Growth of TiO_2 Branched Nanorod Arrays on Transparent Conducting Substrate

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Abstract. Uniform and crack free coating of titanium dioxide dendritic nanorod arrays owning the surface rutile/anatase junctions on TiO_2 seed layer coated fluorine doped tin oxide substrate were successfully synthesized by a hydrothermal method followed by mild aqueous chemistry. Field emission scanning electron microscopy (FESEM), X-ray diffraction (XRD) and Raman spectroscopy revealed a unique flower like branched morphology, surface features, crystal phase, anisotropic crystal growth and orientation of TiO_2. In this nanostructure, vertical orientation of the nanorods can reduce the charge recombination and accelerate the electron transfer towards substrate. On the other hand, the surface anatase/rutile junctions formed on the boundary of branches and trunks serve as photogenerated electron–hole pairs separating sites and promote the transport of charges. This is the key influence factor that improves the photoelectrochemical (PEC) performance. Fine, dense, oriented and branched nanorod arrays result in high specific area. Also, diffuse reflection/transmittance spectroscopy (DRS/DTS) was used for determining the optical properties and band gap. Further sensitization of this nanostructure by metallic nanoparticles or quantum dots can significantly promote its PEC activity. This research provides the great possibility as viable alternatives to traditional single crystalline TiO_2 nanorods for highly efficient photocatalysts, sensitivity sensors or photoanodes of energy devices such as solar cells.

INTRODUCTION

TiO_2 has attracted much attention for future devices because of owning a favorable band edge position, nontoxicity, strong optical absorption, high photocatalytic activity, high redox potential, resistance to photocorrosion, chemical\thermal stability and inexpensive cost [1-5]. It has appealing characteristics for dye sensitized solar cells, molecular sensors, gas sensors, photocatalysts, catalysts, lithium batteries, cosmetics and medical applications [6-17].

Morphologies of TiO_2 directly affect surface area, surface crystal faces, molecular adsorption characteristics, electron mobility and so on [18-21]. They are essential factors to improve properties such as photoenergy conversion efficiency of solar cells, sensitivity of the sensors and luminescence intensity of the optical devices or photocatalytic effects. Therefore, further development of TiO_2 nano/microstructures is strongly required for various applications. Recently, unique TiO_2 nanostructures were synthesized by several methods. Nanosheets of TiO_2 were exfoliated from layered titanates in the solutions [22].TiO_2 nanorods, nanowalls [23] and nanotubes [24] were formed on the substrate for solar cells and sensors.

In this study, TiO_2 branched nanorods which own the surface anatase/rutile junctions were successfully synthesized via a hydrothermal method followed by mild aqueous chemistry and their properties and characteristics were evaluated and discussed.