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THERMOLUMINESCENT RESPONSE OF ZrO_2 + PTFE PREPARED IN MEXICO TO $^{90}Sr/^{90}Y$ BETA PARTICLES

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Abstract — Results of studying the thermoluminescent response of undoped ZrO_2 + PTFE pellets irradiated with $^{90}Sr/^{90}Y$ beta particles are presented. Previously, TL characteristics of ZrO_2 films doped with rare earths were studied. Phosphor powder was obtained by evaporating a solution of zirconium nitrate in ethanol. In order to stabilise the traps in ZrO_2 this phosphor was submitted to different thermal treatments. Optimal thermal treatment consisted in heating at 1100°C for 24 h. With this powder, pressing at room temperature a mixture (2:1) of ZrO_2 and polytetrafluoroethylene (PTFE), pellets of 5 mm diameter and 0.8 mm thickness were made. The glow curve of ZrO_2 + PTFE pellets exhibited two peaks at 200 and 250°C; its TL response as a function of beta particles dose was linear in the range from 2 to 60 Gy. Repeatability over 10 cycles was 1.8%. Fading at room temperature was 3.8% per month.

INTRODUCTION

In recent years in our laboratory the TL response of a great number of materials to beta radiation has been studied. The thermoluminescence response to UV light of irradiated zirconium oxide undoped and rare earth-doped has been studied previously[1]. It has been observed that the TL response of ZrO_2 is closely related with its structure and morphology[2]. The effect of the irradiation in this material has been the subject of experimental research, especially because of the great interest in the field of environmental ultraviolet monitoring. During these investigations it has been observed that for microcrystalline preparations of ZrO_2, the phase at temperatures above 1000°C is tetragonal zirconia. The samples calcinated at higher temperatures have been examined by X ray diffraction. It is very important to investigate the effect of beta radiation in ZrO_2 since the estimation of beta radiation doses requires highly sensitive material, and this requirement causes serious difficulties in obtaining and handling detectors.

EXPERIMENTAL PROCEDURE

All ZrO_2 samples were prepared by the evaporation method from a solution consisting of a mixture of zirconium hexachloride dissolved in ethanol. This mixture was heated until all the solution was evaporated, finally obtaining phosphor powder, as reported in previous works[3,4]. The amorphous powder was then submitted to different thermal treatments in order to stabilise the traps.

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The powder was then crushed and sieved to select powder with grain sizes between 100 and 300 μm. In order to facilitate handling, samples in pellet form were made. Sintered ZrO_2 + PTFE pellets of 5 mm diameter and 0.8 mm thickness pressed at room temperature and then sintered at a temperature slightly lower than that of Teflon fusion, were obtained from a homogenous mixture 2:1 of ZrO_2 and Teflon powder.

Before studying the TL characteristics, the morphological structure of ZrO_2 samples was analysed using X ray diffraction. Before investigating their TL properties, ZrO_2 + PTFE samples were annealed at 300°C for 10 min, in order to erase undesirable information. Then, samples constituted by a set of five pellets were exposed to different doses from 1 Gy to 70 Gy of beta radiation. The beta irradiations were carried out using a Reference Dose Irradiator 6527 A of $^{90}Sr/^{90}Y$ beta particles in active equilibrium, at a dose rate of 1.46 $Gy.h^{-1}$.

TL readings were made using a TL Analyser Harshaw model 4000. The linear heating rate was set at 10°C.s^{-1}; and the reading cycle was performed within 30 s, with a constant nitrogen flux. Light emission was integrated in the temperature range between room temperature (20°C) and 300°C. All the irradiations were carried out under the same conditions. Each reported value corresponds to the average at 10 measurements.

The TL response of ZrO_2 dosemeters as a function of dose was studied in the range from 1 Gy to 70 Gy. The individual repeatability of the dosemeters was investigated for each type of dosemeter by calculating the standard deviation of ten successive dose measurements.

To investigate fading characteristics, the undoped ZrO_2 + PTFE pellets were submitted to the annealing process and then irradiated with $^{90}Sr/^{90}Y$ beta particles and stored for a period of one month at room tempera-

ture. The results obtained for the stored dosemeters were compared with those obtained for the dosemeters annealed immediately after irradiation, stored for 24 h and then read out.

RESULTS

The dosemeters in the form of ZrO_2 + PTFE pellets irradiated with $^{90}Sr/^{90}Y$ beta particles showed a glow curve with two peaks at 200 and 250°C respectively. This is shown in Figure 1 for an absorbed dose of 10 Gy. The TL response of ZrO_2 + PTFE as a function of absorbed dose was linear in the range from 2 to 60 Gy, the plotted data are shown in Figure 2. The average of repeatability can be obtained for ten pellets irradiated with 10 Gy of $^{90}Sr/^{90}Y$ under identical conditions. This repeatability after ten cycles was 1.8%. This value can be appreciated in Figure 3. Fading at room temperature was 3.8% per month as is shown in Figure 4.

CONCLUSION

Thermoluminescence response of ZrO_2 + PTFE as a function of dose showed a good linear response, exhibiting a glow curve with two dosimetric peaks. The dosemeters can be re-used many times with non-appreciable changes in sensitivity if an appropriate annealing pro-

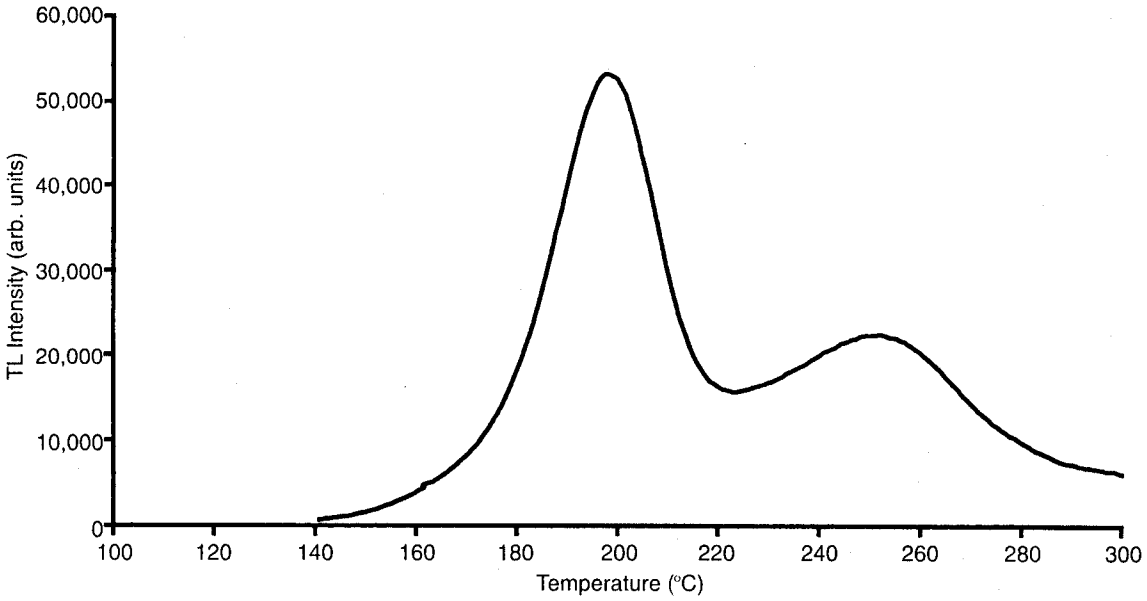

Figure 1. Glow curve of ZrO_2 + PTFE irradiated with $^{90}Sr/^{90}Y$ beta particles at an absorbed dose of 10 Gy.

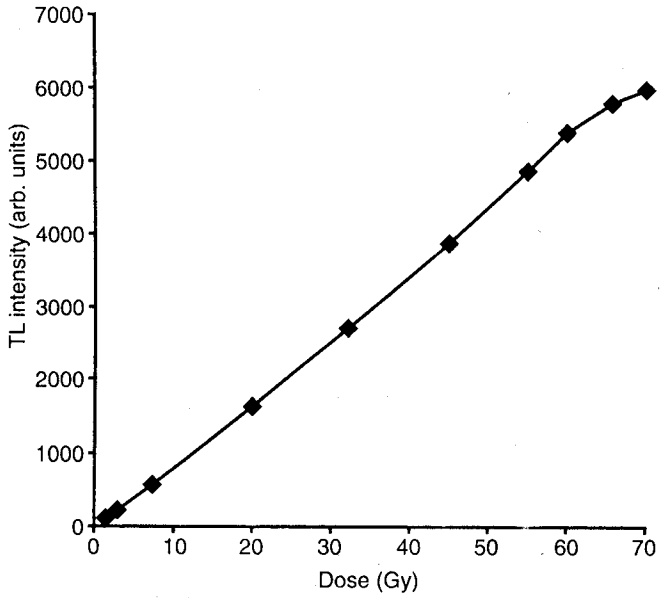

Figure 2. Thermoluminescent response of ZrO_2 + PTFE as function of absorbed dose.

cedure is used, and care is taken to prevent exposure of the dosemeters to light. Taking into account the above results, it can be concluded that the TL dosemeters in the form of ZrO_2 + PTFE pellets produced in Mexico appear attractive for beta dose measurements.

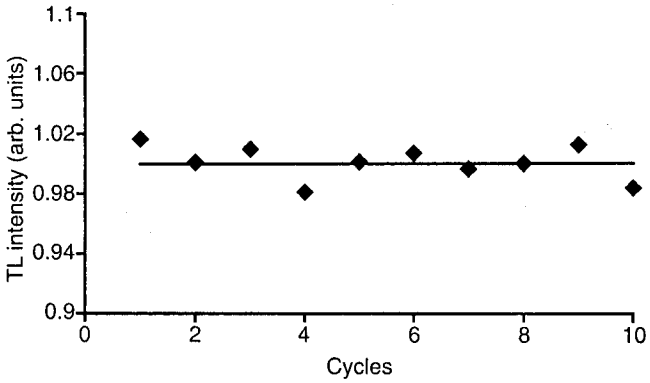

Figure 3. Repeatability of the TL response of ZrO_2 + PTFE over 10 cycles.

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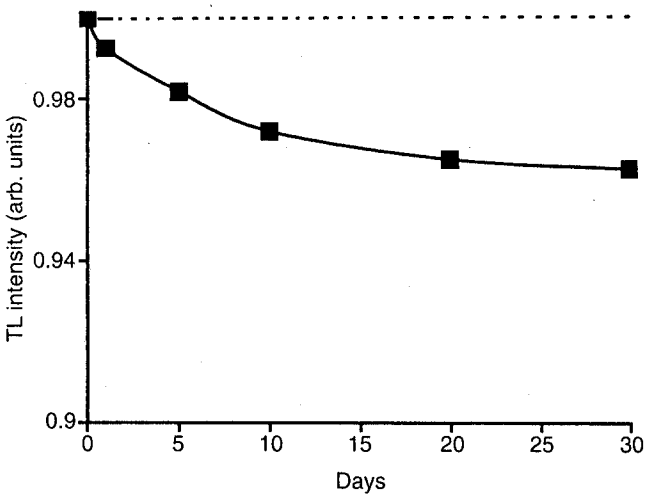

Figure 4. Fading of the TL response of ZrO_2 + PTFE over some days.

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