



# Excitation induced tunable emission from yellow to red in ZnO:Eu<sup>3+</sup>, Na<sup>+</sup> nanophosphors

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## ABSTRACT

Wurtzite structured ZnO:Eu<sup>3+</sup>,Na<sup>+</sup> nanophosphors were synthesized by chemical precipitation method at a temperature of 60 °C. The nanophosphor formation was confirmed by transmission electron microscopy (TEM). Phase and structural parameters were evaluated using x-ray diffraction (XRD) and optical characterization was done by diffuse reflectance spectroscopy (DRS) and photoluminescence (PL). Photoluminescence study reveals the emission from various transition levels of Eu<sup>3+</sup> as well as from the host material and tunable yellow to red emission was observed on varying the excitation energy. Even though the particle size of ZnO:Na<sup>+</sup>, Eu<sup>3+</sup> phosphor falls in the nanoregime, no considerable increase in bandgap was observed due to the band tailing effect.

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## 1. Introduction

In the present era, investigations into the photoluminescence properties of nanomaterials are of considerable interest, due to both the size controllable and shape controllable responses that they exhibit. Nanophosphors of II–VI semiconductor materials have immense importance due to their unique luminescence behaviour extended from their wide band gap and confinement effect. They always act as exclusive host material for the incorporation of activators like transition metals, rare earth (RE) ions etc. The 4f shell present in the RE ions, are shielded from the outer shells and this results in them possessing sharp luminescence, even at room temperature; this improves their professional use in optoelectronic devices as well as in biological applications. The charge transfer behaviour between the host and luminescent centres also induce the long life time and large Stokes shifts of these lanthanides.

In the family of II–VI inorganic semiconductors, zinc oxide (ZnO) is the one, which is chemically and thermally stable, eco-friendly and which possesses high exciton binding energy [1]. It is an eminent oxide host material for lanthanide doping, leading to the sharp and temperature independent luminescence that results from the stable 4f shell transitions [2]. They are extensively used in display and optoelectronic applications such as flat panel displays

[3], fluorescence imaging [4,5], telecommunication [6], cathodoluminescent devices [7], light emitting diodes [8], solar cells [9], photodetectors [10] etc. Among the RE ions, Eu<sup>3+</sup> is the one which is explored for many phosphor applications mainly due to the red emission that results from the intra 4f shell transition.

By way of a literature review, it emerges that there are reports on the ZnO:Eu<sup>3+</sup> nanophosphor by various synthesis techniques like hydrothermal [2,11], microemulsion [12], vapor transport [13], ball milling [14], etc. However there are no reports on the effective red emission from ZnO:Eu<sup>3+</sup>, since the size mismatch between the host and RE ions and the difference in ionicity hinder the doping effect and hence the energy transfer between the host and dopant ions. Currently, there has been an emergence of various researches that seek to overcome the above difficulty: Some of them suggest that the introduction of trap centres can aid the energy transfer thereby enhancing red emission from Eu<sup>3+</sup> center [15,16]. Co-doping is one of such promising strategy to obtain powerful optical properties by increasing the solubility of dopants and the stability of defects.

In the present work we try to improve the optical properties of ZnO:Eu<sup>3+</sup>, by incorporating sodium (Na<sup>+</sup>) defect centres along with europium. Here the effect of molar concentration (MC) of Eu<sup>3+</sup> on the spectral properties is analysed by keeping MC of Na<sup>+</sup> ion a constant.

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