Abs. 261, 206th Meeting, © 2004 The Electrochemical Society, Inc.

Dye-Sensitized Solar Cells Using Titania Nanowire.

Yoshitaka Sanehira, Satoshi Uchida
Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Tohoku University, Sendai 980-8577, japan.

Introduction

The TiO_2 particles have been widely used for various applications such as pigment, photocatalyst, photo-electron conversion device, UV protection shield, Anti-Bacteria material, and so on. In order to improve their specific properties, much effort has been paid for morphology control of the TiO_2 particles. Fibrous titania (Titania Nanowire), such as a nano tube is one of the promising materials for above use because of the high specific surface area and specially ordered structure. Recently a notable simple method has been proposed by Kasuga et al., in which titania nano tubes were obtained by only treating $TiO_2 \cdot SiO_2$ gel in 5-10 M NaOH solutions for 20 h at 110 °C. Here, in this study, the new type of TiO_2 Nanowire was synthesized modeled on the Kasuga's method [1], by using KOH instead of NaOH and changing the reaction condition.

Experimental

Basically titania nano wire was synthesized based on the method developed by Kasuga as mentioned in Introduction. The nano meter sized TiO_2 powder (P25, Nippon Aerosil Co., Ltd.) was used as the starting material. The primary particle size was 30 nm in diameter. The crystal structure was the mixture of anatase form (70 %) and rutile. A typical experimental procedure is as follows. Firstly 11 g of KOH and 10 ml of water were put into a tubular 30 cm^3 of Teflon® cup to form 20 M KOH solution. Then 0.2 g of TiO_2 (P25) powder was added in the solution. These were placed in the pressure resistable glass bottle (100 mL GL-45, Duran). After sealing the bottle, it was set into a dry oven at 110 °C for 20 h. After the reaction was completed, the product was separated from the solution by centrifuge, then rinsed with hydrochloric acid and pure water to remove the residual alkaline, and finally dried by freeze drier.

Photovoltaic properties were measured fundamentally according to the method by Nogueira and Paoli[2].

Result and Discassion

The product was 5-15 nm in width and more than 100 nm, perhaps a few micrometers, in length with fibrous shape as shown in Fig. 1(a). In these products, many nanowires cohered and formed secondary particles. But it found that wires are not connected on intersection portion, each wire exists individually as a single fiber by high magnification TEM images, shown in Fig. 2(b). In the optimum synthesis condition, the specific surface area was over 450 $m^2 \cdot g^{-1}$, much higher than that of starting material titania powder (P25, Nippon Aerosil co., Ltd.) with 50 $m^2 \cdot g^{-1}$ (Fig. 2).

These nano size shaped materials are examined for titania electrode of dye-sensitized solar cell to improve photo-electron energy conversion efficiency. Using high surface materials, such as nanowire, it can expect to increase in dye adsorption, it lead to increase in photocurrent.

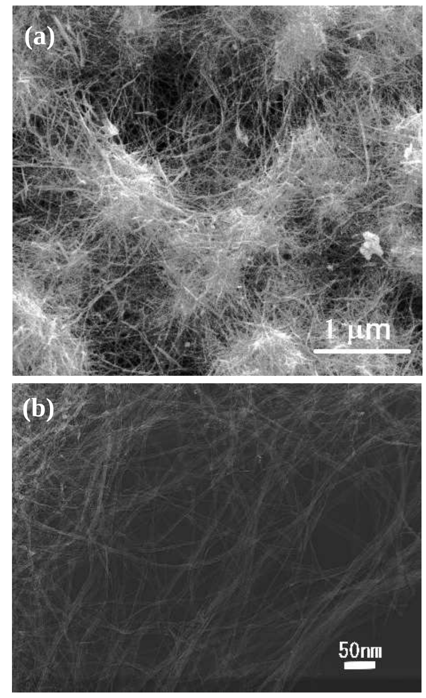

Fig.1 (a) SEM image and (b) high magnification TEM image of titania nano wire synthesized by 20 M KOH solution for 20 h at 110 °C.

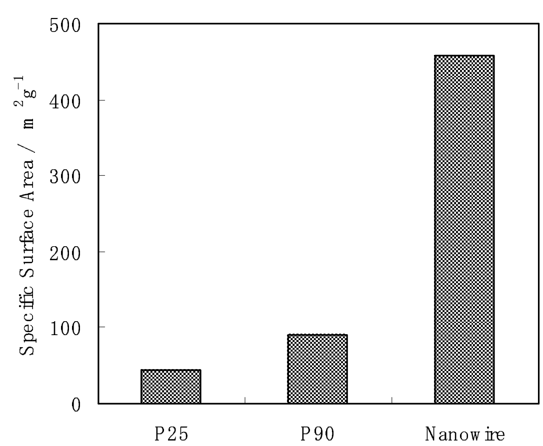

Fig.2 Specific surface area of starting materials titania powder (P25 and P90, NIPPON AEROSIL CO., LTD.) and titania nano wire

References
[1] T. Kasuga et al., *Langmuir*, 14(12) (1998) 3160.
[10] Nogueira, A.F. et al., *Sol. Ener. Mater. Solar Cells*, 61(2), (2000), 135.