Evaluation of TL and OSL Response of CaF_2:Tm for Electron Beams Dosimetry in Radiation Processing

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An increasing number of pytosanitary irradiations using electron beams has encouraged the development of surface dosimetry systems to cope with both low and intermediate absorbed doses and dose rates. Besides the well-established reference and routine dosimeters, ranging from alanine to radiochromic films, there is an interest in dosimeters based on thermoluminescence (TL) and optically stimulated luminescence (OSL) effects. In this context, the aim of this paper is to study the TL and infrared stimulated luminescence (IRSL) response of the calcium fluoride dosimeter doped with thulium (CaF_2:Tm) produced via combustion synthesis (CS) by the Nuclear Energy Department of Federal University of Pernambuco, Brazil. The pellets with 6 mm in diameter and 1 mm thickness were obtained by pressing the powder using 10% PTFE as binder material. The individual TL and OSL sensitivities of the dosimeters of the batch were previously evaluated and a group of 50 pellets with a standard deviation of 6.8% was selected to be used in this study. After that, the performance of these dosimeters to electron beams with 1.5 MeV from a DC 1500/25/4 – JOB 188 Accelerator at the Radiation Technology Center at IPEN-CNEN/SP was investigated. For each dose, four pellets of CaF_2:Tm, together with four pellets of alanine were irradiated with doses from 0.5 kGy up to 10 kGy. The TL and OSL readings were carried out after a preheating at 100°C during 15 min using a Riso TL/OSL reader, model DA-20. The TL measurements were taken with a heating rate of 2°C/s, in the range from 50°C to 350°C. The OSL readings were carried out with infrared stimulation with optical power attenuated to 20% during 240 s. These readings were thermally assisted at 150°C. Residual thermoluminescent glow curves for IRSL were recorded after stimulation times.

The reproducibility and stability of the TL and IRSL responses were also evaluated, as well as the dependence with different dose rates.

The results showed that the main TL peak of the glow is in the region of 200°C and it was observed that the IRSL curve of the dosimeters presents a fast and a slow decaying IRSL signals. The TL and OSL dose response curves were fitted by a second order polynomial function with correlation coefficients of 0.97 and 0.99, respectively. The results indicated the possibility of the application of CaF_2:Tm for electron beam dosimetry in radiation processing.