Optical properties and visible-light photocatalytic response of TiO_2 thin films deposited by PVD methods

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Titanium-dioxide (TiO_2) is one of the most used semiconductors in several technological applications due to its high corrosion resistance, photocatalytic activity, long-term stability, non-toxicity and wide band gap [1, 2]. For obtaining TiO_2 thin films, physical vapor deposition (PVD) methods have some advantages over chemical ones, such as: formation of homogenous and uniform layers on larger surface areas, better control of structural properties during deposition, simplification of photocatalytic usage in comparison to nano-particles etc.

Investigation on structural and optical properties of TiO_2 thin layers deposited by three different PVD methods is presented here. Methods that were used for production of thin films are: e-beam assisted evaporation, RF reactive sputtering and ion sputtering. The aim was to compare these three methods and to define conditions for producing thin layers with optical characteristics that are desirable for photocatalytic purposes in visible light region. Besides monitoring the impact of deposition parameters during synthesis of TiO_2 thin films, effects of different annealing conditions were investigated, roles of the oxygen and titanium vacancy places in the crystal lattice, effects of nitrogen doping and role of the nitrogen incorporation sites in crystal lattice on optical and photocatalytic properties were studied.

Structural and optical characterization of TiO_2 and N-doped TiO_2 thin layers deposited by ion sputtering of Ti target in oxygen/nitrogen atmosphere showed that thin layers deposited by this method were the most suitable candidates for photocatalysis in visible light region. Photocatalytic decomposition of Rhodamine-B, organic dye which simulates pollutant, under visible light irradiation source showed that concentration of substitutional nitrogen in TiO_2 crystal lattice has significant impact on photocatalytic efficiency.

REFERENCES
[1] U. Diebold, Surf. Sci. Rep. 48, 53 (2003).
[2] C. Stegemann et al., Thin Solid Films 625, 49 (2017).