Eosin-Y sensitized nanocrystalline TiO_2 Photoanode for Dye Sensitized Solar Cell application

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Abstract: For efficient charge injection and transportation, wide band gap nanostructured metal oxide semiconductor with dye adsorption surface and higher electron mobility are essential for photoanode in dye sensitized solar cells (DSSCs). In this study, TiO_2 films with anatase phase are prepared by using simple precipitation-annealing followed by cost effective Doctor's Blade method with titanium tetraisopropoxide as Ti-precursor. The influence of annealing temperature on structural, morphological, optical and photovoltaic properties is systematically investigated. The XRD and Raman spectroscopy characterization studies revealed the formation of pure single anatase phase TiO_2 in resultant films. The better optical properties: indirect band gap, absorbance coefficient and transmittance are found to be 3.19 eV, 1.70 x 10^4/cm and 65.4 % respectively in resultant films. The better photovoltaic performance: open circuit voltage (V_{oc}) = 0.564 V, current density (J_{sc}) = 4.80 mA/cm^2, fill factor (FF) = 42.57 % and photo conversion efficiency = 1.03 % using Eosin-Y dye with polyiodide electrolyte is obtained for DSSC of nanocrystalline TiO_2 films obtained at 400 °C.

Keywords: TiO_2; Nanomaterial; Doctor's Blade method; Eosin-Y dye; DSSC.

1. Introduction

In modern day of research, wide band gap semiconductors have been studied intensively due to their potential applications in many areas, such as sensors, laser diodes, high speed electronic devices etc. [1-3]. TiO_2 has attracted considerable attention owing to its wide band gap [4]. Thin films of TiO_2 have been studied widely in recent years for many applications like environmental applications, photocatalysis, electrochromic devices and photovoltaic cells [5-7] because of their better biocompatibility, thermal stability, strong oxidized stability, non-toxicity and long term photo-stability. It is also used in non-electronic applications like optical brightener in wall colors,ingredient in sun cream and bone implants [8]. TiO_2 thin films have been deposited by many researchers by using different techniques like, molecular beam epitaxial, chemical vapor deposition, aerosol pyrolysis, electrodeposition and sol-gel method [9-10]. In present study, TiO_2 films with anatase phase are prepared by using simple precipitation-annealing followed by cost effective Doctor's Blade method with titanium tetra isopropoxide as Ti-precursor. The photovoltaic properties of inexpensive Eosin-Y dye sensitized solar cells of resultant anatase phase pure TiO_2 films are recorded. The data pertaining to this is presented in this communication.

2. Experimental

2.1. Synthesis of TiO_2 powder

A 25 ml of titanium tetra-isopropoxide (TTIP) (Spectrochem Chem., AR grade) was slowly added to 100 ml of double distilled water (DDW). This hydrolysis was carried out in an ice bath under vigorous stirring. The resultant white precipitate was washed with double distilled water for by using centrifuge. Then precipitate was dried at 80 °C for 1 hr. The as-dried precipitate was annealed at 300, 400 and 500 °C for 2 hr to obtain TiO_2 powders.

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