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IRRADIATOR WITH TEMPERATURE CONTROL AND MONITORING FOR THERMOLUMINESCENCE DOSIMETRY

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INTRODUCTION

- The amount of ionization electrons trapped in a thermoluminescent dosimeter (TLD) crystal lattice is proportional to the absorbed dose.
- Variations in ambient temperature can lead to signal fading.

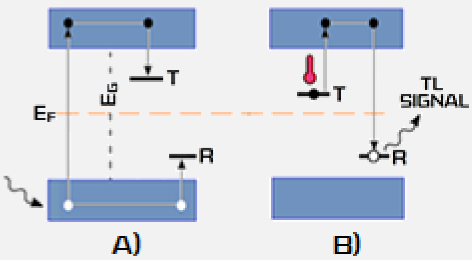

Figure 1 – A) Crystal ionization elevates electrons from the valence band to the conduction band. In deexcitation, electrons are trapped in the T energy levels. The same happens with holes, which are trapped in recombination centers (R); B) Release of charge carriers after heating the crystal and subsequent recombination with the emission of thermoluminescence photons .

OBJECTIVES

- Built an irradiator with temperature monitoring and control to assist in studies with TLDs.

MATERIALS AND RESULTS

- A prototype of the irradiator was assembled using a cellar cabinet with internal support designed in the free software ThinkerCAD and manufactured in ABS in a 3D printer.
- The radioactive source used was a $^{90}\mathrm{Sr}$ pellet of $2\ \mathrm{mm}$ in diameter and activity of $23\,\mathrm{kBq}$. The source is positioned above the sample, radiating it from top to bottom.
- The temperature is controlled by an electronic circuit on-off. A range of stable temperatures for irradiation, between (10 ± 1) ºC and (30 ± 1) ºC, was obtained.
- The total dose efficiency deposited by electrons in the sample was estimated to be $83\ \%$. This value includes the efficiency of interactions at the solid angle ($\sim 98{,}04\ \%$), calculated by the expression:

$$\Omega = 2\pi \cdot \left[1 - \frac{h}{\sqrt{h^2 + b^2}}\right] \quad [1]$$

where h and b are dimensions of the support;

- And the efficiency of scattering in the air ($\sim 85\ \%$), estimated through a Monte Carlo simulation.

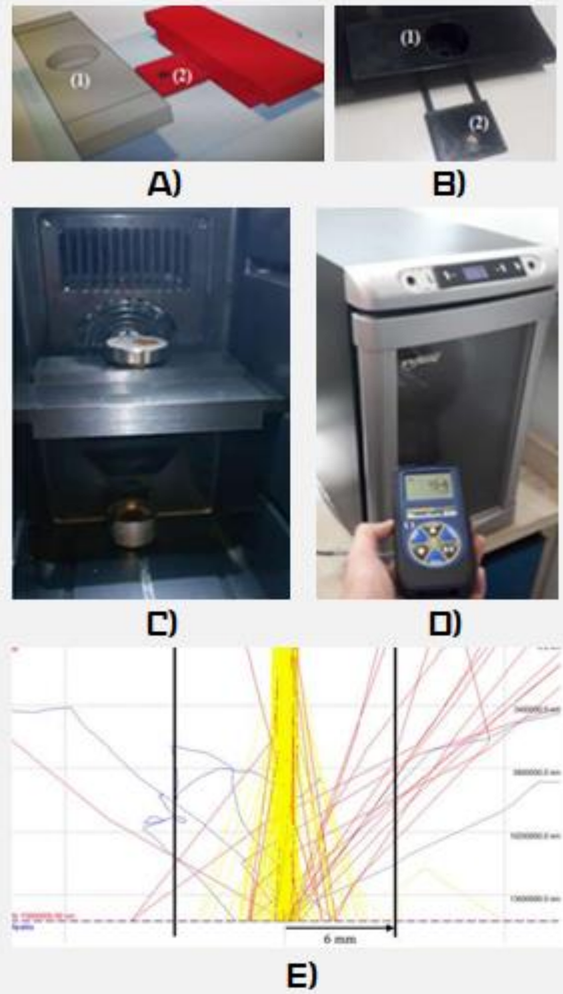

Figure 2 – A) Superior view of support on ThinkerCAD; B) Support printed, number 1 shows the location of the radioactive source, and number 2, the location of the TLD crystal; C) Prototype interior with the radioactive source placed; D) Radioprotection monitoring for the user of irradiator; E) Monte Carlo simulation for dose estimation efficiency: mean energy 182 keV,

CONCLUSIONS

- Possible to carry out experiments to check the signal fading, arising from an atypical environmental condition during irradiation or during storage;
- The irradiation always occurs in the same position, guaranteeing reproducibility in the measure and ensuring that the operator is exposed only to the secondary radiation.

REFERENCES

[1] – ATTIX, Frank Herbert. Introduction to radiological physics and radiation dosimetry. John Wiley & Sons, 2008.