Structural, Ultrasonic and Spectroscopic Studies of Tin Oxide Thin Films; Effect of Ir and (Ni, Ir) Double Doping

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Abstract

In this work, tin oxide (SnO_2), $Sn_{1-x}Ir_xO_2$ ($0.025 \leq x \leq 0.05$) and $Sn_{0.95-y}Ir_{0.05}Ni_yO_2$ ($0.025 \leq y \leq 0.075$) thin films were synthesized by a sol-gel spin coating technique. XRD results showed that the films are of polycrystalline rutile structure with crystallite size < 31 nm. Raman and FTIR spectra are significantly affected by the type and concentration of dopant atoms. AFM measurements illustrated that the surface of the films have pores of circular shape and both the pores diameter and surface roughness depend on the dopant type. EDS confirmed the substitutional replacement of Sn ions by Ir and Ni in the host lattice. Films densities demonstrate the effect of Ir and Ni on the growth rate. Ultrasonic studies by pulse-echo technique are applied for the first time to investigate the mechanical properties of these films. (Ni, Ir) double doped SnO_2 thin films had more pores, less grain agglomeration, less cross-link density and less rigidity. The transmittance spectra and the optical band gap of the films can be tuned by Ir and (Ni, Ir) doping. According to the obtained results, the doped films can be potentially used for different optoelectronic applications as well as for gas sensing.

Keywords: Double doping; SnO_2; Ultrasonic study; moduli of elasticity; band gap tuning.