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Effect of annealing temperature on the wetting properties of electrodeposited Cu₂O

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Surface wettability is one of the important physical parameters, which manifests the affinity of a liquid towards a solid phase. In recent years, controlling the wettability of solid surfaces has drawn significant attention due to its influence in wide range of applications. Cuprous Oxide (Cu₂O) is well known as a technologically important material for various fields due to its unique advantages such as low cost, high chemical stability and remarkable electrochemical performance. This work examines the impact of the post annealing temperature on the wetting ability of Cu₂O thin films. A set of Cu₂O thin films was deposited on Ti substrate at a deposition potential of -200 mV vs saturated calomel electrode (SCE) in an acetate bath containing an aqueous solution of 0.1 M sodium acetate and 0.01M cupric acetate at bath temperature of 60 °C and pH value of 6.5 for 45 min. Potentiostatic electrodeposited Cu₂O films were annealed in air at 100 °C, 150 °C, 200 °C, 250 °C, 350 °C and 400 °C for 20 and 40 minute separate time intervals. The surface morphological and structural characterizations of prepared samples were studied using scanning electron microscopy (SEM) and X-ray diffraction (XRD) techniques. SEM (Zeiss evols 15) and SHIMADZU (XD-D1) X-ray diffractometer were used to study the samples. XRD spectral patterns indicated the presence of Cu₂O without having any impurity phases. The water contact angles were measured using the sessile drop method in order to investigate the effect of temperature on the wettability of the Cu₂O films. The contact angle of Cu₂O thin film changed from 110° (non-wetting) to 10° (completely wetting) with the increase in the annealing temperature. The contact angle measurement for cuprous oxide showed a transition of cuprous oxide surface from hydrophobicity to hydrophilicity and the maximum hydrophobicity was observed at 150 ± 1 °C. Similar variation and maximum hydrophobicity of the contact angle were observed for both annealing durations (20, 40 minutes). SEM micrographs of electrodeposited Cu₂O thin films indicated significant changes in the surface morphology with annealing temperature. Dimension of grains becomes smaller with increasing temperature. This suggests that higher heating temperatures lead to a decrement in the contact angle. Based on the results of the investigation, surface morphology is the primary determinant of the wettability qualities of Cu₂O thin films.

Keywords: Cuprous oxide, Contact angle, Electrodeposition, Wettability, Hydrophobicity