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ASSESSMENT OF THE AMBIENTAL EXPOSURE AT IPEN USING $CASO_4$:Dy DETECTORS WITH DIFFERENT FILTERS COMBINATION

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ABSTRACT

To perform environmental and area radiation monitoring at Instituto de Pesquisas Energéticas e Nucleares (IPEN) and in some external institutions and to assess the exposure in these areas, a new badge with different lead filters arrangement was studied aiming to reduce the TL response of $CaSO_4$:Dy as a function of incident radiation energy to improve the environmental exposure evaluation.

1. INTRODUCTION

$CaSO_4$: Dy is one of the most useful and sensitive thermoluminescence dosemeter material for radiation dosimetry. Because of its high sensitivity to gamma radiation and stability of response, it is often used to assess the radiation dose to the general public from nuclear or radiological facilities [1,2,3,4] and also for personal dosimetry. Due to its high effective atomic number, $CaSO_4$: Dy presents a response that is energy dependent, and the compensation for this is often achieved by the use of different filters with a higher atomic number. In this case, two or more detectors are placed behind different filters (or without filters) and from the ratio of responses of these different filters, the energy of the incident radiation can be estimated [5]. In order to improve the environmental exposure evaluation, a new badge with different lead filters arrangement was studied aiming to reduce the TL response of $CaSO_4$:Dy as a function of incident radiation energy.

2. MATERIALS AND METHODS

The thermoluminescence material used for this work was $CaSO_4$:Dy in the form of sintered pellets with 6mm in diameter and 0.8mm in thickness, mounted on a plastic badge under different metal filters to evaluate and correct the energy dependence of $CaSO_4$: Dy dosemeters. The IPEN TL dosemeters accommodate three $CaSO_4$: Dy detectors. In this work two arrangements of TL detectors were used. The first one,called A1, consists of three detectors placed between plastic filters (2,3mm thick), lead filters (1mm thick) and lead filters with a hole (0,8mm thick) with 2mm in diameter. The second one, called A2, consists of a detector placed between plastic filters and the others two placed between lead filters with a hole with 2mm in diameter. All the TL detectors are in contact with filters. The filter area is larger than the TL detector. The TL measurements were performed using a Harshaw 5500 Automatic TLD Reader in a nitrogen atmosphere, with a linear heating rate of $10°C.s^{-1}$. The reading cycle was performed within 23s. The maximum temperature of 250°C was reached in

each readout cycle. In order to determine the TL characteristic of the dosemeters, they were irradiated using gamma radiation from a ^{60}Co source, with an activity of 0,35GBq (14/08/2003), and an X ray machine (ISOVOLT 160HS/Pantak-Seifert). The qualities used are shown in table 1. Prior to each irradiations, the detectors were thermally treated at 400°C for one hour.

Table 1. Specifications of the X-ray system of IPEN.

Radiation Quality	Voltage (kV)	Additional Filtration (mm)	Half-value layer (mm)	Effective Energy (keV)
N-60	60	2,5 (Al)	2,95 (Al)	33,05
N-80	80	23,5 (Al)	6,86 (Al)	49,40
N-100	100	2,0 (Cu)	0,58 (Cu)	65
N-150	150	0,733 (Sn)	2,36 (Cu)	118

2.1. Reproducibility

The reproducibility of the TL response of the $CaSO_4$: Dy detectors was obtained using 10 sintered pellets, each one measured 10 times after repeated procedures of a standard annealing and irradiation. The TL response spread of each pellet, after 10 readout cycles was less than 2%. The pellets were irradiated with 5mGy and then stored for one hour before being evaluated.

2.2. Radiation Dose Response

The TL response of the $CaSO_4$: Dy pellets as a function of the absorbed dose of ^{60}Co gamma radiation was measured and a linear dose response was obtained in the range between 0,5 and 10mGy. Data are shown in Fig. 1.

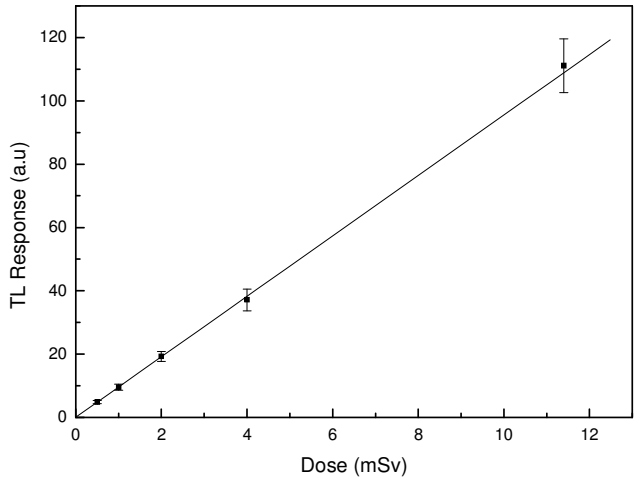

Figure 1. Thermoluminescence response of $CaSO_4$: Dy detectors as a function of dose.

2.3 Energy Dependence

The energy response of the $CaSO_4$: Dy dosemeters were studied for a range of X-rays energies, and the values were normalized to ^{60}Co. The TL response was measured from dosemeters exposed to 5mGy in X radiation beams of 48, 65, 83 and 118keV of effective energies in air. Fig. 2a shows the TL response of the $CaSO_4$: Dy below plastic, lead and lead with hole filters in the present bagde used at IPEN as a function of photon energy (A1). Fig 2b shows the response of $CaSO_4$: Dy below plastic and lead filters with a hole as a function of photon energy (A2). Each point represents the mean value of the 5 dosemeter samples. The maximum energy dependence was reached for 48keV of effective energy.

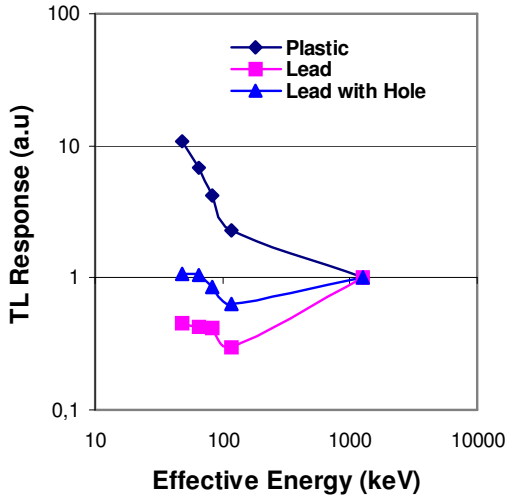

Figure 2a. The TL response of the $CaSO_4$: Dy below plastic, lead and lead with hole filters (A1).

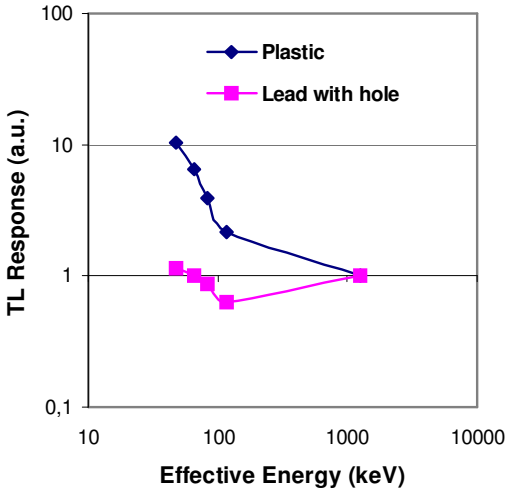

Figure 2b. The TL response of the $CaSO_4$: Dy below plastic, lead with hole filters (A2).

3. CONCLUSIONS

The TL dosemeter of the Instituto de Pesquisas Energéticas e Nucleares gives a good performance for the assessment of the ambiental exposure. Despite the high energy dependence of the $CaSO_4$: Dy sintered pellets, the results obtained are in agreement with the literature. This study has also shown that with a slight modification in the metal filters in the TL badge, that is, arrangement A2, the ambiental exposure evaluation can be improved with a better estimative of the uncertainties involved.

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