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# Analysis of Structural and Photocatalytical Properties of Anatase, Rutile and Mixed Phase TiO2 Films Deposited by Pulsed-Direct Current and Radio Frequency Magnetron Co-Sputtering

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**Abstract :** Amongst many water purification techniques, TiO<sub>2</sub> photocatalysis is recognized as one of the most promising sustainable methods. It is known that for photocatalytical applications anatase is the most suitable TiO<sub>2</sub> phase, however heterojunction of anatase/rutile phases could improve the photocatalytical activity of TiO<sub>2</sub> even further. Despite the relative simplicity of TiO<sub>2</sub> different synthesis methods lead to the highly dispersed crystal phases and photocatalytic activity of the corresponding samples. Accordingly, suggestions and investigations of various innovative methods of TiO<sub>2</sub> synthesis are still needed. In this work structural and photocatalytical properties of TiO<sub>2</sub> films deposited by the unconventional method of simultaneous co-sputtering from two magnetrons powered by pulsed-Direct Current (pDC) and Radio Frequency (RF) power sources with negative bias voltage have been studied. More specifically, TiO<sub>2</sub> film thickness, microstructure, surface roughness, crystal structure, optical transmittance and photocatalytical properties were investigated by profilometer, scanning electron microscope, atomic force microscope, X-ray diffractometer and UV-Vis spectrophotometer respectively. The proposed unconventional two magnetron co-sputtering based TiO<sub>2</sub> film formation method showed very promising results for crystalline TiO<sub>2</sub> film formation while keeping process temperatures below 100 °C. XRD analysis revealed that by using proper combination of power source type and bias voltage various TiO<sub>2</sub> phases (amorphous, anatase, rutile or their mixture) can be synthesized selectively. Moreover, strong dependency between power source type and surface roughness, as well as between the bias voltage and band gap value of TiO<sub>2</sub> films was observed. Interestingly, TiO<sub>2</sub> films deposited by two magnetron co-sputtering without bias voltage had one of the highest band gap values between the investigated films but its photocatalytic activity was superior compared to all other samples. It is suggested that this is due to the dominating nanocrystalline anatase phase with various exposed surfaces including photocatalytically the most active {001}.

**Keywords :** films, magnetron co-sputtering, photocatalysis, $TiO_2$
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