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CaSO4:Dy and CaSO4:Ce,Eu Intrinsic Efficiencies Dependence on Ionizing Radiation Type and Quality

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The dependence of the thermoluminescent (TL) dosimeters response with the type and the quality of the radiation is a key issue that is being tackled worldwide by the development of new dosimetric materials associated to this technique. In this context, the aim of the present work is to evaluate the intrinsic efficiency of $CaSO_4 : Dy$, considered as the standard material, and $CaSO_4 : Ce, Eu$, a newly developed TL material, for different ionizing radiation types and energies. To do so, a batch of fifty five dosimeters of each material was selected according to their non-irradiated TL readout and intrinsic efficiency to the ^{60}Co gamma radiation on air and electronic equilibrium conditions and then divided into eleven sets of five dosimeters, one of the sets being kept as the control set to evaluate the non-irradiated TL signal while the ten remaining sets were irradiated, again in air and electronic equilibrium conditions, with doses ranging from 0.1 mGy to 10 Gy in secondary standards ^{60}Co and ^{137}Cs gamma radiation sources, RQR, RQA and RQT ISO/IEC 61267 series and N ISO 4037 series X-ray beams, always including the reference quality for the radiation beam series, and tertiary standard collimated electron beams with effective energies from 4 MeV to 20 MeV. A Thermo (Harshaw) 3500 thermoluminescent reader was used to evaluate TL readouts 24 h after the irradiations and the obtained glow curves were exported in the ASC format through WinREMS TL reader controller associated software. Individual peak intensity, integrated response, peak to peak intensity ratio, calibration curves and intrinsic efficiency, provided that all dosimeters are 0.8 mm thick pellets of 6.0 mm of diameter containing 16.67 mg of TL material, were calculated with the aid of SciLab 5.5.2 software, also used to graphically explore the behavior of $CaSO_4 : Dy$ and $CaSO_4 : Ce, Eu$ intrinsic efficiencies with the radiation type or the radiation quality. As expected from literature, $CaSO_4 : Dy$ intrinsic efficiency presented a dependence of up to 30% with radiation type or quality while $CaSO_4 : Ce, Eu$ intrinsic efficiency varied in 200% with radiation quality. Despite this huge dependence, $CaSO_4 : Ce, Eu$ peak I to peak II intensity ratio remains stable with the radiation type and varies in 5% from one radiation type to another, so that this newly developed TL material can be used as a dosimeter capable of determining, in non-mixed radiation fields and after an adequate and rigorous calibration, both radiation type and quality besides the dose.

Country/Organization invited to participate

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