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Effect of annealing conditions on the photocatalytic activity of anodic TiO2

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Photocatalysis using titanium dioxide nanomaterial remains one of the most promising technologies for sustainable and environmental remediation. Because of their morphology (i.e. a high surface area), nanostructured TiO2 nanotubes have been actively studied due to their potential use in photocatalytic applications.
In this work, anodic TiO2 nanotubes are used as photocatalysts for the degradation of methylene blue dye. The TiO2 nanotubes were fabricated at ambient temperature in an ethylene glycol-based electrolyte under a constant voltage. The as-anodized tubes were annealed in an oxygen-rich atmosphere and in vacuum at different temperatures and then characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The annealed samples were used as photocatalysts to degrade methylene blue dye under irradiation from a Xenon Lamp.
The XRD results show that heterophase anatase-rutile samples (with specific compositions) can be achieved by systematically varying the annealing temperature. SEM and TEM analysis reveal the formation of two distinct layers corresponding to the anatase and rutile TiO2 phases. The heterophase anatase-rutile samples exhibit the best performance, with near-complete degradation of the pollutant. It is shown the degradation efficiency increases with the rutile composition. The sample annealed at 700oC has a higher rutile composition and its degradation efficiency is 10% higher than that of the sample annealed at 600 oC. In comparison to the aspect ratio of the nanotubes, the results indicate that at higher annealing temperatures, the phase is likely the dominant factor contributing to the degradation efficiency of the organic pollutant.
The reaction rate in the presence of the heterophase TiO2 as well as the mechanisms of degradation are also presented and discussed.

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