

TL and OSL response of CaF₂:Tm for electron beam radiation processing

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The use of electron beams for industrial applications has increased worldwide requiring accurate dosimetry systems to assure the quality of irradiated products. The radiochromic films and alanine/EPR dosimeters are often employed in electron beam radiation processing. The thermoluminescent (TL) and optically stimulated luminescent (OSL) dosimeters are mainly used for the electron beam dosimetry for radiotherapy applications. The aim of this work is to study the TL and infrared stimulated luminescence (IRSL) response of the calcium fluoride dosimeter doped with thulium (CaF₂:Tm) for electron beam radiation processing.

The pellets of CaF₂:Tm (6mm in diameter and 1mm thickness) were produced via the solution combustion synthesis technique at the Nuclear Energy Department - UFPE. The individual TL and OSL sensitivities of a batch of these dosimeters were previously evaluated and 50 pellets with a standard deviation of 6% were selected to be used in this study. Irradiation was performed at the Radiation Technology Center at IPEN-CNEN/SP using 1.5MeV electron beam from a DC 1500/25/4 – JOB 188 accelerator covering the dose rate range 2-32kGy/s and doses from 0.5kGy up to 10kGy. The TL and OSL readings were carried out after a preheating at 100°C during 15min 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 240s. 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 from 2kGy/s up to 32kGy/s.

The results showed a deconvoluted TL glow curve with four components, being the main two TL peaks centred in the regions of 150°C and 200°C. The area of the TL peaks increases linearly with the absorbed dose up to 6kGy for all the dose rates evaluated. For doses higher than 6kGy, the TL response is sublinear with saturation around 10kGy. The IRSL curves of the dosimeters present a fast and a slow decaying IRSL signals. The total area of IRSL curves were measured for both different doses and dose rates. The correspondent results were linearly dependent on the absorbed dose and saturated in almost 10kGy. The IRSL residual TL glow curves exhibited a symmetrical decrease to the growing OSL signal.

All the results presented regarding TL and IRSL response of CaF₂:Tm have shown that these dosimeters are suitable for electron beam dosimetry in radiation processing.

Keywords: calcium fluoride, thermoluminescence, optically stimulated luminescence, electron dosimetry