Advanced Powder Technology 22 (2011) 336–339

Contents lists available at ScienceDirect

Advanced Powder Technology

journal homepage: www.elsevier.com/locate/apt

Original Research Paper

Hydrothermal synthesis and characterization of TiO_2 nanostructures using LiOH as a solvent

Saeid Zanganeh [a,e], Amir Kajbafvala [b], Navid Zanganeh [c], Roya Molaei [d], M.R. Bayati [d], H.R. Zargar [d], S.K. Sadrnezhaad [e,*]

[a] Department of Electrical and Computer Engineering, University of Connecticut, 371 Fairfield Way, U-2157 Storrs, CT 06269-2157, USA
[b] Department of Materials Science and Engineering, North Carolina State University, 911 Partners Way, Raleigh, NC 27695-7907, USA
[c] Chemical Engineering Department, Amirkabir University of Technology, P.O. Box 15875-4413, Tehran, Iran
[d] Department of Metallurgy and Materials Engineering, Iran University of Science and Technology, P.O. Box 16845-161, Tehran, Iran
[e] Department of Materials Science and Engineering, Center of Excellence for Production of Advanced Materials, Sharif University of Technology, P.O. Box 11365-9466, Tehran, Iran

ARTICLE INFO

Article history:
Received 14 October 2009
Received in revised form 23 March 2010
Accepted 26 April 2010
Available online 8 May 2010

Keywords:
Inorganic materials
Nanostructured materials
Hydrothermal synthesis
Nanofabrications

ABSTRACT

In the present study, we performed hydrothermal method as a simple and efficient route for the synthesis of rutile TiO_2 nanostructures in various concentrations of lithium hydroxide solutions. TiO_2 nanopowders with average sizes of 15 and 23 nm were prepared using 4 M and 7 M LiOH solutions. X-ray diffraction analysis (XRD), transmission electron microscope (FEG-STEM), scanning electron microscopy (SEM), and Brunauer–Emmet–Teller (BET) analyses were used in order to characterize the obtained products and comparison of the morphology of the powders obtained in different concentrations of LiOH solvent. It was shown that alkali solution concentration has affected the crystallinity, agglomeration ratio, particle size and specific surface area of the obtained rutile phases.

1. Introduction

Titanium dioxide (TiO_2) has attracted considerable attention due to its interesting properties, such as chemical inertness [1], non-toxicity [2], high refractive index [3], low cost [4], and high photocatalytic efficiency [5]. TiO_2 nanocrystals are extremely promising materials for extensive applications in photocatalysis [6], solar energy conversion [7] sensor systems [8], biomedical applications [9] and pigments [10].

TiO_2 nanocrystals can be synthesized with different methods, which the most common are chemical processes such as hydrothermal [11,12] and sol–gel [13,14] methods, which can be accompanied by surface directing agents [15,16], ultrasonic irradiation [17] or microwaves [18]. Due to some advantages such as appropriate crystallization temperature, being friendly to the environment, controllability of reaction conditions, low energy consumption and low cost, hydrothermal method has been considered as a suitable synthetic route.

Several researchers have investigated the effect of solvents on crystalline phase and morphology of TiO_2 nanostructures [19]. In this manner the most focus has been attributed to the NaOH as the most well known solvent in the materials preparation techniques [20]. The researches have shown that NaOH has affected the growth of TiO_2 nanostructures led to the formation of one dimensional material such as nanotubes, nanorods and nanowires [21,12]. Although there are several reports on the influence of NaOH on the crystalline phase and morphology of TiO_2 nanostructures, there are no precise investigations utilizing other alkali solutions as the solvents. Since gathering such information about the effect of other alkali solutions on the preparation of nanostructures would be beneficial, we investigated the effect of LiOH alkali solution concentration on the morphology and crystal structure of the TiO_2 nanostructures obtained by the hydrothermal method.

2. Experimental

Titania nanostructures obtained in this work prepared by using the following procedure: 0.8 g of pure titanium dioxide (TiO_2) with rutile phase (99.99%, Merck, Germany) was first introduced into a 7 M LiOH solution and mixed vigorously using a magnetic stirrer. The mixture was put into a Teflon-lined stainless-steel autoclave and then the autoclave was sealed completely and heated up to 130 °C and kept at this temperature for 10 h, without any shaking or stirring. After the desired time, the autoclaves were cooled down naturally in the ambient condition to the room temperature. In order to assess the effect of LiOH concentration, a similar experimental procedure was carried out using 4 M LiOH as the solvent.

* Corresponding author.
E-mail addresses: SAZ@ENGR.UCONN.EDU (S. Zanganeh), sadrnezh@sharif.edu (S.K. Sadrnezhaad).

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doi:10.1016/j.apt.2010.04.010