The low temperature effects on up-conversion emission of Er$^{3+}$/Yb$^{3+}$ co-doped Y$_2$O$_3$

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Abstract Rare Earth (RE$^{3+}$) ions doped materials have been attracted a great deal of interest due to the potential application as optical temperature sensors. Luminescence properties of these materials are sensitive and changeable with the temperature. Here, we have investigated yttrium oxide co-doped with Yb$^{3+}$ and Er$^{3+}$ that was synthesized through spray pyrolysis method at 900 °C and afterwards additionally thermally treated at 1100 °C for 24h. Structural and morphological characterizations were done through X-ray powder diffraction (XRPD) and scanning electron microscopy (SEM). The obtained particles are spherical in shape and crystallized in cubic bixbyite structure with the space group Ia-3. Photoluminescent measurements (PL) were recorded in the temperature range from 10 K to 300 K using the 978 nm exciting wavelength. Emission spectra are assigned to the following trivalent erbium f-f electronic transitions: $^4H_{9/2} \rightarrow ^4I_{15/2}$ (blue: 407-420 nm), ($^2H_{11/2}, ^4S_{3/2}$) $\rightarrow ^4I_{15/2}$ (green: 510-590 nm), and $^4F_{9/2} \rightarrow ^4I_{15/2}$ (red: 640-720 nm). The fluorescent intensity ratios of the blue, green and red areas under emission bands show significant temperature sensitivity, with the largest value of 2.3 K$^{-1}$.

Conclusion Observed temperature dependence exposed through comparison of red/blue and green/blue emission ratios implies impressive sensitivity: 0.35 K$^{-1}$ for red/blue and 2.3 K$^{-1}$ for green/blue ratio.

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