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INVESTIGATION OF DOSIMETRIC PROPERTIES OF $CaSO_4$:Mn PHOSPHOR PREPARED USING THE SLOW EVAPORATION ROUTE

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Introduction: In order to provide adequate monitoring of the possible dangerous effects caused by ionizing radiation, the use of a radiation detector is necessary. Studies on new dosimetric materials have been widely published in order to contribute to the determination of absorbed dose from ionizing radiation in environmental, personal monitoring, clinical, accident, retrospective and industrial applications.

Calcium sulphate ($CaSO_4$) has been used and investigated extensively for dosimetric applications. Despite its high thermoluminescent (TL) sensitivity, $CaSO_4$ doped with manganese ($CaSO_4$:Mn) presents a high fading of the TL signal, impairing its application in all dosimetric fields, e.g., personal monitoring.

Other studies state that this material also has a potential application in dosimetry of ionizing radiation using the optically stimulated luminescence (OSL) technique. In this context, trying to overcome the limitations of this material, the current research mainly targets to produce crystals of $CaSO_4$:Mn and dosimetric characterization by the TL e and OSL techniques.

Materials and methods: The phosphors were produced by means of the slow evaporation route [1] and characterized by x-ray diffraction (XRD), Raman spectroscopy and photoluminescence analysis. The composites in the form of pellets were obtained from the addition of Teflon to the phosphors. The TL and OSL emissions of the samples were analysed in a Risö TL/OSL reader.

Results: X-ray diffraction analyses showed that the obtained samples agree with the ICDD 00-037-1496 pattern, a crystal of orthorhombic symmetry; relative intensities corresponding to the anhydride structure; and no evidence of secondary phases was observed. Raman spectra showed nine vibrational modes, corresponding to SO_4 tetrahedron vibrational modes. Luminescent measurements revealed emission band fitting with the characteristic line of the Mn^{2+} emission features, ascribed to $^6A_1 \rightarrow {}^4T_1$ transition.

The effect of variation in the heating rate with $CaSO_4$:Mn phosphors resulted in a peak shift to higher temperatures and lowering of the peak height. This shift is qualitatively similar to that produced by a delocalized recombination process. From the TL parameters obtained employing the general kinetic order fitting readout at different heating rates, the trapping center located at ~ 0.99 eV and kinetic order of ~ 1.86 were determined.

The material presented a reproducible luminescent signal of TL and OSL responses proportional to the absorbed doses in the range of 169 mGy to 100 Gy; minimum detectable dose in order of hundreds of mGy; besides having significantly less fading than the reported in the literature [2]. Excitation with blue LEDs showed a typical exponential OSL decay curve with a predominance of a fast decay component.

Conclusions: All samples presented properties useful for dosimetric purposes, such as linearity, reproducibility, minimum detectable doses in the order of hundreds of mGy in OSL and TL, and only after 30 days, the glow curve showed a fading of 75% of its original value. The $CaSO_4$:Mn prepared using the slow evaporation route minimized the fading behavior in comparison to that reported in the literature.

References:

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