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Effects of annealing on properties of ZnO thin films prepared by electrochemical deposition in chloride medium

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Abstract

The development of cost-effective and low-temperature synthesis techniques for the growth of high-quality zinc oxide thin films is paramount for fabrication of ZnO-based optoelectronic devices, especially ultraviolet (UV)-light-emitting diodes, lasers and detectors. We demonstrate that the properties, especially UV emission, observed at room temperature, of electrodeposited ZnO thin films from chloride medium (at 70°) on fluor-doped tin oxide (FTO) substrates is strongly influenced by the post-growth thermal annealing treatments. X-ray diffraction (XRD) measurements show that the films have preferably grown along (0 0 2) direction. Thermal annealing in the temperature range of 150–400° C in air has been carried out for these ZnO thin films. The as-grown films contain chlorine which is partially removed after annealing at 400 °C. Morphological changes upon annealing are discussed in the light of compositional changes observed in the ZnO crystals that constitute the film. The optical quality of ZnO thin films was improved after post-deposition thermal treatment at 150° C and 400° C in our experiments due to the reducing of defects levels and of chlorine content. The transmission and absorption spectra become steeper and the optical bandgap red shifted to the single-crystal value. These findings demonstrate that electrodeposition have potential for the growth of high-quality ZnO thin films with reduced defects for device applications.