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Concentration effect on the spectroscopic behavior of Tb³⁺ ions in zinc phosphate glasses

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Abstract

Zinc phosphate glasses (PZABPTb) in the compositional system: P₂O₅ - ZnO - Al₂O₃ - BaO - PbO) doped with variable Tb³⁺ concentrations (1-5 wt% Tb₂O₃) were prepared and characterized through absorption, excitation, emission and intensity decay rate measurements. The Judd-Ofelt model has been adopted to evaluate the radiative properties of the ⁵D₄ → ⁷F_{6,3} emission transitions. The effect of Tb³⁺ ion concentration on the emissions from the ⁵D_{3,4} excited levels is discussed in detail. Analysis of the intensity decay curves corresponding to blue and green emissions from levels ⁵D₃ and ⁵D₄, respectively, allowed determination of effective lifetimes, which confirmed the Tb³⁺ ion concentration quenching of the blue emission in these glasses. The decay curves for the ⁵D₃ level are found to be non-exponential in nature for all the studied concentrations due to ion-ion energy transfer through cross-relaxation. In an attempt to identify the origin of the energy transfer mechanism, the decay curves were well fitted to Inokuti-Hirayama model for S = 6, which indicates that the energy transfer process is of dipole-dipole type. The optical band gap energy (E_{opt}) has been evaluated taking into account the ultraviolet edge of absorption spectra.

Keywords: Zinc phosphate glasses; Tb³⁺ ion; Judd-Ofelt theory; Luminescence; Decay time.

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