Journal of Sol-Gel Science and Technology
https://doi.org/10.1007/s10971-025-06838-x

ORIGINAL PAPER

Efficient perovskite $CaTiO_3$: Eu^{3+} co-doped with Mg^{2+} for light emitting diodes and degradation of organic dyes prepared by sol-gel combustion method

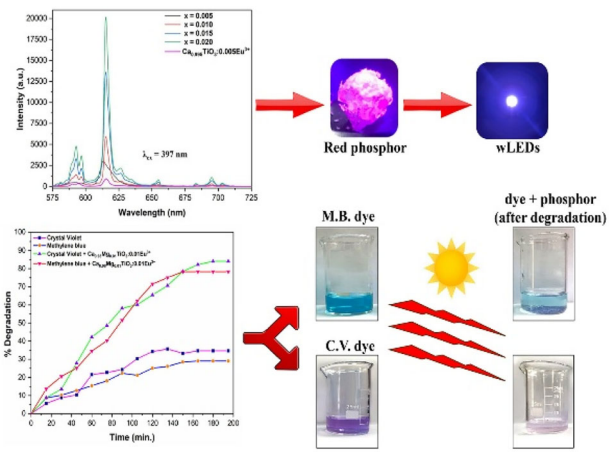
Zahraa Abbas T.[1,2] · Dhia A. Hassan[1] · Chao Li[3] · Jian Xu[3]

Received: 22 March 2025 / Accepted: 2 June 2025

Abstract

In this study, the preparation and characterization of $Ca_{1-x}Mg_{x/2}TiO_3$:x/2Eu^{3+} perovskite phosphors via a hybrid sol-gel combustion method. The phosphors were characterized by X-ray diffraction analysis, photoluminescence, and scanning electron microscopy. The PL study reveals the prepared phosphor has a wide range of emission between 575-730 nm with a strong emission peak in the red region, indicating the potential use in wLED applications. The study aims to investigate the photocatalytic activity of the perovskites in the degradation of hazardous organic dyes such as methylene blue (MB) and crystal violet (CV). X-ray diffraction results demonstrate the formation of the pure crystalline phases with variable concentrations of Mg^{2+}, whereas photoluminescence studies reveal the characteristic emissions from Eu^{3+}. Photocatalytic characterization displayed an excellent degradation percentage; the degradation rate of MB was 78.33%, and that of CV was 84.08%, which indicates that the in-situ synthesized material may be a good adsorbent for remediation purposes in the environmental remediation procedure. The recovery of dyes from the surface of perovskite was studied to evaluate surface efficiency, and the reaction order was determined through the study of the degradation kinetics. Using a hybrid synthesis approach, this study demonstrated the creation of perovskite-based materials with significant improvements to their luminescent properties for optoelectronic devices and photocatalytic performance for environmental applications. The results highlight the versatility of the material, which can lead to further exploration and implementations in commercial LED technology and pollution control.

Graphical Abstract



✉ Dhia A. Hassan
dhia.hassan@uobasrah.edu.iq

[1] Department of Chemistry, College of Education for Pure Sciences, University of Basrah, Basrah 61004, Iraq

[2] Educational Directorate of Basrah, Ministry of Education, Basrah 61001, Iraq

[3] Lab of New Energy Materials and Devices, School of Physics and Electronic Information, Henan Polytechnic University, Jiaozuo 454000, China

Published online: 07 July 2025