The influence of the preparation route in the TL/OSL signal of $CaSO_4$:Eu,Ag samples

Danilo O. Junot[1], Divanizia N. Souza[2], Linda V. E. Caldas[1]

(1) Instituto de Pesquisas Energéticas e Nucleares/Comissão Nacional de Energia Nuclear, São Paulo, SP, Brazil
(2) Departamento de Física, Universidade Federal de Sergipe, São Cristóvão, SE, Brazil

The techniques of thermoluminescence (TL) and optically stimulated luminescence (OSL) are highly sensitive to defects caused by external elements to the crystalline matrix of a luminescent material. The structure of these defects can be controlled by the preparation method [1]. The aim of this work was to produce crystals of $CaSO_4$ doped with europium (Eu) and silver (Ag) nanoparticles, by means of three different preparation routes, and to study their applicability in radiation dosimetry by the TL and OSL techniques.

The crystals were produced by variations of the slow evaporation route. In all preparations, calcium carbonate ($CaCO_3$) was used as precursor, and incorporated in a solution of sulfuric acid, that was evaporated. Samples of $CaSO_4$:Eu,Ag(a) were obtained using europium oxide and the silver particles, produced by the polyol method, as dopants. For the growth of the crystals of $CaSO_4$:Eu,Ag(b), silver was incorporated in nitrate form, dissolved in water. $CaSO_4$:Eu,Ag(c) phosphorus were synthetized mixing europium oxide in a colloidal suspension of silver nanoparticles dispersed in ethylene glycol. Composites of all samples were obtained from the addition of Teflon to the powdered phosphors.

Scanning electron microscopy and X-ray diffraction analyses showed that samples exhibit only a single phase corresponding to the crystal structure of anhydrite. Optical characterization confirmed the presence of Eu^{3+}/Eu^{2+} in the crystal matrix. Dosimetric characteristics such as reproducibility, linearity, signal kinetics, and minimum detectable dose were evaluated after the exposure of the samples to a $^{90}Sr/^{90}Y$ source in a dose range from 0.1 to 10 Gy and to a blue-light stimulation. The $CaSO_4$:Eu,Ag(a) and $CaSO_4$:Eu,Ag(b) composites presented the most intense signals and showed a linear and reproducible dose response, but the $CaSO_4$:Eu,Ag(a) samples showed the best potential for application in TL/OSL dosimetry.

Keywords: $CaSO_4$ synthesis methods, radiation dosimetry, thermoluminescence, optically stimulated luminescence

[1] J. Azorin. Preparation methods of thermoluminescent materials for dosimetric applications: An overview. Applied Radiation and Isotopes 83, 2014, 187-191.