

Effect of alkali/mixed alkali metal ions on the thermal and spectral characteristics of $\text{Dy}^{3+}:\text{B}_2\text{O}_3\text{-PbO-Al}_2\text{O}_3\text{-ZnO}$ glasses

ABSTRACT

Thermal and spectroscopic features of 50 B_2O_3 -10 PbO -10 Al_2O_3 -10 ZnO -(x) Li_2O -(y) Na_2O -(z) K_2O -1.0 Dy_2O_3 (mol %) ($x = 19, y = 0, \text{ and } z = 0$; $x = 0, y = 19, \text{ and } z = 0$; $x = 0, y = 0, \text{ and } z = 19$; $x = 9.5, y = 9.5, \text{ and } z = 0$; $x = 9.5, y = 0, \text{ and } z = 9.5$; $x = 0, y = 9.5, \text{ and } z = 9.5$) glasses, that were fabricated by utilizing melt-quenching approach, are investigated by thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), optical absorption, photoluminescence excitation (PLE), photoluminescence (PL), and PL decay lifetimes. PL spectra for all the Dy^{3+} -doped samples show emission bands at 453 nm (blue), 482 nm (blue), 573 nm (yellow), 662 nm (red), and 752 nm (red) corresponding to the $^4\text{I}_{15/2} \rightarrow ^6\text{H}_{15/2}$, $^4\text{F}_{9/2} \rightarrow ^6\text{H}_{15/2}$, $^4\text{F}_{9/2} \rightarrow ^6\text{H}_{13/2}$, $^4\text{F}_{9/2} \rightarrow ^6\text{H}_{11/2}$, and $^4\text{F}_{9/2} \rightarrow ^6\text{H}_{9/2}$ transitions, respectively, upon excitation at 350 nm. Here, $\text{Dy}^{3+}:\text{Li-Na}$ glass shows the highest PL intensity for all identified emissions. The yellow-to-blue (Y/B) emission intensity ratio (varied within the range 1.257–1.376), CIE chromaticity coordinates (x,y) (slight variation between (0.3410, 0.3802) and (0.3495, 0.3872), and correlated color temperatures (CCTs) (changed from 4953 K to 5212 K) are calculated following the PL spectra. $\text{Dy}^{3+}:\text{}^4\text{F}_{9/2}$ decay curves show non-exponential behavior and are fitted by the Inokuti-Hirayama (I-H) model, where $S = 6$ shows best fit, indicating dipole-dipole (d-d) interactions for Dy^{3+} excited (donor) and ground state (acceptor) ions.

Keyword: $\text{Dy}^{3+}:\text{B}_2\text{O}_3\text{-PbO-Al}_2\text{O}_3\text{-ZnO}$ glass; TGA/DSC; Judd-Ofelt theory; Luminescence property; Decay lifetime; Inokuti-Hirayama (I-H) model