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Evaluation of the best strategy to obtain N-doped TiO₂ thin films by reactive rf magnetron sputtering for visible light photocatalysisJerome PULPYTEL¹, Wilson Smith², Houssam Fakhouri², Farzaneh Arefi-Khonsari²¹UPMC-ENSCP, Paris, France ²UPMC - ENSCP, Paris, France

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TiO₂ has been used as an effective photocatalyst for several decades, however, its major drawback is its inability to absorb visible light irradiation. One of the most attractive methods for improving this deficiency has been through doping, primarily with nitrogen, due to its small ionic radius and optimal electronic band positions.

In this study, we have compared three different techniques to incorporate nitrogen into TiO₂ via RF magnetron sputtering; i) simultaneous introduction of nitrogen and oxygen gases, ii) oxidation of TiN films, and iii) fabrication of novel TiO₂/TiN bi-layer films stacks. By studying and controlling the plasma characteristics by OES, thin films were created in order to optimize their crystalline, optical, and electronic properties.

The first method, which consist in the simultaneous introduction of O₂ and N₂, lead to the formation of homogeneous TiON films with different concentrations of nitrogen based on the deposition parameters. In the second method, pure TiN films were deposited and oxidized in air. TiO₂ was formed during the oxidation process, and the phase proportion and crystallinity were determined by the deposition conditions. Finally, in the third method, novel bi-layer thin film stacks with alternate layers of TiO₂ and TiN were fabricated, with the number of bi-layers increasing up to 45. The bi-layer stacking significantly affected the films optical properties by lowering the band gap into the visible light region, and also showed significant improvement in photoelectrochemical performance under visible light irradiation.

Nitrogen was successfully incorporated into TiO₂ by rf sputtering using three distinctly different techniques in order to create films with optimal structural and electronic properties. The comparison of the different method has revealed several of the key aspects that are essential and required for visible light photocatalysis.

KeywordsN-doped TiO₂
visible light photocatalysis
rf sputtering
multilayer