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Structural, Morphological, Optical Properties and Wettability of Spin Coated Copper Oxide; Influences of Film Thickness, Ni, and (La, Ni) co- Doping

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Abstract

Controlling the properties of nano-sized copper oxide (CuO) is an interesting approach for broadening its multifunctionality. This paper reports the deposition of CuO thin films on ultrasonically cleaned glass substrates. The sol-gel spin coating technique was employed to prepare un-doped films with different thickness, Ni-doped and (La, Ni) co-doped CuO films in the formulas; $Cu_{1-x}Ni_xO$ ($0 \leq x \leq 0.06$) and $Cu_{0.94-y}Ni_{0.06}La_yO$ ($0.02 \leq y \leq 0.06$). The structural and morphological properties were studied by X-ray diffraction (XRD), Fourier transformation infrared (FTIR) spectroscopy and atomic force microscopy (AFM). The optical and wetting properties were investigated by UV-Vis spectrophotometer and water contact angle (WCA) measurement, respectively. XRD and FTIR results confirm the synthesis of nanostructured CuO of monoclinic structure. The average crystallite size, *D*, is dependent on the number of the coated layers of the pure CuO film. The value of *D* increased from 22.2 nm for the four-layered CuO film to 24.2 nm upon the incorporation of 6% Ni content. Then, it decreased to 11.4 nm after the co-doping with 6% La. Ni doping improved the (002) preferential orientation and La co-doping reduced the crystallinity of the films. The films are hydrophilic and their wetting properties were enhanced by increasing the film thickness and La incorporation. Ni and La co-doping could efficiently control transmittance, optical band gap, and the refractive index of the films. The existence of stable copper oxide films at room temperature with band gaps around 2.0 eV supports their use in catalysts and gas sensing applications as well as in optoelectronics and solar technologies.

Keywords: CuO; Film thickness; (La, Ni) co-doping; Refractive index; Hydrophilic surfaces