

Abstract No: 163

Physical Sciences

ANALYSIS OF AFM IMAGES FOR INVESTIGATING THE MORPHOLOGY AND POROSITY OF FLUORINE-DOPED TIN OXIDE THIN FILMS

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Research in the field of optoelectronic materials optimization is motivated by the growing demand for efficient and transparent conductive materials. This study focuses particularly on the evaluation of porosity in Fluorine-doped Tin Oxide (FTO) thin films. Porosity analysis is pivotal in optimizing the optical, electrical, mechanical, and structural properties in optoelectronic market applications, including solar cells, transparent electrodes, and gas sensors. Researchers and engineers can design and fabricate materials with enhanced performance, efficiency, and reliability for a wide range of optoelectronic devices by characterising and controlling porosity. In this study, a quantitative analysis of key parameters in a series of FTO layered Atomic Force Microscopy (AFM) images using a combination of analytical software tools, namely Gwyddion and MATLAB, and methods such as adaptive thresholding and Monte Carlo simulations were carried out. The methodology and analytical techniques presented here facilitate a comprehensive characterization of porosity, offering valuable insights into the microstructural features of the films; in particular, the significance of performing such analysis on strictly morphological images obtained using an AFM were denoted. A mean porosity of 0.93% in singly layered FTO is reported; however, in evaluating the porosity of serial layers of FTO thin films, the efficacy of FTO films in various optoelectronic devices with pertinence to porosity may be determined; hence, the defined analytical methods represent a crucial stage in the fabrication, commercialization, and optimization of future optoelectronics.

Financial assistance from the Georgia Space Grant Consortium, a NASA, United States; Training Grant NNH18ZHA007C. (Grant No: NNH18ZHA007C) is acknowledged.

Keywords: Atomic Force Microscopy (AFM), FTO Thin Films, MATLAB, Optoelectronic Devices, Porosity