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Elaboration and Characterization of Al-doped ZnO nanostructured Thin Films for ultraviolet photodetectors

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Abstract

Undoped and Al-doped ZnO nanostructured thin films have been deposited onto glass substrates by sol–gel spin coating method. Zinc acetate dehydrate [$Zn(CH3COO)_2.2H2O$], Aluminium chloride hexahydrate [$AlCl_3 \cdot 6H_2O$], Isopropanol and monoethanolamine (MEA) were used as a precursor, doping source, solvent and stabilizer respectively. The molar ratio of MEA to metal ions was maintained at 1.0 and a concentration of metal ions is 0.6 $mol.L^{-1}$.The Al dopant level was defined by the Al/(Al+Zn) ratio it varied from 0 to 7% mol. The XRD results showed that all films crystallized under hexagonal wurtzite structure and presented a preferential orientation along the c-axis with the maximum crystallite size was found is 25 nm for undoped film. The results of SEM indicate that the ZnO thin film has uniform surface with small ZnO grains. The average transmittance of all films is over 95% in the visible region and the band gap energy increases from 3.25 to 3.29eV with increase of Al concentration. In addition to the vibrational modes from undoped ZnO, longitudinal optical (LO) mode in the Raman spectra was enhanced by the Al doping. Photoluminescence of the films showed a ultraviolet (UV) and defect related visible emissions like violet, blue and green. The possible origins responsible for these emission bands have been discussed. Al doped ZnO thin film shows the best photocurrent properties. ZnO thin films with Al exhibited the best optical and photocurrent properties, therefore such films can be usefully applied in different device applications such as UV photodetectors.

Keywords: Sol-Gel method; ZnO thin film; Aluminium doping; photoluminescence; optical properties; Photocurrent; Defects

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