Desalination and Water Treatment
www.deswater.com

28 (2011) 23–27
April

1944-3994/1944-3986
doi: 10/5004/dwt.2011.2195

Electrochemical synthesis of doped TNT as a nano photocatalyst for color degradation applications

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Received 1 February 2009; Accepted 1 July 2010

ABSTRACT

The preparation of high aspect-ratio TiO_2 nanotubes and their photocatalytic activity were demonstrated in this study. The high aspect-ratio TiO_2 nanotube thin films were produced by electrochemical anodic oxidation of Ti in chloride-containing electrolytes. Nanotubes were doped with different concentrations of ZnO particles through anodization. The catalytic behavior was evaluated under batch reactor with photo-degradation test of Red Dye. The experimental results collectively demonstrate the successful ZnO doping of the resultant nanotube layers with significant abundant OH groups on their increased surfaces. The nanotubes doped with high content combined with an anatase as a two phase semiconductor led to the formation of very active photocatalyst with highly surface reaction sites. In contrast, to the undoped TNT, its anatase/rutile phase ratios are increased. These effects could be attributed to the enhanced critical active-site density on the surface, which provides better photocatalytical properties.

Keywords: Photocatalyst; Titania nanotube; Microstructure; Electrochemical

1. Introduction

Titania nanotubes are materials of increasing interest due to their excellent applications to photocatalyst [1], liquid solar cell [2], and electroluminescent hybrid device [3], hence considerable effort has focused on developing efficient routes to fabricate titania nanotubes of controllable dimensions. Titania nanotubes of different geometrical shapes and microstructures have been fabricated by various methods, such as sol–gel, anodization, electrodeposition, sonochemical deposition, and other methods involving the chemical treatment of fine titania particles [4–14]. Among the methods, TiO_2 nanotubes with diameters of 70–100 nm were produced a sol–gel processing [5]. Zhao et al. [8] fabricated titanium oxide nanotube arrays by anodic oxidation, which the nanotubes had an inner diameter of 100 nm and the length of 200 nm. Kasuga et al. [6] reported the first evidence that titanium oxide nanotubes with the diameter of 8 nm and length of 100 nm could be obtained via chemical treatment. Zhang et al. [15] got much longer nanotubes, which is about 500 nm long and the diameters about 12–18 nm with the ultrafine rutile phase nanoparticles in size of 7.2 nm by chemical treatment.

Titanium dioxide (TiO_2) as a photocatalyst for degrading organic pollutions has attracted much attention because of its various advantages [16]. Unfortunately, the technological use of TiO_2 is limited by its wide band gap (3.2 eV for anatase), which requires UV light irradiation to obtain its photocatalytic activity. Because UV light only accounts for a small fraction (5%) of the Sun's energy compared to visible light (45%), any

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Presented at the 1st International Conference on Water and Wastewater Treatment, April 21–22, 2010, Isfahan, Iran