Physics Letters A 579 (2026) 131516

Contents lists available at ScienceDirect

Physics Letters A

journal homepage: www.elsevier.com/locate/pla

Letter

Influence of tungsten doping on the structural, morphological features, and optical properties of the Co_3O_4 nanoparticles

Preeti Kumari Prasad [a], S. Gnanam [a,*], J. Gajendiran [b,*], G. Thennarasu [c]

[a] Department of Physics, School of Basic Sciences, Vels Institute of Science, Technology & Advanced Studies (VISTAS), Pallavaram, Chennai 600 117, India
[b] Department of Physics, Vel Tech Rangarajan Dr.Sagunthala R&D Institute of Science and Technology, Avadi, Chennai 600 062, India
[c] Department of Chemistry, C. Kandaswami Naidu College for Men, Anna nagar, Chennai 600102, India

ARTICLE INFO

Editor: Jia Grace Lu

Keywords:
Cobalt oxide
Wet chemical synthesis
Doping process
Luminescence
Chromaticity

ABSTRACT

In this research article, nanocrystalline Co_3O_4 and Co_3O_4 with three different weight percentages (1, 3 and 5) of W-doping were synthesized by involved microwave synthesis followed by a calcined process. The spectral characterizations of prepared Co_3O_4 and Co_3O_4 with W-doping samples were assessed with the aid of XRD, FT-IR, EDX, optical spectra measurement and luminescence, as well as chromaticity studies. Using the aforementioned tools, notable spectral shifts such as vibration band wavenumber, absorption/luminescence, and colour co-ordinates, as well as elemental composition variations of synthesized Co_3O_4 material, were observed under the impact of W-doping. Topographical surface features were also significantly varied in W-dopant Co_3O_4 particles, when compared to the pure Co_3O_4 through scrutiny via SEM and TEM measurement. These all feature changes happened due to the ionic radius difference between W and Co ions. The finding optical properties of synthesized material results suggests to implication in potential applications of photonic devices.

1. Introduction

Strong photoemission of Light Emitting Diodes (LED) provides fascination to engineering researchers. Numerous semiconductor nanostructure materials are employed to design a unique LED device [1–3]. This kind of modern LED is very useful for the civilization. The importance of nanocrystalline of semiconductor based-LED, such effective photoemission efficiency, thermo-chemical steadiness and other unique optical properties etc. Among these semiconductors, cobalt oxide (Co_3O_4) is one of the most fascinating due to its remarkable optoelectronic sensing properties. The reason is this material has a narrow optical band gap as well as semiconducting properties, photo absorption/emission wavelengths in both the ultraviolet and visible portion, active site characteristics, outstanding heat steadiness, etc. [4,5]. In recent years, some semiconductor metal oxides have been improved in energy efficiency and tuning of optical features to induce the electron-hole pairs by controlling optical band gap as well as creating structural defects by introducing various dopants [3,6,7] and other semiconductor intermixing [8] for potential applications in LED technology. Chromaticity characteristics are one of the characterizations for testing the suitability of design in a variety of LEDs. The aforesaid studies are obtained from the CIE 1931 under the applied the recorded photoluminescence spectral wavelength and its corresponding emission values. The colour coordinates values can be found from the chromaticity studies, which help to identify the characteristics for acting as an efficient LED device.

Various chemical element doping (Cu, Fe, Ni, Nd and Ag) with the Co_3O_4 nanostructures were attempted with the help of photochemical reduction, co-precipitation, sol-gel, surfactant-assisted sol-gel, hydrothermal, and wet chemical reaction steps for the various technological applications such as waste water treatment, photodiodes, energy and magnetic storage, etc. [7,9–15]. They investigated outcomes of optical properties results that are significantly tuned under the influence of doping on the Co_3O_4 and their optical properties impact on the aforementioned chosen applications.

Guoxuan Gu et al. [16] reported the metal-organic frame assisted W-doped Co_3O_4 nanosheets for high performance TEA gas sensing application. Electrocatalytic activity of wet chemically synthesized W-doped Co_3O_4 toward methanol oxidation reaction are reported by Haoran Wang et al. [17]. The synthesized chemicals are complex to obtain the pure phase structure of Co_3O_4. Lina Chen et al. [18] reported the hydrothermally synthesized W/Cr-co doping Co_3O_4 for examined the electrocatalyst application. In this work, numerous chemicals are involved for the synthesis of cobalt oxide material. In addition, it needs

* Corresponding authors.
E-mail addresses: gnanam.nanoscience@gmail.com (S. Gnanam), gaja.nanotech@gmail.com (J. Gajendiran).

https://doi.org/10.1016/j.physleta.2026.131516
Received 15 September 2025; Received in revised form 22 January 2026; Accepted 19 February 2026
Available online 20 February 2026