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RELATIVE THERMOLUMINESCENT RESPONSE OF $CaSO_4$:Tm AND $CaSO_4$:Dy FOR ^{90}Sr RADIATION BEAM

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Introduction: Thermoluminescent dosimetry (TLD) is one of the most used techniques in radiation protection. The use of calcium sulfate doped with dysprosium ($CaSO_4$:Dy) is well established in the literature and its high sensitivity is adequate for low doses applications. Calcium sulfate doped with other rare earths have been studied and $CaSO_4$:Tm has shown even higher sensitivity for photon beams[1]. For personal dosimetry, however, it can be necessary to know the dosimeter's response to mixed radiation beams (photons plus beta radiation, for example). In this work the relative response of thermoluminescent pellets of $CaSO_4$:Tm and $CaSO_4$:Dy was studied in a ^{90}Sr beta radiation beam.

Material and method: Powder $CaSO_4$:Tm was produced using the Yamashita method [2]. To achieve dosimetric pellets the phosphor was mixed with Teflon® to a ratio mass of 2:1. A total of 60 pellets were then pressed in a hydraulic press (3 ton) resulting in pellets with 30.6 ± 1.8 mg. All pellets went through an annealing process at 400ºC for 1 h before use. Commercial $CaSO_4$:Dy pellets (MRA Industries, Brazil) were used for comparison.

The pellets of $CaSO_4$:Tm and $CaSO_4$:Dy received an initial dose of 16 mGy in a ^{137}Cs source in order to stabilize the thermoluminescent (TL) signal. Readings were performed in a Thermo model QS 3500 TL reader. The TL signal, given as the integral of the TL emission, was acquired for temperatures ranging from 50ºC up to 400ºC at 10ºC/sec.

A dose-response curve for the materials was obtained for a ^{90}Sr source, with doses ranging from 166 mGy up to approximately 1.7 Gy. The TL signals were compared after a mass correction was applied for each pellet.

Results: Figure 1 represents the TL signals of $CaSO_4$:Tm and $CaSO_4$:Dy for the ^{90}Sr source. A good linearity was found for both materials in the studied dose range (r^2 equals 0.984 and 0.999 for CaSO4:Tm and CaSO4:Dy, respectively). The sensitivities for CaSO4:Tm and CaSO4:Dy were found to be 0.101±0.006 μC/s and 0.138±0.001 μC/s, respectively, showing a higher sensitivity for the commercial pellets. However, it can be seen that the standard deviation for the CaSO4:Dy pellets increase with dose, possibly indicating a damage caused by dose accumulation after the irradiations. For comparison, the sensitivity of the CaSO4:Tm pellets was also obtained for the photon beam from ^{137}Cs, resulting in 99.5±1.6 nC/mGy.

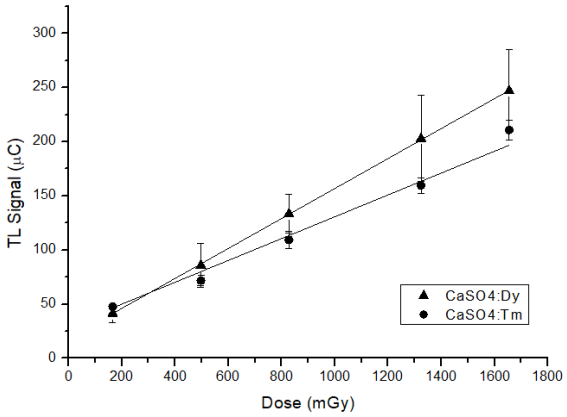

Figure 1: Thermoluminescent signal for $CaSO_4$:Tm and $CaSO_4$:Dy as a function of dose for ^{90}Sr source.

Conclusion: The produced $CaSO_4$:Tm pellets showed adequate sensitivity, reproducibility and linearity in the studied dose range for the ^{90}Sr beta radiation. Further studies can be performed to assess their potential use in personal monitoring.

References:

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