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Microstructural characterization, electrical, and optical study of V_2O_5-doped Cr_2O_3 films for photonic applications

Adel M. El sayed[1], Faisal Katib Alanazi[2*]**

[1]Department of Physics, Faculty of Science, Fayoum University, El-Fayoum 63514, Egypt.

[2]Department of Physics, College of Science, Northern Border University, Arar 73222, Saudi Arabia.

Abstract

The performance and optoelectronic properties of the transition metal (TM) oxide thin films can be enhanced by doping with other materials. In this study, V_2O_5 nanoparticles (NPs) were prepared by sol-gel and then used to prepare V_2O_5-doped Cr_2O_3 thin films using the spin-coating technique. The microstructural, morphological characterization, I-V measurements, and optical properties of the films were investigated. The XRD, FE-SEM, EDAX, and FTIR measurements revealed the polycrystalline nature, granular morphology, reduction in particle size (from 43±2.58 nm to 21±1.25 nm), crystallinity deterioration, and the limited stretching vibrations of Cr–O and Cr–O–Cr upon inclusion of V_2O_5. The doping didn't alter the rhomoboedric corundum structure of Cr_2O_3. The films exhibited linear I-V behavior and their resistance decreased with doping. The films are highly transparent (up to 88%), and their absorption was minimal in the visible region. A new figure of merit was in the range of 0.255-0.270. The refractive index has bell-shaped behavior with the wavelength and increased with increasing V_2O_5. Additionally, the optical band gap (E_g) of the films decreased from 3.0 to 2.5 eV. The influences of 0.5–5.0% V_2O_5 doping ratio on the grain size, dislocation density, microstrain, and charge carrier concentration were investigated. The finding of this study indicates that the optoelectronic features of V_2O_5-doped Cr_2O_3 films were improved and the films can be used for various optoelectronic and photonic devices.

***Keywords*:** V_2O_5 NPs, Cr_2O_3 films; Granular morphology; Refractive index; New figure of merit.

[*]**Corresponding author:** Fisal.Alanazi@nbu.edu.sa; +966556892819
[**]**Corresponding author:** ams06@fayoum.edu.eg; +201093637986