The Effects of Addition of Chloride Ions on the Properties of ZnO Nanostructures Grown by Electrochemical Deposition

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Abstract : Zinc oxide as a wide band semiconductor materials, especially nanostructured materials, have potential applications in large-area such as electronics, sensors, photovoltaic cells, photonics, optical devices and optoelectronics due to their unique electrical and optical properties and surface properties. The feasibility of ZnO for these applications is due to the successful synthesis of diverse ZnO nanostructures, including nanorings, nanobows, nanohelixes, nanosprings, nanobelts, nanotubes, nanopropellers, nanodisks, and nanocombs, by different method. Among various synthesis methods, electrochemical deposition represents a simple and inexpensive solution based method for synthesis of semiconductor nanostructures. In this study, the electrodeposition method was used to produce zinc oxide (ZnO) nanostructures on fluorine-doped tin oxide (FTO)-coated conducting glass substrate as TCO from chloride bath. We present a systematic study on the effects of the concentration of chloride anion on the properties of ZnO. The influence of KCl concentrations on the electrodeposition process, morphological, structural and optical properties of ZnO nanostructures was examined. In this research electrochemical deposition of ZnO nanostructures is investigated using conventional electrochemical measurements (cyclic voltammetry and Mott-Schottky), scanning electron microscopy (SEM), and X-ray diffraction (XRD) techniques. The potentials of electrodeposition 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. SEM images shows different size and morphology of the nanostructures and depends greatly on the KCl concentrations. The morphology of ZnO nanostructures is determined by the corporated action between [Zn(NO3)2] and [Cl-].Very netted hexagonal grains are observed for the nanostructures deposited at 0.1M of KCl. XRD studies revealed that the all deposited films were polycrystalline in nature with wurtzite phase. The electrodeposited thin films are found to have preferred oriented along (002) plane of the wurtzite structure of ZnO with c-axis normal to the substrate surface for sample at different concentrations of KCl. 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 : electrodeposition, ZnO, chloride ions, Mott-Schottky, SEM, XRD
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