Journal of Electronic Materials
https://doi.org/10.1007/s11664-024-11061-5

ORIGINAL RESEARCH ARTICLE

SM^{3+}-Activated $LiZnPO_4$ Phosphors: Synthesis, Characterization, and Their Luminescent Properties for White Light-Emitting Diode Applications

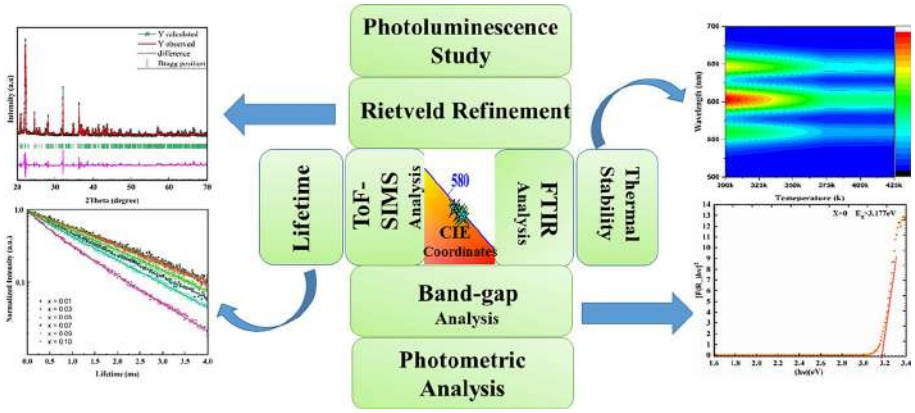
Haqnawaz Rafiq[1] · Mudasir Farooq[1] · Seemin Rubab[2] · Mir Hashim Rasool[1]

Received: 20 December 2023 / Accepted: 20 March 2024

Abstract

This work presents a comprehensive analysis of the synthesis, structural–spectroscopic characterization, thermal stability, and luminescent attributes of Sm^{3+}-activated $LiZnPO_4$ phosphors with diverse Sm^{3+} doping percentiles that work towards developing luminescent materials for white-light-emitting diode (WLED) applications. The polycrystalline samples of $LiZn_{(1-x)}Sm_x^{3+}PO_4$ ($x = 0$, 0.01, 0.03, 0.05, 0.07, 0.09, and 0.10) phosphor were synthesized using a solid-state reaction (SSR) technique. X-ray diffraction (XRD) and Rietveld refinement indicate a single-phase monoclinic structure of all compositions with the C1c1 space group. Phase purity and stoichiometry of elemental composition were validated by Fourier transform infrared (FTIR) spectroscopy and energy-dispersive spectroscopy (EDS) examination. Field-emission scanning electron microscopy (FE-SEM) images indicate irregular and nonuniform microstructures for all compositions with a mean dimension of 1.252 µm. The investigation of diffuse reflectance (DR) spectra with the Kubelka–Munk function $F(R_\infty)$ determines the compound's bandgap to be 3.1 eV. Time-of-flight secondary ion mass spectroscopy (ToF-SIMS) indicates various ions are regularly distributed across the surface. Further, the photometric analysis reveals that the Commission Internationale de l'Éclairage (CIE) coordinates are roughly (0.55, 0.44), and color purity is greater than 82% in all compositions. These results, along with the photoluminescence (PL) spectral analysis, lifetime analysis, and thermal stability, indicate that Sm^{3+}-doped $LiZnPO_4$ is a viable orange-red-emitting phosphor candidate for creating white-light-emitting diodes (WLEDs).

Graphical Abstract



Keywords Phosphors · rare-earth ions · luminescent materials · XRD · photoluminescence · CIE

Extended author information available on the last page of the article

Published online: 20 April 2024