ASEC 2024 Conference

The 5th International Electronic Conference on Applied Sciences

04–06 December 2024 | Online

MDPI

Variable Angle Spectroscopic Ellipsometry of thick TiO_2-P25 films: graded-layer modeling for depth-dependent optical analysis

Grazia Giuseppina Politano

Department of Environmental Engineering, University of Calabria, 87036 Rende, CS, Italy

INTRODUCTION & AIM

Titanium dioxide (TiO_2) is a highly versatile material extensively used due to its non-toxic nature, chemical stability and high photocatalytic activity. These features make TiO_2 particularly promising for a wide range of applications, especially as a film coating on various substrates. TiO_2 is commercially available in many forms, including pure anatase and mixed-phase products like P25, which is a mixture of anatase (80%) and rutile (approximately ≤20%), ideal for photocatalysis.

METHOD

In this study, TiO_2-P25 films on FTO substrates were synthesized using the sol-gel process and studied using Variable Angle Spectroscopy Ellipsometry (VASE) to determine their optical constants and thickness. The measurements were carried out at room temperature in the wavelength range (300–900) nm at incident angles varying from 55° to 70°. The resulting thicknesses were found to be ranging from 1000 nm to 10000 nm.

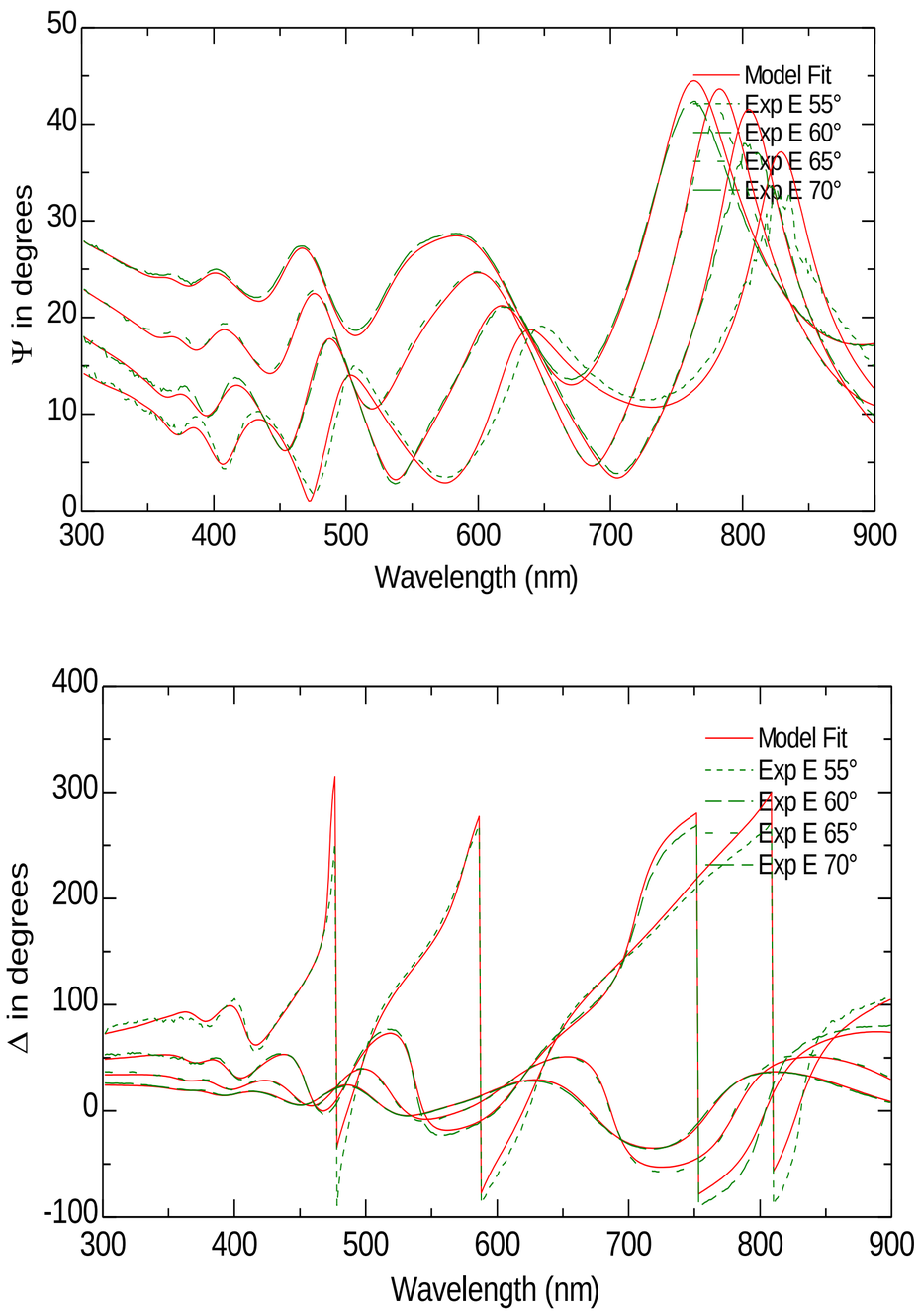

Figure 1: Variable Angle Spectroscopic Ellipsometry measurements of TiO_2-P25 on FTO. Experimental and model generated ψ (a) and Δ (b) data fits at different angles of incidence.

RESULTS & DISCUSSION

A graded layer model, which allowed for an accurate representation of the depth-dependent optical variations, was employed to model the properties of these TiO_2-P25 films. This advanced modeling approach provided deeper insights into the internal structure of the films, particularly how the graded structural characteristics impact the overall optical behavior. The bottom layers of the films typically exhibited a significant increase in both refractive index and extinction coefficient, indicating greater density and higher absorbance compared to the top layers. Understanding these depth-dependent variations is essential for optimizing the use of TiO_2-P25 films in technologies such as solar cells and optical devices, where precise control over material properties is critical.

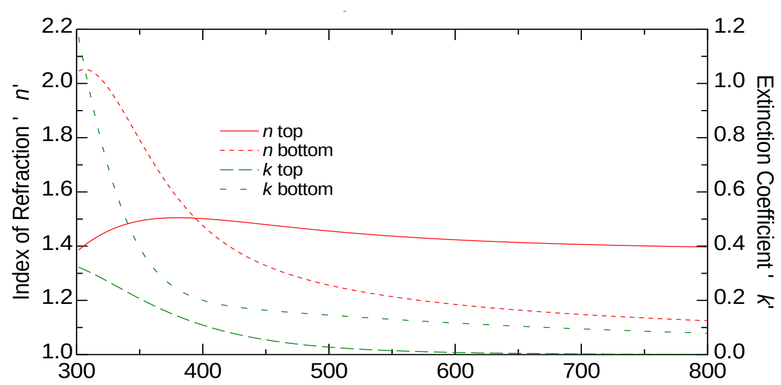

Figure 2: The graded optical constants at the bottom and top of TiO_2-P25 films on FTO substrate by ellipsometry characterization. The curves represent the index of refraction (red curves) and the extinction coefficient (green curves).

CONCLUSION

Herein, Variable Angle Spectroscopic Ellipsometry (VASE) was carried out to investigate the optical properties of thick TiO_2-P25 films, a material widely recognized for its photocatalytic effectiveness. This advanced modeling approach provided deeper insights into the internal structure of the films, particularly how the graded structural characteristics impact the overall optical behavior. The bottom layers of the films typically exhibited a significant increase in both refractive index and extinction coefficient, indicating greater density and higher absorbance compared to the top layers.