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Doping and Annealing Effects on Structural, Electrical and Optical Properties of Tin-doped Zinc-Oxide Thin Films

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Abstract

In this study, Sn doped ZnO thin films at different Sn content (of 0.5 % to 3.0 %) were successfully deposited on soda-lime glass substrates using RF /DC magnetron sputtering technique. The effects of doping concentration and annealing on structural, electrical, and optical properties of Sn doped ZnO thin films were determined in detail. XRD measurements not only revealed the deterioration of crystallinity but also a gradual shift of main peak position to higher values following the doping process. Following the annealing process at different temperatures (150, 250 and 500 ^{o}C) a drastic improvement in crystallinity of both doped and undoped ZnO films was observed. AFM measurements have shown that there is a significant modification in surface morphology following the doping process. The mulberry-like structures, for instance, were observed for the 3.0 % Sn doped ZnO film. The average transmittance in the visible range was found to be around 90 % for all the Sn- doped films after annealing at 500 ^{o}C. From the transmission and reflection measurements the band gap energies were calculated, which exhibited a decreasing trend with the increasing Sn content. The observed red-shift in band gap from 3.26 to 3.15 eV was attributed to the band gap shrinkage due to the generation of deep levels in the forbidden band gap following the doping