Thermoluminescence study of a novel Yb^{3+}/Tm^{3+}-coactivated CaF_2 material for radiation dosimetry applications

Rafael Rodríguez (1) José Luis Plaza (2)

Email: rafael.rodriguez@ciemat.es
Affiliation
(1)CIEMAT. Avda. Complutense 40, 28040 Madrid (Spain)
(2)Universidad Autónoma de Madrid (UAM). Cantoblanco, 28049 Madrid (Spain)

Introduction

This study shows the most important features of a new TL material (CaF:Yb,Tm) for dosimetry in Medicine. Stability of the traps and their structure is addressed, as well as the response and applicability in Medicine. In addition, the study performs an analysis of the GCF and the kinetic parameters with the Tm-Tstop and VHR classical methods.

Methods

Two compact samples (CaF-Tm and CaF-YbTm) were fabricated using an own method of pressure and annealing (Rodriguez, R., et al.). SEM/EDX elemental mapping and composition were obtained at the UAM (Autonomous University of Madrid), Spain. Next, the TL response of the irradiated samples with gamma and X-rays was determined in the Ciemat External Dosimetry Service, accredited by ISO 17025 (Romero, A.M., et al.). Finally, the VHR method was used for various heating rates and the Tm-Tstop method through several pre-reading cycles.

Results

SEM/EDX analysis showed the homogeneity of the two prepared samples: CaF_2:Tm(0.5at%) and CaF_2:Yb(1.0at%),Tm (0.5at%). The stability of the irradiated samples was evaluated after 1 month of storage in the dark. The TL response of CaF-Tm and CaF-YbTm was quite different; regarding the second component, fading was significantly lower for CaF-YbTm. Another significant feature is related to the first component at low temperature, whose traps remain stable due to the added Yb. This behavior is especially useful for dosimetry of mixed fields neutron-gamma, e.g. in proton therapy, due to the different TL response between low and high temperature peaks (Muñoz I.D., et al.). In addition, fitting of the glow curves to the found kinetic parameters confirms a first-order kinetics.

Conclusions

This study determined a lower fading of the two TL components of CaF_2:Yb,Tm compared to CaF_2:Tm. The most relevant finding is that the incorporation of Yb allows maintaining the stability of the low-temperature TL component, particularly useful for dosimetry applications in Medicine.

Characterization of FXG dosimeters with gold nanoparticles for brachytherapy applications

Priscila Rodrigues[1], Ana Burin[1], Angélica Barbezan[1], Cristhian Talacimon[1], Ilca Medeiros[1], Lara El Hajj Teodoro[1], Maria Rigo[1], Maysa Gesserame[1], Paulo Tavares[1], Thuany Nogueira[1], Wilmmer Rosero[1], Orlando Rodrigues Jr[1], Carlos Zeituni[1], Maria Rostelato[1].

Email: priscilasrodrigues@usp.br
[1]Instituto de Pesquisas Energéticas e Nucleares, Universidade de São Paulo (IPEN/USP), Avenida Professor Lineu Prestes, 2242, Cidade Universitária, São Paulo SP, CEP 05508-000, Brazil.

Introduction

Chemical dosimeters are based on detectors produced by chemicals sensitive to radiation. Fricke xilenol gel dosimeters have advantages such as well-known solution chemistry and tissue equivalence over a wide range of photon energies. In addition, it is also a viable and low-cost dosimeter, despite being non-reusable, and it can be implanted in the measurement laboratory and radiotherapy clinics. The objective of this work is to produce a Fricke xylenol gel (FXG) dosimeter with the addition of formaldehyde and gold nanoparticles for low dose rate brachytherapy dosimetry.

Methods

The FXG recipe was adapted using the previously established protocol with the addition of formaldehyde and different amounts of gold nanoparticle solution. A ^{60}Co source (Gammacell) was used for irradiation; to analyze the visible spectrum, a Shimadzu UV-1800 and for 3D attenuation analysis, a Vista16 optical computed tomography scanner with a 590 nm light source were used.

Results

The results were promising, showing that a small amount of 1%(v/v) gold nanoparticles significantly increased the sensibility of the dosimeter, showing that both Fe^{+2} and Fe^{+3} peaks increased absorbance with the addition of gold nanoparticles (Figure 1). Which is particularly important in medical applications where patient exposure to radiation must be minimized.

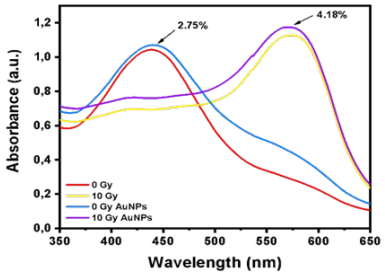

Figure 1: FXG spectra with the addition of 1%(v/v) gold nanoparticles with doses of 0 and 10 Gy.

Conclusions

Summarizing, the addition of gold nanoparticles to Fricke Xylenol Gel is a promising area of research that may result in a more sensitive and accurate dosimeter for ionizing radiation measurement. This could have important implications in medical applications, where accuracy in measuring radiation dose is essential.