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Luminescence characterization of Sm^{3+}-doped sodium potassium borate glasses for laser application

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ABSTRACT

Sodium potassium borate glasses doped with different concentrations of Sm^{3+} ions (NKBSm) were prepared using a normal melt quench technique. Optical absorption, excitation, emission and emission decay measurements were performed to understand visible luminescence and lasing potentialities of the prepared glasses. The bonding parameters (δ) have been estimated from the absorption spectra to know about the bonding nature between Sm^{3+} ions and nearby ligands. The Judd–Ofelt (J–O) intensity parameters (Ω_λ, λ= 2, 4, and 6), acquired from the experimental oscillator strengths of the absorption spectral features were used to estimate different radiative properties of the fluorescent transitions, $^4G_{5/2}\rightarrow{}^6H_J$, J=5/2, 7/2, 9/2 and 11/2, of Sm^{3+} ions in NKBSm glasses to get knowledge about the potentiality of these materials as visible lasers. The asymmetric ratios (*O/R*) were calculated to know the local disorder of Sm^{3+} ions in the glass network. The experimental lifetimes (τ_{exp}) for $^4G_{5/2}$ emission state were found to be decreasing with increasing Sm^{3+} ion concentration owing to energy transfer. The quantum efficiency (η) of NKBSm10 glass has been measured by coupling the experimental lifetime (τ_{exp}), measured from the decay profiles with radiative lifetimes (τ_R), obtained from J-O theory. The strong visible emission, large stimulated emission cross-section (σ_e), high branching ratios (β_R) and good quantum efficiency (η) were observed for the most intense transition $^4G_{5/2}\rightarrow{}^6H_{7/2}$ (orange) in NKBSm10 glass, indicating the suitability of this glass for the development of laser and photonic devices operating in visible region.

Keywords: Absorption spectra, Luminescence, Transition probability, Decay time