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Morphology Evolution in Titanium Dioxide Nanotubes Arrays Prepared by Electrochemical Anodization

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Abstract : Photocatalysis has established as viable option in the development of processes for the treatment of pollutants and clean energy production. This option is based on the ability of semiconductors to generate an electron flow by means of the interaction with solar radiation. Owing to its electronic structure, TiO_2 is the most frequently used semiconductors in photocatalysis, although it has a high recombination of photogenerated charges and low solar energy absorption. An alternative to reduce these limitations is the use of nanostructured morphologies which can be produced during the synthesis of TiO_2 nanotubes (TNTs). Therefore, if possible to produce vertically oriented nanostructures it will be possible to generate a greater contact area with electrolyte and better charge transfer. At present, however, the development of these innovative structures still presents an important challenge for the development of competitive photoelectrochemical devices. This research focuses on established correlations between synthesis variables and 1D nanostructure morphology which has a direct effect on the photocatalytic performance. TNTs with controlled morphology were synthesized by two-step potentiostatic anodization of titanium foil. The anodization was carried out at room temperature in an electrolyte composed of ammonium fluoride, deionized water and ethylene glycol. Consequent thermal annealing of as-prepared TNTs was conducted in the air between 450 °C-550 °C. Morphology and crystalline phase of the TNTs were carried out by SEM, EDS and XRD analysis. As results, the synthesis conditions were established to produce nanostructures with specific morphological characteristics. Anatase was the predominant phase of TNTs after thermal treatment. Nanotubes with 10 μm in length, 40 nm in pore diameter and a surface-volume ratio of 50 are important in photoelectrochemical applications based on TiO_2 due to their 1D characteristics, high surface-volume ratio, reduced radial dimensions and high oxide/electrolyte interface. Finally, this knowledge can be used to improve the photocatalytic activity of TNTs by making additional surface modifications with dopants that improve their efficiency.

Keywords : electrochemical anodization, morphology, self-organized nanotubes, TiO_2 nanotubes
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