Electrochemical deposition of Copper Decorated Titania Nanotubes and Its Visible Light Photocatalytic Performance

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Abstract. Coupling of titania with narrow band gap materials has been a promising strategy in preparing visible light responsive photocatalyst. In this work, self-organized copper decorated TiO_2 nanotube (Cu/TNT) was prepared via electrodeposition of Cu onto highly ordered titania nanotube arrays (TNT). The catalysts were characterized by X-ray diffraction, diffuse reflectance spectroscopy (DRS), field emission scanning electron microscopy (FESEM) and energy-dispersive X-ray spectroscopy (EDX). The DRS studies clearly show the extended absorption of Cu/TNT into the visible region and present a red shift of band gap to 2.1 eV. FESEM analysis has shown the dispersion of cubic-like Cu particles upon electrodeposition and EDX analysis supports the presence of copper species on the nanotubes surface. The photocatalytic ability of Cu/TNT was evaluated by the degradation of methyl orange from aqueous solution under low power visible light illumination. Compared to TNT, an appreciable improvement in methyl orange removal was observed for Cu/TNT and the highest removal efficiency of 80% was achieved. The effects of catalyst loading and samples repeatability were investigated and under optimum conditions, the removal efficiency of methyl orange over Cu/TNT had further increased to 93.4%. This work has demonstrated a feasible and simple way to introduce narrow band gap transition metal into nanotube arrays, which could create novel properties for functionalized nanotube arrays as well as promise a wide range of applications.

Keywords: Photocatalytic,Electrochemical Deposition, Titania Nanotubes

INTRODUCTION

In recent years, development of new active TiO_2 based semiconductor has gained great attention of the scientific community because of its vast applications including in hydrogen generation, water and air purification, remediation of toxic inorganic and organohalide pollutants and conversion of CO_2 to fuel. However, the use of unmodified titania has several drawbacks, including poor visible light absorption due to wide 3.2 eV band gap of anatase and high recombination rate of photogenerated electron-hole pairs [1-3]. Therefore, in photocatalytic removal of recalcitrant environmental pollutants, there is a necessity to use a UV light source to activate the pristine TiO_2 for optimum removal. In addition, additional cost will incur in separating the suspended TiO_2 from the treated water. As such, modification of the optical and electronic properties of TiO_2 has been widely employed to fabricate visible-driven photocatalyst. Several approaches have been carried out such as metal and nonmetal doping, composites with other semiconductors, surface modification and dye/noble metal sensitization [4-7]. Among such approaches, metal doping appears to be a promising and effective strategy to enhance the photocatalytic activity of titania by reducing the band gap or/and reducing the electron-hole recombination.

One of the promising metal dopant is Cu. Copper is abundant in the earth and thus low cost, has high electronic conductivity, non-toxic and has recently attracted much interest as visible light sensitizer [8]. Moreover, many

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