Exploring the Morphology, Optical and Electrical Properties of Nickel Oxide Thin Films under Lead and Iridium Doping

Physica B: Condensed Matter 600 (2021) 412601. https://doi.org/10.1016/j.physb.2020.412601

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Abstract

Expanding the industry and technology of semiconductors requires developing the multifunctionality and performance of p-type transparent conducting oxides (TCO). This work is an attempt to tune the physical properties of nickel oxide (NiO) by using the codoping approach. Pb-doped and (Ir, Pb) codoped films have been deposited by sol-gel combined with spin coating technique. XRD, EDS, and AFM were used to investigate the crystal structure, chemical composition, size, particles' shape, and surface morphology. All films exhibited a polycrystalline structure and a cubic phase. The crystallite size and surface roughness significantly affected by type and dopant content. A maximum root mean square roughness (R_q) with a distinctive island formed layer was obtained at 1.0% Ir + 2.0% Pb doping level. UV-vis-IR measurements showed that the optical parameters; absorption index, optical band gap, refractive index, dielectric constant, and optical conductivity are sensitive to Pb and Ir doping ratios. IV measurements showed good Ohmic behavior and sheet resistance of 13 x 10^4 Ω/sq. for pure NiO was decreased to be < 6 x 10^4 Ω/sq., at 2.0% Pb doping. Moreover, the figure of merit exhibited the highest value of 1.35 x 10^{-7} Ω^{-1} for NiO: (1.0% Ir + 2.0% Pb) which enables the use of these films as a window layer in smart windows and solar cells and for other optoelectronic applications.

Keywords: Ir-doped NiO films; Sol-gel spin coating; Island growth; Optical conductivity; figure of merit; band gap engineering.