H₂Ti₂O₅ ·H₂O NANOWIRE AS AN INTERMEDIARY PHASE OF TiO₂ ANODE FOR DYE SENSITIZED SOLAR CELL

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Abstract

In the last years, nanostructures have been widely used in energy harvesting devices, such as dye-sensitized solar cells (DSSCs), nanogenerators, and fuel cells, due to their high efficiency and light weight [1-4]. Therefore, nanostructure based DSSCs are likely to be low-cost, high efficiency, and simple in preparation, which is promising as a renewable energy resource for sustainable development of the future. Besides DSSC applications, nanostructures have been used in energy storage fields, such as lithium ion batteries (LIBs), due to their high energy density and long cycle life [5, 6]. A great challenge is to combine solar energy conversion and storage into one device. Using (Ti) sheet as substrate for TiO₂ nanorods grown as intermediary, the integrated power pack can be flexible and directly harvest and store energy by the electron conduction of the substrate. Thereby, using double-sided TiO₂ nanorods not only provide larger electrode area for DSSCs and LIBs but also can improve the electron transport properties of DSSCs and avoid irregular expansion when the insertion/removal of lithium along a specific orientation in anode material [7]. Compared with other integrated solar power supplies, double-sided TiO₂ nanorods with large area can be prepared by a simple, cost-effective, and controllable electrochemical process.

Moreover, such H₂Ti₂O₅ ·H₂O material are good precursor of titania and metal titanate, and have well-controlled shapes such as nanotubes and nanosheets [8,9]. H₂Ti₂O₅ are usually synthesized by solvothermal treatment of titania or by ion-exchange of alkaline metal titanates. Until now, the synthesis of H₂Ti₂O₅ have been less frequently reported than those of other hydrogen titanates, such as H₂Ti₃O₇ and H₂Ti₄O₉, and it is formed as sheet-like particles[10,11]. The structure of H₂Ti₂O₅ has not been well established, it is reported to be a layered compound which is an isostructure to K₂Ti₂O₅ [12].

In this paper, we report the successful hydrothermal synthesis of H₂Ti₂O₅ ·H₂O nanowire as an intermediary phase of TiO₂ anode for dye sensitized solar cell. The structure of products was determined by powder X-ray diffraction (XRD) PW 3040/60 X’Pert PRO using Cu-Kα radiation with (λ=1.5418Å), in the range 2θ = 10-80°, at room temperature. A Scanning Electron Microscope InspectS (SEM) was used to observe the morphology of synthesized nanocrystals. The diffuse reflectance spectra (DSR) was obtained using a Lambda 950 UV-Vis-NIR Spectrophotometer with 150 mm integrating sphere in the wavelength range of 300–800 nm.
Figure 1. (a) X-ray diffraction patterns of $\text{H}_2\text{Ti}_2\text{O}_5 \cdot \text{H}_2\text{O}$ obtained at 220 °C for 24 hours at various concentrations of NaOH, a) 1M, b) 2M, c) 3M

Figure 2. SEM images of $\text{H}_2\text{Ti}_2\text{O}_5 \cdot \text{H}_2\text{O}$ obtained at 220 °C for 24 hours at various concentrations of NaOH, a) 1M, b) 2M, c) 3M

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References
(4) J. Zhu, Y. Cui, Nat. Mater. 2010, 9 (3), 183–184