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Fabrication and Characteristics of Ni Doped Titania Nanotubes by Electrochemical Anodization

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Abstract : It is well known that titanium dioxide is a semiconductor with several applications in photocatalytic process. Its band gap makes it very interesting in the photoelectrodes manufacturing used in photoelectrochemical cells for hydrogen production, a clean and environmentally friendly fuel. The synthesis of 1D titanium dioxide nanostructures, such as nanotubes, makes possible to produce more efficient photoelectrodes for solar energy to hydrogen conversion. In essence, this is because it increases the charge transport rate, decreasing recombination options. However, its principal constraint is to be mainly sensitive to UV range, which represents a very low percentage of solar radiation that reaches earth's surface. One of the alternatives to modifying the TiO2's band gap and improving its photoactivity under visible light irradiation is to dope the nanotubes with transition metals. This option requires fabricating efficient nanostructured photoelectrodes with controlled morphology and specific properties able to offer a suitable surface area for metallic doping. Hence, currently one of the central challenges in photoelectrochemical cells is the construction of nanomaterials with a proper band position for driving the reaction while absorbing energy over the VIS spectrum. This research focuses on the synthesis and characterization of Nidoped TiO2 nanotubes for improving its photocatalytic activity in solar energy conversion applications. Initially, titanium dioxide nanotubes (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. Afterwards, the nanotubes were superficially modified by nickel deposition. Morphology and crystalline phase of the samples were carried out by SEM, EDS and XRD analysis before and after nickel deposition. Determining the photoelectrochemical performance of photoelectrodes is based on typical electrochemical characterization techniques. Also, the morphological characterization associated electrochemical behavior analysis were discussed to establish the effect of nickel nanoparticles modification on the TiO2 nanotubes. The methodology proposed in this research allows using other transition metal for nanotube surface modification.

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