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Role of Chloride Ions on The Properties of Electrodeposited ZnO Nanostructures

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Abstract : Zinc oxide (ZnO), as a transparent semiconductor with a wide band gap of 3.4 eV and a large exciton binding energy of 60 meV at room temperature, is one of the most promising materials for a wide range of modern applications. With the development of film growth technologies and intense recent interest in nanotechnology, several varieties of ZnO nanostructured materials have been synthesized almost exclusively by thermal evaporation methods, particularly chemical vapor deposition (CVD), which generally require a high growth temperature above 550 °C. In contrast, wet chemistry techniques such as hydrothermal synthesis and electro-deposition are promising alternatives to synthesize ZnO nanostructures, especially at a significantly lower temperature (below 200°C). In this study, the electro-deposition method was used to produce zinc oxide (ZnO) nanostructures on fluorine-doped tin oxide (FTO)-coated conducting glass substrate from chloride bath. We present the influence of KCl concentrations on the electro-deposition process, morphological, structural and optical properties of ZnO nanostructures. The potentials of electro-deposition of ZnO were determined using the cyclic voltammetry. From the Mott-Schottky measurements, the flat-band potential and the donor density for the ZnO nanostructure are determined. Field emission scanning electron microscopy (FESEM) images showed different sizes and morphologies of the nanostructures which depends on the concentrations of Cl-. Very netted hexagonal grains are observed for the nanostructures deposited at 0.1M of KCl. X-ray diffraction (XRD) study confirms the Wurtzite phase of the ZnO nanostructures with a preferred oriented along (002) plane normal to the substrate surface. UV-Visible spectra showed a significant optical transmission (~80%), which decreased with low Cl-1 concentrations. The energy band gap values have been estimated to be between 3.52 and 3.80 eV.

Keywords : Cl-, electro-deposition, FESEM, Mott-Schottky, XRD, ZnO
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