

Spectroscopic Studies and Reddish Luminescence Enhancement with the Increase in Concentration of Europium Ions in Oxy-Fluoroborate Glasses

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Abstract : The different concentrations of Eu^{3+} ions doped in Oxy-fluoroborate glasses of composition $60 \text{ B}_2\text{O}_3\text{-}10 \text{ BaF}_2\text{-}10 \text{ CaF}_2\text{-}15 \text{ CaF}_2\text{-}(5\text{-}x) \text{ Al}_2\text{O}_3\text{-}x \text{ Eu}_2\text{O}_3$ where $x = 0.1, 0.5, 1.0$ and 2.0 mol%, have been prepared by conventional melt quenching technique and are characterized through absorption and photoluminescence (PL), decay, color chromaticity and Confocal measurements. The absorption spectra of all the glasses consists of six peaks corresponding to the transitions $7\text{F}_0\text{-}5\text{D}_2$, $7\text{F}_0\text{-}5\text{D}_1$, $7\text{F}_1\text{-}5\text{D}_1$, $7\text{F}_1\text{-}5\text{D}_0$, $7\text{F}_0\text{-}7\text{F}_6$ and $7\text{F}_1\text{-}7\text{F}_6$ respectively. The experimental oscillator strengths with and without thermal corrections have been evaluated using absorption spectra. Judd-Ofelt (JO) intensity parameters (Ω_2 and Ω_4) have been evaluated from the photoluminescence spectra of all the glasses. PL spectra of all the glasses have been recorded at excitation wavelengths 395 nm (conventional excitation source) and 410 nm (diode laser) to observe the intensity variation in the PL spectra. All the spectra consists of five emission peaks corresponding to the transitions $5\text{D}_0\text{-}7\text{F}_J$ ($J = 0, 1, 2, 3$ and 4). Surprisingly no concentration quenching is observed on PL spectra. Among all the glasses the glass with 2.0 mol% of Eu^{3+} ion concentration possesses maximum intensity for the transition $5\text{D}_0\text{-}7\text{F}_2$ (612 nm) in bright red region. The JO parameters derived from the photoluminescence spectra have been used to evaluate the essential radiative properties such as transition probability (A), radiative lifetime (τ_R), branching ratio (β_R) and peak stimulated emission cross-section (σ_{se}) for the $5\text{D}_0\text{-}7\text{F}_J$ ($J = 0, 1, 2, 3$ and 4) transitions of the Eu^{3+} ions. The decay rates of the 5D_0 fluorescent level of Eu^{3+} ions in the title glasses are found to be single exponential for all the studied Eu^{3+} ion concentrations. A marginal increase in lifetime of the 5D_0 level has been noticed with increase in Eu^{3+} ion concentration from 0.1 mol% to 2.0 mol%. Among all the glasses, the glass with 2.0 mol% of Eu^{3+} ion concentration possesses maximum values of branching ratio, stimulated emission cross-section and quantum efficiency for the transition $5\text{D}_0\text{-}7\text{F}_2$ (612 nm) in bright red region. The color chromaticity coordinates are also evaluated to confirm the reddish luminescence from these glasses. These color coordinates exactly fall in the bright red region. Confocal images also recorded to confirm reddish luminescence from these glasses. From all the obtained results in the present study, it is suggested that the glass with 2.0 mol% of Eu^{3+} ion concentration is suitable to emit bright red color laser.

Keywords : Europium, Judd-Ofelt parameters, laser, luminescence

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