

# International Conference on Wave Equations, Optical Engineering and Quantum Mechanics (ICWOQ-2025)

Conference Proceedings

April 25, 2025 - Barcelona, Spain

## VUV Spectroscopy of Metal Oxide Thin Films: Bridging Structure and Photonic Applications

Helena Cristina Vasconcelos

Associate Professor, Laboratory of Instrumentation, Biomedical Engineering and Radiation Physics (LIBPhys, UNL), Department of Physics, NOVA School of Science and Technology, Caparica, Portugal

This presentation explores the structural and electronic transformations of sol-gel-derived metal oxide thin films, focusing on the interplay between annealing-induced phase evolution and photonic properties. Using titanium dioxide ( $\text{TiO}_2$ ) thin films as a model system, we examine the transitions that occur as the films progress from an amorphous phase to anatase, then to mixed anatase-rutile, and ultimately to rutile phases as the annealing temperature increases. These phase changes are characterized using advanced vacuum ultraviolet (VUV) spectroscopy ( $< 200$  nm), which reveals critical information about the material's electronic structure. Key spectral features, such as the  $\sigma \rightarrow \pi^*$  transition, which is associated with bonding to antibonding orbital excitations, as well as the  $\pi \rightarrow \pi^*$  and  $t2g(\pi) \rightarrow t^*2g(\pi^*)$  transitions, are observed. These features highlight the material's intrinsic electronic states and the effects of defects on its optical behavior.

The findings emphasize the crucial role of understanding the relationship between material structure and optical properties in the development of photonic and optoelectronic technologies. By mapping these structural and electronic transitions, the study provides a deeper understanding of how annealing parameters can be used to tune the photonic properties of  $\text{TiO}_2$  thin films, advancing their potential applications in a range of optoelectronic devices.