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Effect of growth parameters and gamma ray irradiation on luminescence properties of Eu-doped barium titanate thin films

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Eu-doped $BaTiO_3$ thin films were deposited on quartz and borosilicate glass substrates by a sol-gel spin coating process. The films were grown with various growth parameters including film thickness, spinning speed, annealing time, annealing temperature and concentration of europium to evaluate their influence on film luminescent properties. We studied their luminescent properties using excitation wavelengths in a UV range. The electric-dipole transition $^5D_0 \rightarrow ^7 F_2$ at about 615 nm and the magnetic transition $^5D_0 \rightarrow ^7 F_1$ transition at about 589 nm were observed. With an annealing temperature at 600°C for 1 hr, the luminescent intensity of the films deposited on quartz increased with the number of layer deposited. Moreover, the luminescent intensity depended on the spinning speed which was related to the varying film thickness. The luminescent intensity was higher as the thickness increased according to lowering spin speed. The annealing time was varied in the range of 20 min to 80 min and we found that the film annealed for 40 min yielded the best luminescent intensity. Further annealing time and annealing temperature above 600°C caused the luminescent intensity to decrease. This was due to the fact that the longer annealing time and the higher temperatures caused a reduction of europium concentration, resulting in a rapid quenching of Eu^{3+}. Also, we found that the luminescence intensity increased as the Eu concentration increased from 3 mol% to 7 mol% and dropped above 7 mol%. Furthermore, the post-synthesis parameter were also analyzed. The films were gamma irradiated with doses of 10, 20, 30 and 40 kGy, and their emission spectra were compared with those of non-irradiated films. The emission maxima in the spectra decreased after gamma exposure doses higher than 20 kGy. The decrease of the emission peak intensities became most apparent in the case of the irradiated film at 30 kGy, the reduction of the emission was 17.2 % for the 615 nm peak wavelength. Gamma ray doses higher than 30 kGy did not cause any further reduction the emission peak intensities.

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