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SYNTHESIS AND CHARACTERIZATION OF TiO_2(B) NANOTUBES PREPARED BY HYDROTHERMAL METHOD USING $[Ti_8O_{12}(H_2O)_{24}]Cl_8.HCl.7H_2O$ AS PRECURSOR

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Abstract

Low-dimensional TiO_2-related material has been synthesized by hydrothermal treatment of $[Ti_8O_{12}(H_2O)_{24}]Cl_8.HCl.7H_2O$) crystal as precursor in a 10 M NaOH aqueous solution at 150 °C for 24 h. Characterization of the obtained product was carried out by a range of techniques including X-ray diffraction (XRD), high resolution scanning electron microscopy (HRSEM), high resolution transmission electron microscopy (HRTEM), Raman spectroscopy and nitrogen adsorption-desorption isotherm (Brunauer-Emmett-Teller (BET)-Barret-Joyner-Halender (BJH)). From HRTEM, XRD and Raman spectra showed that the obtained product has a TiO_2(B) structure. According to HRTEM observations, it was found that TiO_2(B) has nanotubular structure with approximately 5-8 nm in outer and 3-6 nm in inner diameter. The BET surface area of TiO_2(B) nanotubes is quiet large, values of 418.3163 m^2/g being obtained. Pore structure analysis by the BJH method showed that the average pore diameter of TiO_2(B) nanotubes has 5.5781 nm.

Keywords: hydrothermal methodnanotubes, synthesis, TiO_2(B), titania

1. Introduction

Titanium dioxide (TiO_2) has a wide range of applications due to its excellent physical and chemical properties, it is widely used as white pigment in paints, cosmetics, photoelectrochemistry and catalyst carrier in industry [1]. Titanium dioxide as a n-type semiconductor with a wide energy band gap, is well-known for its potential applications in the field of photovoltaic devices [2-6], super hydrophilic and light-induced amphiphilic surfaces [7-10] and antibacterial applications [11-13], it can be also applied in heterogeneous photocatalysis. Nanosized TiO_2 particles show high photocatalytic activities because they have a large surface area per unit mass and volume, and hence facilitate the diffusion of excited electrons and holes towards the surface before their recombination. This process involves a large variety of reactions, for example, partial or total oxidation, dehydrogenation, hydrogen transfer, water detoxification, or gaseous pollutant removal [14-20].

Recently, low-dimensional (1D) TiO_2-related materials, such as nanotubes, nanowires, nanoribbons and nanofibers have attracted particular interest because of their unique microstructure and promising functions. Low-dimensional (1D) TiO_2-related materials obtained by chemical process are particularly interesting, because of their large specific surface area caused by low-dimension morphology, leading to the development photocatalyst, environment purification, solar cell, gas and humidity sensor [21-26]. Kasuga et al. [27] treated TiO_2 in the 10 M NaOH aqueous solution for 20 h at 110 °C without the need for molds for template and nanotubes with 8 nm in diameter and 100 nm in length were obtained. This simple and low-cost synthetic method through chemical process may be applied in the fabrication of other oxide nanotubes.

In this paper, a conventional hydrothermal method was used to synthesize low-dimensional (1D) TiO_2-related materials. The structural investigations of obtained products were analyzed by various methods, such as X-ray diffraction (XRD), high resolution scanning electron microscopy (HRSEM), high resolution transmission electron microscopy (HRTEM), Raman spectroscopy and nitrogen adsorption-desorption isotherm (Brunauer-Emmett-Teller (BET) - Barret-Joyner-Halender (BJH)).