaz is found in nature in the form of crystalline blocks. Topaz is an aluminium fluorosilicate with a general composition of $Al_2(SiO_4)(FOH)_2$. It crystallizes in a rhombohedral structure, belonging to the space group Pbnm.

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In previous papers [1, 2] the influence of the gamma radiation and UV light on the TL emission of natural topaz from different parts of Brazil was studied. The natural samples present up to six TL peaks when irradiated with gamma radiation. For thermally treated colourless samples irradiated with gamma and X radiation there are three TL peaks at 110°C, 170°C and 250°C and one TSEE peak at 190°C. The UV light can promote the filling of some TL traps. The emission spectra of these peaks are similar to the spectra observed in quartz and it is possible that the emission centres could be the same ones found in quartz and silica. On the other hand, there is no model available in the literature to explain the TL trapping centres in topaz and this will be the next step of the work.

In the present work the influence of the dose and the energy of alpha, beta, gamma and X rays on the TL and TSEE response of pellets of natural colourless topaz was studied. The main aim is to investigate the potential application of these pellets as TL and TSEE dosimeters.

2. EXPERIMENTAL

Pellets of natural colourless topaz samples from Santo Antonio do Jacinto, Minas Gerais, Brazil, were prepared by mixing topaz with Teflon. The crystals were powdered and the grains between 0.075 and 0.150 mm were thermally treated at 300°C for 30 min followed by another thermal treatment at 400°C for 1.5 h. The thermally treated topaz powder was mixed with Teflon in the 1:2 ratio (wt) and cold pressed producing pellets sizing 6 mm diameter × 1 mm thickness. Pellets were thermally treated prior to irradiation at 300°C during 1 h in air, and then quickly cooled down to room temperature.

Photon, alpha and beta irradiations were performed at the IPEN-CNEN/SP facilities. X-ray irradiations were carried out using a Rigaku Denki generator, model Geigerflex, with Philips tube (60 kV), with effective energies of 14.3 keV and 21.3 keV. Gamma irradiations were performed using ^{60}Co (Telecobalt unit, Keleket Barnes Flexarey model IS) and ^{137}Cs (Gamma calibrator, model 64–764) sources. For alpha irradiation, a ^{241}Am source with 74000 s^{-1} emission flux was used, and for beta doses a ^{90}Sr + ^{90}Y source was employed. The pellets were irradiated under electronic equilibrium conditions in the cases of ^{60}Co and ^{137}Cs.

The TSEE and TL responses as a function of absorbed dose were obtained in the interval between 0.5 Gy and 5.0 Gy for photon and beta radiation. For alpha radiation the response was obtained as a function of irradiation time.

The TSEE signal was registered using a system with a 2π windowless gas-flow proportional counter. The heating was linear at a rate of 5°C/s from room temperature up to 300°C [3].

TL emission measurements were carried out using a home-made reader described in a previous paper [2]. The samples were heated linearly at 4°C/s up to a maximum temperature of 300°C in each readout cycle.

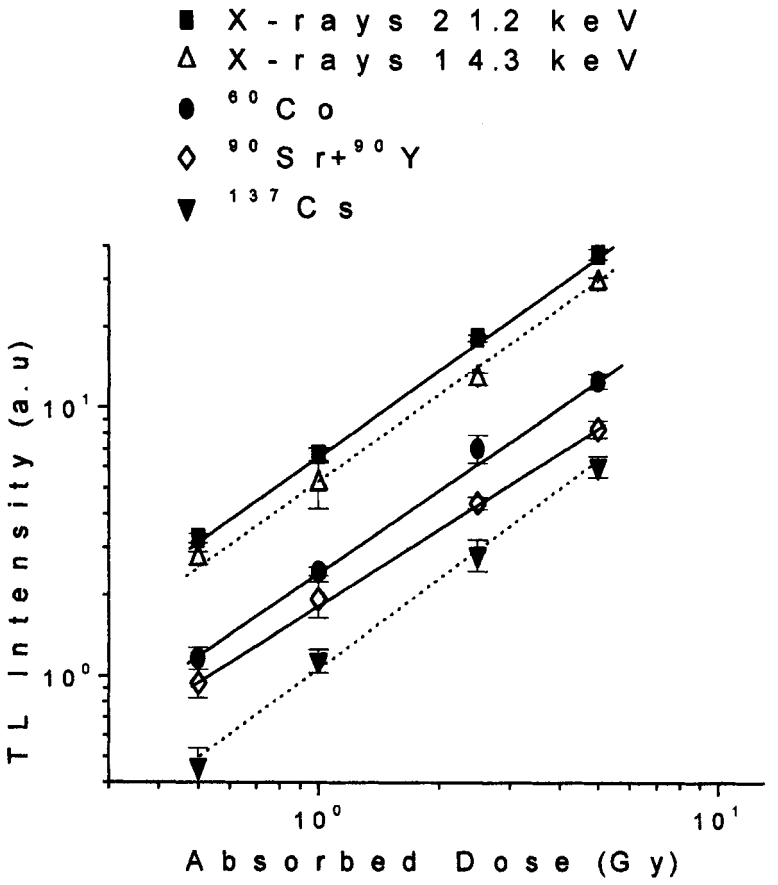

FIGURE 1 TL response (peak intensity) at 170°C of pellets of Brazilian natural topaz as a function of absorbed dose for gamma, beta and X radiation.

3. RESULTS AND DISCUSSION

Figure 1 presents the intensity of the TL peak at 170°C of the pellets of Brazilian natural topaz as a function of absorbed dose for gamma, beta and X radiation in the interval between 0.5 Gy and 5.0 Gy. The intensity of the peak increases with the dose.

In Figure 2 the TSEE peak area as a function of absorbed dose for gamma, beta and X radiation in the same dose range can be observed. The pellets irradiated with X-rays of 14.3 keV are more intense than those irradiated with 21.2 keV. This fact may be explained if considering

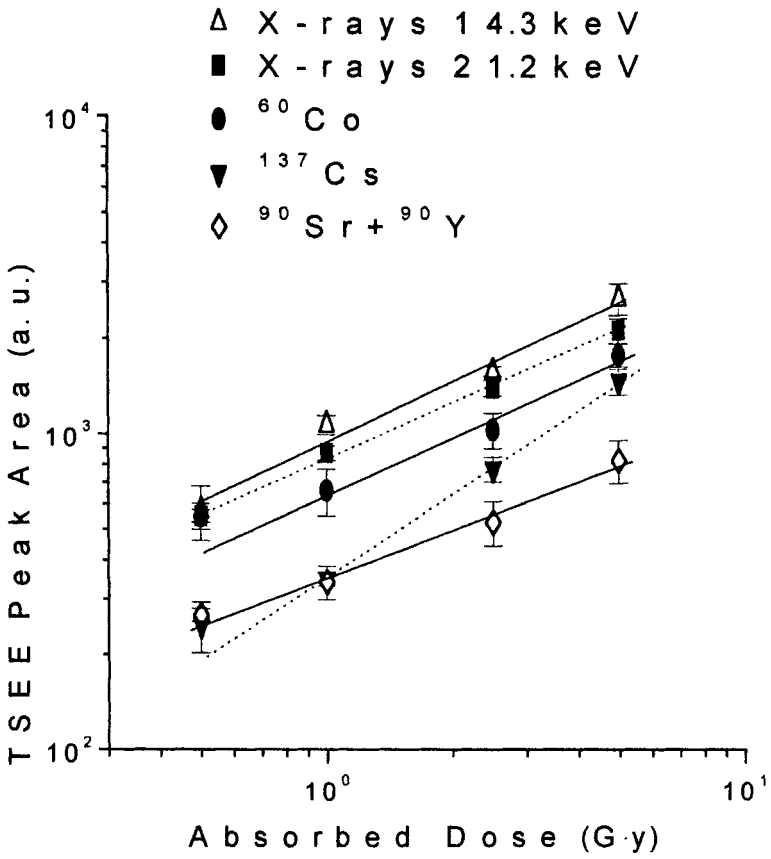

FIGURE 2 TSEE response (area) of pellets of Brazilian natural topaz as a function of absorbed dose for gamma, beta and X radiation.

that less energetic X-rays are more efficient at ionizing the surfaces than more energetic beams, and the TSEE signal is mainly related to the superficial emission of solids.

In the case of alpha irradiation (^{241}Am), the intensities of both TL and TSEE peaks increase as a function of the exposure time.

Figure 3 shows the results of the dependence the TSEE peak area and the TL intensity as a function of energy of the gamma and X-rays. The pellets were all exposed to the same absorbed dose of 1.0 Gy. The TL response reaches a maximum at 21.2 keV, while in the case of TSEE, the response decreases as the energy increases for the tested X-ray energy interval.

In a previous work [4] we have investigated the emission spectra of the TL emission of topaz and the results, combined with the results presented

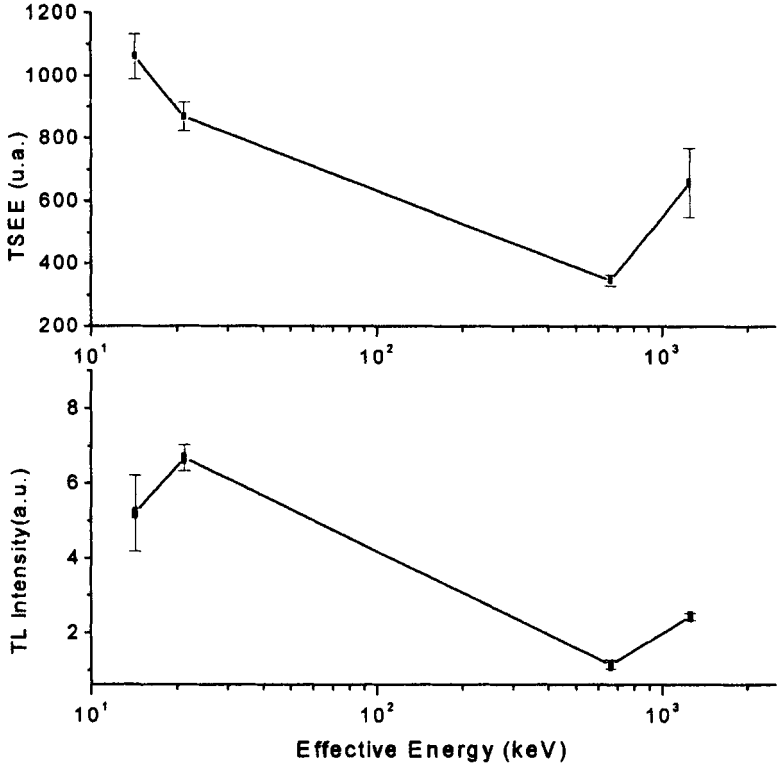

FIGURE 3 TSEE and TL response of pellets of Brazilian natural topaz as a function of energy of gamma and X radiation for a fixed absorbed dose of 1 Gy.

in the present paper, indicate that the charge traps in topaz could be related to the centres observed in other silicates. Since in topaz the concentration of Al^{3+} is high, the emission could be due to a centre similar to the well known $[AlO_4]^0$ centre in quartz or silica.

CONCLUSION

The results presented here, combined with those obtained in a previous paper [4], clearly indicate that pellets of natural colourless topaz is a very promising material for several TL and TSEE dosimetric applications.

References

[1] Souza, D. N. de Lima, J. F. and Valerio, M. E. G. (1995). *Rad. Eff. & Def. Sol.*, **135**, 109.
[2] Souza, D. N. de Lima, J. F. and Valerio, M. E. G. (1997). *Mat. Sci. For.*, **239–241**, 765.
[3] Rocha, F. D. G. "Desenvolvimento de um Sistema de Emissao Exoeletrnica Termicamente Estimulada para Aplicação em Dosimetria", PhD Thesis, Instituto de Pesquisas Energéticas e Nucleares, São Paulo, Brazil, 1997.
[4] Souza, D. N. Valerio, M. E. G. Lima, and Caldas, L. V. E. (2000). *Nuc. Inst. and Meth.*, **B166–167**, 209.