Effect of Anodization Parameters on the Surface Morphology and Photoelectrochemical Properties of TiO₂ Nanotubes

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Titanium sheets are anodized to prepare titanium dioxide nanotubes (TiO₂ NTs) with varying chemical polishing times, anodizing voltages, anodizing times and NH₄F electrolyte concentrations. The surface morphology of the TiO₂ NTs is observed by a Scanning Electron Microscope (SEM) and used to characterize the inner diameter \(d_i\), centre to centre distance \(l\) and wall thickness \(w\). The photoelectrochemical performance of TiO₂ NT arrays is described by measurements of the photocurrent density and the incident photon to current efficiency (IPCE). The data show \(l\) can be controlled by the anodizing voltage; in contrast, \(d_i\) and \(w\) are influenced by the anodizing time and NH₄F electrolyte concentration. Furthermore, the effects of the anodization parameters on the TiO₂ NTs’ surface morphology were determined to influence each other. Using the optimum condition of an anodizing voltage of 60 V at 60 min in 0.125 mass % NH₄F ethylene glycol, TiO₂ NTs were fabricated that showed a photocurrent density of 90.42 \(\mu\)A/cm² and maximum IPCE of 18.76 % at 300 nm. The results indicate that the effects of the anodization parameters on the photocurrent response of TiO₂ NTs are primarily achieved through control of the wall thickness and the ratio of the diameter to the wall thickness \(d_i / w\). For a wall thickness that is greater than a critical value, the ratio \(d_i / w\) can reach a range in which the TiO₂ NTs show a high photocurrent output.

Keywords: TiO₂ nanotubes; anodization; surface morphology; photoelectrochemical property; wall thickness

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