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Studies on Physical Properties and Carrier Conversion of SnO_2:Nd Thin Films

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Abstract: Neodymium (Nd)-doped SnO_2 transparent conducting oxide thin films were prepared by vapour deposition technique under different deposition parameters: substrate temperature, time and flow rate of vapour deposition, amount of base material, distance between the substrate and spray gun tip, and dopant (Nd) concentration. The structural, optical, electrical and photo-electronic properties of the doped and undoped SnO_2 films were studied. X-ray diffraction studies shows the polycrystalline nature of the films with preferential orientation along the (101), (211) and (301) planes and an average grain size of 100 Å. The optical properties of these films were studied by measuring their optical transmission spectra in the UV-VIS-NIR range. Optical transmission is found to increase with Nd doping. Band gap, refractive index and thickness of the films were calculated. Its electrical properties were determined using four probe, Van der Pauw and Hall probe methods. On doping with Nd^{+3}, carrier conversion takes place from n-type to p-type; p-conductivity dominates. The resistivity of SnO_2 films changes from 91.9 \times 10^{-4} Ω m to 1.073 \times 10^{-4}Ω m as the substrate temperature varied 400--575 °C; and resistivity decreases initially on doping and increases as doping concentration increases. The minimum resistivity for the doped SnO_2 films was found to be 0.556 \times 10^{-4} Ω m at the deposition temperature 575 °C with 1 wt% concentration of the dopant. Photoconductivity and photovoltaic effects of doped SnO_2 films were also studied.

Key Words: Thin films, vapour deposition, x-ray diffraction, electrical properties, optical properties.

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