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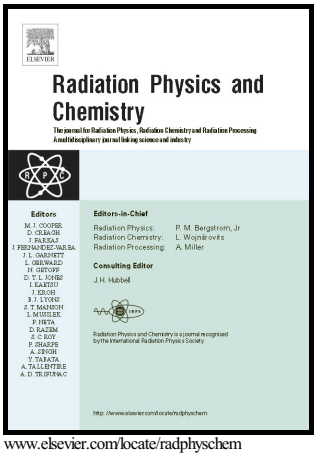

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$BaSO_4$:Eu as an energy independent thermoluminescent radiation dosimeter for gamma rays and C^{6+} ion beam

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Abstract. $BaSO_4$:Eu nanophosphor is delicately optimized by varying the concentration of the impurity element and compared to the commercially available thermoluminescent dosimeter (TLD) LiF:Mg,Ti (TLD-100) and by extension also to $CaSO_4$:Dy (TLD-900) so as to achieve its maximum thermoluminescence (TL) sensitivity. Further, the energy dependence property of this barite nanophosphor is also explored at length by exposing the phosphor with 1.25 MeV of Co-60, 0.662 MeV of Cs-137, 85 MeV and 65 MeV of Carbon ion beams. Various batches of the phosphor at hand (with impurity concentrations being 0.05, 0.10, 0.20, 0.50 and 1.00 mol %) are prepared by the chemical co-precipitation method out of which $BaSO_4$:Eu with 0.20 mol % Eu exhibits the maximum TL sensitivity. Further, the optimized nanophosphor exhibits a whopping 28.52 times higher TL sensitivity than the commercially available TLD-100 and 1.426 times higher sensitivity than TLD-900, a noteworthy linear response curve for an exceptionally wide range of doses i.e. 10 Gy to 2 kGy and a simple glow curve structure. Furthermore, when the newly optimized nanophosphor is exposed with two different energies of gamma radiations, namely 1.25 MeV of Co-60 (dose range- 10 Gy to 300 Gy) and 0.662 MeV of Cs-137 (dose range- 1 Gy to 300 Gy), it is observed that the shape and structure of the glow curves remain remarkably similar for different energies of radiation while the TL response curve shows little to no variation. When exposed to different energies of carbon ion beam $BaSO_4$:Eu displays energy independence at lower doses i.e. from 6.059 kGy to 14.497 kGy. Finally, even though energy independence is lost at higher doses, the material shows high sensitivity to higher energy (85MeV) of carbon beam compared to the lower energy (65 MeV of C^{6+}) and saturation is apparent only after 121.199 kGy. Therefore the present nanophosphor displays potential as an energy independent TLD.

Keywords- Gamma Radiation, Nanoparticles, Energy Independence, Thermoluminescence, Ion beams.
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1. Introduction