The Role of Annealing Temperature on the Structure and Optical Properties of ZnO Nanoparticles

H.Sivaram
RAJALAKSHMI INSTITUTE OF TECHNOLOGY, Kuthambakkam, Post, Chembarambakkam, Chennai, Tamil Nadu 600124

Abstract

The current study describes ZnO nanoparticles were synthesized by sol-gel method. The synthesized nanoparticles annealed at different thermal temperatures. The annealed samples are then characterized by X-ray diffractometry (XRD), scanning electron microscopy (SEM). The XRD pattern of annealed samples showed the purity of the samples. From the XRD pattern the crystallite size of annealed samples is derived through Debye–Scherrer equation. The morphology of the annealed samples is carried out by scanning electron microscopy (SEM). The UV-vis spectra showed the absorption of the annealing sample when the temperature was increased.

Introduction

In recent years metal oxide-based nanoparticles have attracted more attention due to unique features[1-2]. The nanoparticles features are differed from those of bulk materials. The metal oxide nanoparticles are widely used in non-linear optics, solar energy conversion, gas sensors, catalysis, varistors, paint, etc. Zinc oxide (ZnO) is a material with great potential for a wide of practical applications, such as optical waveguides, piezoelectric transducers, surface acoustic wave devices, phosphors, varistors, chemical and gas sensors, transparent conductive oxides, spin functional devices[3-6]. The significance of zinc oxide nanoparticles has increased for both fundamental and technical uses. The ZnO is a semiconductor material utilised in photochemical, optoelectronic, electrical, and catalytic processes. It has a wide band gap, with an energy gap of 3.37 eV. The various method for the preparation of ZnO nanoparticles have been applied: sol–gel method, thermal decomposition, hydrothermal method, co-precipitation method, etc[7]. In this paper we report the synthesis of ZnO nano particles by solgel techniques. The prepared samples should be annealed at different temparture are 70 °C, 100 °C,130 °C. The annealing temperature affects the ZnO nanoparticles size, morphological and optical properties.

Experimental procedure

Zinc acetate dihydrate, $Zn(Ac)_2 \cdot 2H_2O$ (99.9%, Sigma Co.), ethanol (99.9% Sigma Co.) and sodium hydroxide (NaOH 99.9% Sigma Co.) are used as received, without further purification. The zinc acetate dihydrate solutions are prepared by adding 1 g of $Zn(Ac)_2 \cdot 2H_2O$ in 50 ml ethanol. The above solution should be mixed 0.05 g NaOH under vigorous stirring at room temperature and then ultrasonicating for 10 min. A clear transparent solution would be obtained. The solutions are heated at 55 °C under hot air oven. The prepared ZnO samples should be washed with ethanol and DI water to remove the impurities form of the samples. The precipitates were subsequently annealed at various temperatures from 70, 100 and 130 °C for 2 h in box furnace.

Result and Discussions

The XRD pattern of annealed samples shows the purity and phase of the samples. From the XRD pattern the crystallite size of annealed samples is derived through Debye–Scherrer equation. The SEM images for three different annealed ZnO nanoparticles have been taken at different resolutions and temperatures. The absorption peaks from UV–visible spectroscopy are observed in between 320 and 390 nm for all annealed samples. The absorption peak is probably related to the electronic transition taking place from valence band to the conduction band due to quantum size of particles.

Reference

[1] R. Zhang, L.L. Kerr, J. Solid State Chem. 180 (2007) 988.
[2] C.X. Xu, X.W. Sun, B.J. Chen, P. Shum, S. Li, X. Hu, J. Appl. Phys. 95(2004) 661.
[3] Han J. and Kim D. "Fabrication of dense ZnO-varistors by atmosphere sintering" J. uropean Ceramic. Soc. 18: 765-770 (1998).
[4] Gao P. and Wang Z. "Nanoarchtecture of Semiconducting and Piezoelectric ZnO". J. Appl. phys. 97: 044304-044311 (2005).
[5] C. Jagadish, S.J. Pearton, "Zinc Oxide Bulk, Thin Films and Nanostructure", Amsterdam, Elsevier,2006.
[6] U. Abhulimen, Mater.Res.Soc.Symp.Proc.,1, 27.1 (2005).
[7] S. Jurablu, M. Farahmandjou, and T. P. Firoozabadi. "Sol-Gel Synthesis of Zinc Oxide (ZnO) Nanoparticles :Study of Structural and Optical Properties". Journal of Sciences, Islamic Republic of Iran 26(3): 281 - 285 (2015). University of Tehran, ISSN 1016-1104