Electrochemical Properties and Thin-Film Morphology of Mn-doped TiO₂ Thin Layer Prepared by Electrodeposition Technique and Its application as photocatalyst for Rhodamine B degradation

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This study was conducted to investigate the Mn concentration effect as dopant on morphological, structural, electrochemical and photocatalytic properties of Mn-doped TiO₂ thin films. The pure TiO₂ and Mn-doped TiO₂ thin films were synthesized through electrodeposition method and XRD, SEM, electrochemical and photodegradation analyses were applied for characterization of synthesized thin films. XRD results showed the pure TiO₂ and Mn-doped TiO₂ thin films were deposited in anatase phase of TiO₂ and TiO₂ nanocrystal sizes were slightly decreased with the increasing of dopant concentration. SEM analysis showed that the pure TiO₂ and Mn-doped TiO₂ thin films were synthesized in relatively dense, highly homogenous, porous and highly effective specific surface areas of nanoparticles on substrates. The electrochemical studies exhibited that Mn doping lead to decrease of recombination rate of photogenerated electron-hole pairs which can be related to creation defects as electroactive and photoactive sites in electrodeposited film through doping process. Results also showed the presence of Mn could narrow the band gap of doped films which promotes photoactivity of TiO₂ films in visible light range. EIS study results showed that the smallest resistance of charge transfer was belonging to TiO₂: Mn (5%) thin film. Results of photodegradation analyses for degradation of RhB under sunlight irradiation displayed that the all Mn-doped TiO₂ thin films showed more degradation efficiency than pure TiO₂ and the photocatalytic performance of films was improved with increasing Mn concentration up 5% and best degradation efficiency was obtained for TiO₂: Mn (5%) thin film (99% degradation efficiency under 120 minutes sunlight irradiation) due to hinder the recombination of photogenerated holes and electrons. Therefore, the appropriate amount of Mn in TiO₂ thin film was obtained in TiO₂: Mn (5%) thin film for electrochemical and photoelectrochemical performance.

Keywords: Mn-doped TiO₂ thin films; Electrodeposition; Electrochemical impedance spectroscopy; Photodegradation; Photocatalyst

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