

Investigation of the Influences of Post-Thermal Annealing on Physical Properties of TiO₂ Thin Films Deposited by RF Sputtering

© H.E. Doghmane¹, T. Touam^{1,2,¶}, A. Chelouche³, F. Challali⁴, B. Bordji⁵

¹ Laboratory of Semiconductors, University of Badji Mokhtar-Annaba, BP 12, Annaba 23000, Algeria

² Research Unit in Optics and Photonics (UROP), Centre for Development of Advanced Technologies (CDTA), University of Sétif 1, Sétif, 19000, Algeria

³ Laboratory of Environmental Engineering, University of Bejaia, Bejaia 06000, Algeria

⁴ Laboratory of Sciences of Processes and Materials (LSPM), CNRS-UPR 3407, Paris 13 University, 99 Jean-Baptiste Clément Avenue,illetaneuse 93430, France

⁵ Laboratory of Materials and Structure of Electromechanical Systems and Their Reliability, Larbi Ben M'Hidi University, Oum El Bouaghi 04000, Algeria

¶ E-mail: touamt@gmail.com

Received May 9, 2019

Revised October 9, 2019

Accepted October 9, 2019

For this study, titanium dioxide (TiO₂) thin films were deposited on glass substrates at room temperature by the RF magnetron sputtering technique. The preparation parameters that offer better control and reproducibility of film fabrication were first optimized. Then, the effects of post-deposition annealing temperature at 350, 450, and 550°C on the microstructure, surface morphology, and optical properties of the prepared films were investigated using X-ray diffraction (XRD), Raman spectroscopy (RS), scanning electron microscopy (SEM), atomic force microscopy (AFM), and UV-Visible (UV-Vis) spectrophotometry. Interestingly, XRD analysis shows that as-deposited and annealed TiO₂ film possess anatase crystal structure only with a preferential orientation along the (101) plane. The intensity of the (101) diffraction peak and crystallite size are found to increase with increasing annealing temperature, which indicates an improvement in the crystallinity of the films. Raman spectra confirm that all samples possess anatase phase and the crystallinity is enhanced with increasing thermal annealing. From the analysis of SEM and AFM images, it is revealed that the heat treatment significantly affects the morphology, grain size, and surface roughness of the TiO₂ films. The UV-Vis spectroscopy analysis shows that as-deposited TiO₂ thin film is highly transparent in the visible region with an average transmittance about 84%, whereas the transmission decreases slightly with an increase in annealing temperature. Moreover, the optical band gap energy shows a red shift with increasing the annealing temperature.

Keywords: TiO₂ thin films, RF sputtering, annealing temperature, structure and morphology, optoelectronic applications.

Full text of the paper will appear in journal SEMICONDUCTORS.