

Enhanced Red Emission in Europium-Doped Niobate Phosphors for High-Efficiency Warm White LEDs

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1. Introduction

Rare-earth doped crystalline materials are of significant interest for photonic and optoelectronic applications, particularly in phosphor-converted white-light-emitting diodes (pc-WLEDs), which offer high brightness, energy efficiency, compact size, durability, and environmental friendliness. However, pc-WLEDs lack a red color component. To address this, europium-doped niobate-based phosphors were synthesized using a high-temperature solid-state reaction technique at 1300°C[1].

2 Results and Discussions

The XRD patterns of both undoped and Eu-doped phosphors showed excellent crystallinity and phase purity, with diffraction peaks matching the standard JCPDS data, indicating that Eu^{3+} ions did not alter the tetragonal tungsten bronze (TTB) structure. Photoluminescence excitation (PLE) spectra for Eu^{3+} -doped niobate phosphors across various concentrations (1.0-10.0 mol%) revealed efficient excitation at 392 nm (near-UV) and 466 nm (blue). Photoluminescence (PL) spectra under 392 nm excitation displayed five main emission peaks (550-700 nm), with the optimal Eu^{3+} concentration at 9.0 mol% to avoid quenching. The internal quantum yield (IQE) measures the efficiency of converting electrical power into optical power for a phosphor, with IQE representing the ratio of emitted to absorbed photons and external quantum efficiency (EQE) representing the ratio of emitted to incident photons. For optimal Eu^{3+} -doped phosphor, IQE, absorption efficiency, and EQE under 392 nm excitation are more than 90%, 60%, and 55%, respectively. These high values, along with color coordinates close to standard red phosphors, indicate their potential for use in warm white LEDs.

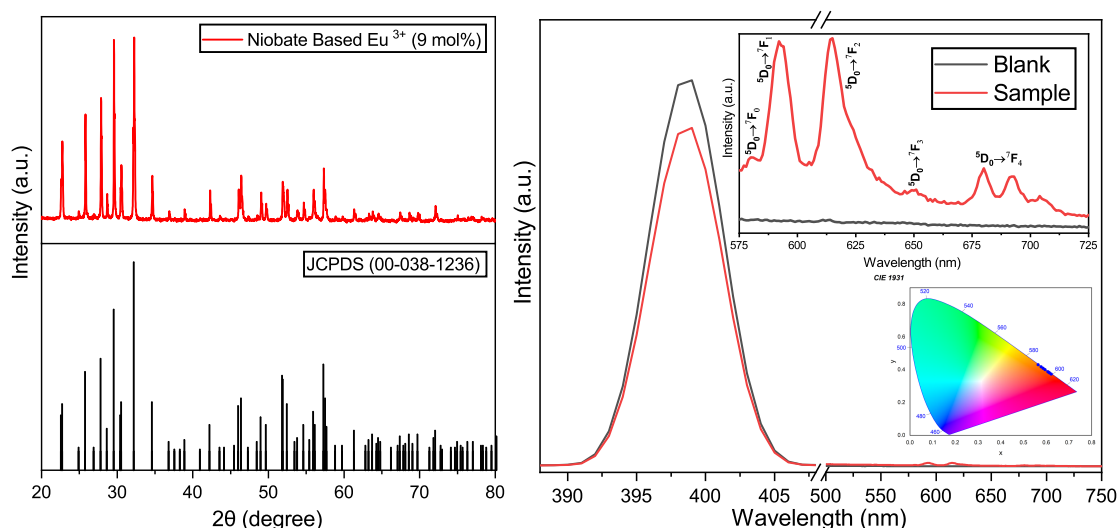


Figure 1: (a) XRD pattern for JCPDS and optimal phosphor. (b) Enhanced internal quantum yield for optimal phosphor (Inset: CIE chromaticity diagram)

- [1] Poria K, Lohan R, Bhatia S, Kumar A, Singh R, Deopa N, Punia R, Shahi JS, Rao AS., "Lumino-structural properties of Dy^{3+} activated $\text{Na}_3\text{Ba}_2\text{LaNb}_{10}\text{O}_{30}$ phosphors with enhanced internal quantum yield for w-LEDs", RSC adv. **13** 11557-68 (2023).