

Effect of Deposition Time and Annealing Atmosphere on the Morphological and Physical Properties of SnO₂ Thin Films

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Abstract: Tin oxide (SnO₂) thin films were deposited via spray pyrolysis with deposition times of 1–5 min and subjected to post-deposition thermal treatment at 400 °C for 1 h in either vacuum or air to investigate the influence of processing conditions on their morphological, wetting, electrical and optical properties. Atomic force microscopy (AFM) revealed that the surface morphology evolved from smooth, homogeneous films to well-defined granular structures with increasing deposition time. Vacuum-annealed films exhibited a gradual increase in roughness followed by morphological stabilization, whereas air-annealed films displayed more pronounced surface development, with larger grains and higher roughness, indicating enhanced surface diffusion and grain coalescence under oxidizing conditions. Contact angle measurements revealed a transition toward hydrophobic behavior in SnO₂ films subjected to vacuum annealing, in contrast to the typically hydrophilic nature of the glass substrate ($\leq 90^\circ$). SnO₂ thin films prepared by the spray pyrolysis method is typically reported to be hydrophilic [1]. However, the deposited films exhibited hydrophobic behavior, which could be advantageous for SnO₂-based photodetector applications, since hydrophobic surfaces are often associated with improved stability in humid environments. In contrast, air-annealed films exhibited nearly constant hydrophobic wettability, highlighting the combined role of surface topography and chemical composition in determining wetting properties. Optical characterization showed high transparency (80–90%) for all films. The film thickness increased with deposition time, reaching approximately 720 nm, while the refractive index decreased from approximately 2.75 to 1.8 in the 350–800 nm spectral range, in agreement with literature data. These results demonstrate that deposition time and annealing atmosphere are key parameters for controlling the morphological and functional properties of SnO₂ films.

Keywords: SnO₂ thin films, spray pyrolysis, annealing atmosphere, wettability, refractive index, optical properties.

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References

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