Structural, Optical and Gas Sensing Properties of Cu_2O/CuO Mixed Phase: Effect of the Number of Coated Layers and (Cr + S) co-Doping

Phase Transitions 92 (2019) 347-359. https://doi.org/10.1080/01411594.2019.1581886

Authors: Mohamed Shaban[1], Khaled Abdelkarem[1], Adel M. El Sayed*[2,3]

[1]Nanophotonics and Applications (NPA) Lab, Department of Physics, Faculty of Science, Beni- Suef University, Beni-Suef 62514, Egypt.
[2]Department of Physics, Faculty of Science, Fayoum University, Fayoum 63514, Egypt.
[3]Department of Physics, Faculty of Science, Northern Border University, Arar 91431, Saudi Arabia.

Abstract

Thin films of Cu_2O/CuO mixed phase have been deposited on pre-cleaned glass substrate by a spin-coating technique. The influence of Cr-doping, (Cr + S) co-doping and the number of coated layers on the structures and optical behaviors of the films were investigated by X-ray diffraction (XRD), Fourier transform infrared (FTIR), Raman, and UV-Visible spectroscopies. From XRD, FTIR and Raman results; the films are composed of polycrystalline monoclinic CuO and cubic Cu_2O phases with crystallite sizes ranged from 10.05 to 23.08 nm. Increasing the thickness improves the films' crystallinity and decreases the defects level in the films. Cr and S incorporation encourages the growth of CuO phase at the expense of Cu_2O one and affects the preferred growth direction. The doping with Cr and S blue shifted the B_g mode and multi-phonon transitions. The direct and indirect optical band gaps decreased from 2.25 eV and 1.60 eV to 2.10 eV and 1.20 eV by growing the number of deposited layers from 2 to 8 layers. The film sensitivity towards CO_2 at different gas flow rate was studied and compared with those of similar systems. Also; response time, recovery time, detection limit, and limit of quantification are estimated.

Keywords: Cu_2O/CuO mixed phase Nanofilms; Raman spectroscopy; Band gap; CO_2 gas sensors.