

THE STUDY OF PHOTOTRANSFER THERMOLUMINESCENCE IN CaSO₄:Dy USING LASER AND ULTRAVIOLET NON-IONIZING RADIATION

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INTRODUCTION

Due to the growth of the use of ultraviolet (UV) and laser radiation in industry, medicine and university, the preoccupation with damages from these types of radiation has increased so much. In many establishments the control of health hazards of both laser and radioactive sources is made by the same group, and the possibility of using a TLD system to monitor laser radiation has been investigated (1). If thermoluminescent (TL) materials are preirradiated with known doses of ionizing radiations, the dosimeters are sensitive to laser radiation by phototransferred thermoluminescence (PTTL) and the laser dose can be measured (2). Like in many TL materials, CaSO₄:Dy irradiated with high dose of gamma radiation, annealed and exposed to UV and laser radiation, shows phototransferred thermoluminescence. The PTTL is a technique that was developed through the study of light effects in TL materials. The objective of this work is to study the PTTL in CaSO₄:Dy using UV and laser non-ionizing radiation. The PTTL can be utilised for various dosimetric applications e. g., high dose dosimetry, dose reevaluation, UV and laser radiation dosimetry. The objective of this work is study different parameters of PTTL in CaSO₄:Dy using laser and UV radiation.

MATERIALS AND METHODS

Teflon pellets of CaSO₄:Dy produced at IPEN weighting 20 mg each., with a 6.0 mm diameter and a thickness of 0.8 mm were used (3). The pellets were annealed at 300 °C during 15 minutes before the gamma and laser or UV irradiations and thermally treated at 100 °C during 15 minutes after laser or UV irradiation.

A source of ⁶⁰Co with 15.0 TBq was used for sample irradiation. The samples were always irradiated under electronic equilibrium conditions, that is, the samples were placed between 3 mm thick Lucite plates.

The laser irradiation system contains a N₂ pulsed laser of 10 kW with pulse duration of 10 ns and wavelength of 337 nm. The UV irradiation system was composed by a Hg lamp Bausch & Lomb SP-200 and a Kratos GM-200 monochromator.

For the thermoluminescent measurement a Harshaw model 2000 AB TL reader was used. The linear heating rate was set at 10 °C.s⁻¹, and the reading cycle was performed within 36 s, with a constant flux of N₂ of 4 l.min⁻¹. Light emission was integrated in the temperature interval between 200 and 360 °C.

The pellets were first calibrated with ⁶⁰Co and selected at a range of 5 % of reproducibility.

Each reported value corresponds to the average of five measurements.

RESULTS

With respect to the laser radiation were studied two parameters:

- The PTTL response with a laser exposure time of 5 minutes as a function of gamma dose of ⁶⁰Co. It was measured between 10 Gy (10³ rad) and 65 Gy (6.5 × 10³ rad). The results are showed in Figure 1 and it is seen that the response is linear in this interval of measurements.

- The dependence of the PTTL response, using a gamma dose of 30 Gy (3 × 10³ rad), with laser exposure time was studied from 5 to 20 minutes. It is seen in Figure 2 that the time of 15 minutes has the greater response and was found to reduce for the time of 20 minutes.

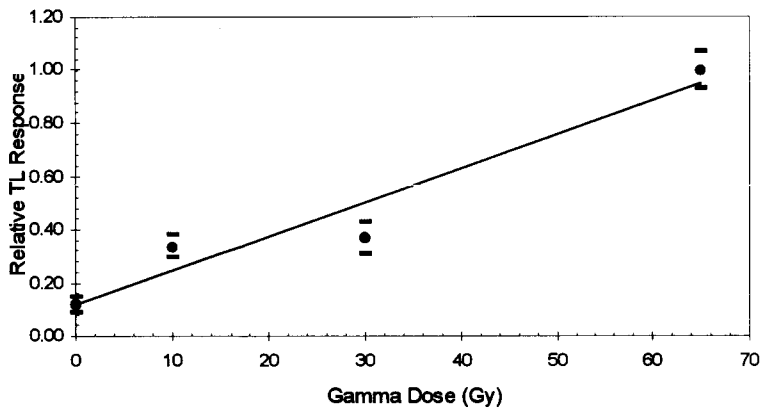


Figure 1. Dependence of TL Response as a Function of the Gamma Dose for CaSO₄:Dy

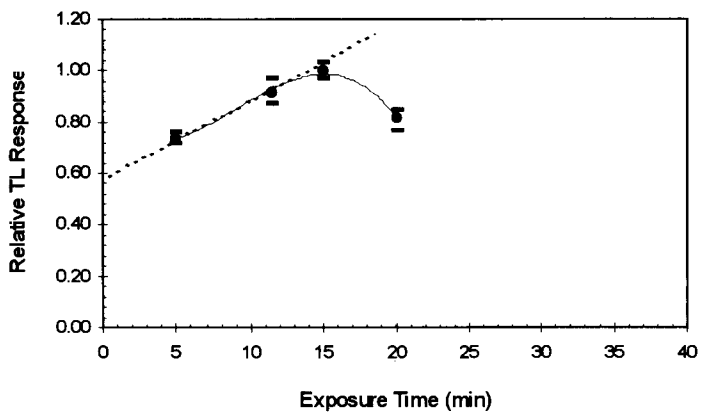


Figure 2. Dependence of TL Response as a Function of the Laser Exposure Time for CaSO₄:Dy

For the UV radiation was studied the dependence of the PTTL response as a function of UV exposure time. It was used a gamma dose of 10 Gy (10^3 rad) and a light wavelength of 310 nm and the time range studied was from 5 to 30 minutes. It is seen in Figure 3 that a better response was obtained for the exposure time of 20 minutes and was found to reduce for 30 minutes.

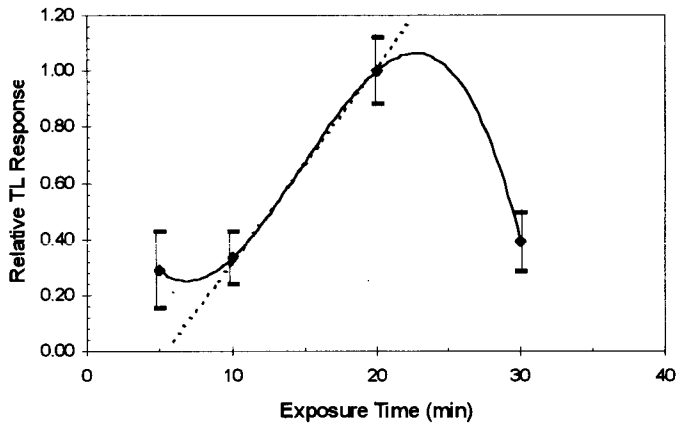


Figure 3. Dependence of TL Response as a Function of the UV Exposure Time for $\text{CaSO}_4:\text{Dy}$

The curves' behaviour of the figures 2 and 3 can indicate that there is an equilibrium between the population and depopulation of the traps placed in these temperatures. Comparing these two figures it can be seen that both curves are similar, presenting a linear and sublinear range, expected result considering their close wavelength (310 and 337 nm). It is expected that the lower limit for the laser radiation be similar to UV.

The objective of this project is to propose a theoretical model to explain this phenomenon and determine the minimum and maximum detection limits.

CONCLUSIONS

This work can be very useful to those institutions which work with non-ionizing radiation, as laser and UV and these preliminary results show that $\text{CaSO}_4:\text{Dy}$ Teflon pellets present a good performance to PTTL to be used in laser and UV dosimetry and permits to continue this research.

REFERENCES

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