Journal of Advances in Applied Sciences and Technology
ISSN : 2393-8188 (print)
2393-8196 (online)
www.milliyasrcollege.org.journal.php

DIFFERENT PROPERTY STUDIES ON ZnO QUANTUM DOTS SYNTHESIZED BY SOL-GEL AUTO COMBUSTION ROUTE

Bodke Milind R.[1]*, Gaikwad Harsh K.[2] Sonawane Tanaji B.[3]

[1*]Assistant Professor Dept. of Electronic Science, Modern College of Arts, Science and Commerce Shivajinagar, Pune, Maharashtra, India.
[2] Assistant Professor, Dept. of Chemistry, Modern College of Arts, Science and Commerce Shivajinagar, Pune, Maharashtra, India.
[3] Research Scholar,Dept. of Electronics,Shivaji University, Kolhapur, Maharashtra, India.
e-mail: milindbodke@gmail.com

ABSTRACT:

Zinc oxide quantum dots were synthesized by sol-gel auto combution route without heat treatement (annealing). Structrual study was undertaken by X-ray diffraction XRD technique. Structural parameters were investigated from XRD data. It confirms that the prepared sample was having hexagonal (wurtzite) structure. Crystalline size determined from XRD data was around 4.22nm. Chemical species present in the samples and their weight percentage were detected by energy dispersive spectroscopy. XRD , EDS study and SEM image concludes, there were no impurity phases present in the ZnO sample. Surface morphology was investigated by scanning electron microscopy (SEM). Photoluminescence measurement spectra showed the ultraviolet (UV) emission. Single emission peak observed around 358nm, it was due to free excition recombination.

KEYWORDS: Quantum dots; sol-jel auto combustion route; X-ray diffraction (XRD); photoluminesence.

1. INTRODUCTION

Zinc oxide is one of the most promising Diluted magnetic semiconductors. Many researchers have great attraction towards it, due to its piezoelectric behavior [1] as unique property. It is widely used for sensors and actuators. ZnO also emitts the broad lunminescence emission in the visible region, it gives rise to high efficiency exciton emission at room temperature (RT) due to its large exciton binding energy (60 meV). Due to a strong luminescence in the green–white region of the spectrum, ZnO is also a suitable material for phosphor applications. Zinc oxide nanostructures have varityof applications in era of nanotehnology, such as nanogenerators [2], field emission transistors [3], and ultraviolet photo detectors [4]. It has one of the most important applications as DNA sequence detector [5] in bio-medical system.

There were different synthesis techniques used for ZnO nanomaterials such as chemical co-precipitation [6], organometallic precursor method [7], microemulsion process [8] sol-gel synthesis [9], chemical vapor deposition (CVD) [10] and sol-gel combution method [11].

In this research work for the synthesis of ZnO quantom dots, the recently developed solgel auto combution route is adopted. By this gel combusion technique, homogenious, highpurity nanopowder was produced. In this study, Zinc nitrate is used as starting material and N-N dimethylformamide was used as fuel.

1. EXPERIMENTAL DETAILS

For the synthesis of ZnO quantum dots, Zinc nitrate and N-N dimethyl formamide were used. Both chemicals were having AR grade and used without further purification. N-N dimethyl formamide was used as fuel for combustion. Zinc nitrate (17.8482 gm) was added into 60ml of N-N Dimethyl formamide (N-NDMF) to prepare 1M solution. This mixture was stirred continuously for 2h at 70^{0}C temperature to get completely clear solution. Then the clear solution was kept on hot plate at 170^{0}C for 3h to form thick jel. Further heating of the jel, auto combustion takes place and the ZnO quantum dots were formed. Sample was ground for 15min with the help of ageto mortal pistal to get homogenous quantum dots.

2. RESULT AND DISCUSSION

2.1 STRUCTURAL STUDY

Structural study was intervened by X-ray diffraction spectroscopy. The XRD pattern of ZnO quantum dots is as shown in figure 1. Diffraction peaks corresponds to the lattice planes for ZnO quantum dots synthesized via sol-gel auto combustion route were (100), (002), (101), (102), (110), (103), (200), (112) and (201). 2□ values corresponds to the lattice plane are (32.0685), (34.6468), (36.5492) (47.8582), (56.9096), (63.145), (66.6459), (68.1735) and (69.3247). XRD diffraction data compared with JCPDS card and it was well matched with JCPDS card no. (75-1526). It is concluded that the sample exhibits hexagonal (wurtzite) structure. The average values of Lattice constants ‘a’ and ‘b’ are 3.23061 and 5.1809, very close to the JCPDS card values. Crystalline size was calculated for the highest intensity diffraction peak and it is 4.2257 nm.

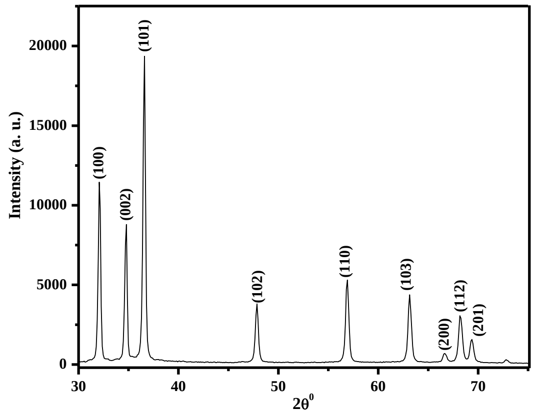

Fig. 1 *X-ray diffraction (XED) pattern of ZnO*

2.2 CHEMICAL COMPOSITION STUDY

Chemical compositio study of the sample was carried out by using energy dispersive spectroscopy technique. Energy dispersive spectra of ZnO quantum dots sample is as shown in the fig. 2 with their weight and atomic percentage of the chemical species (elements). In the EDS spectra only two peaks of Oxygen and Zinc were observed as shown in figure. Individual totals of Weight% and atomic% are 100. Therefore it is confirmed that the prepared sample is with out any impurity.

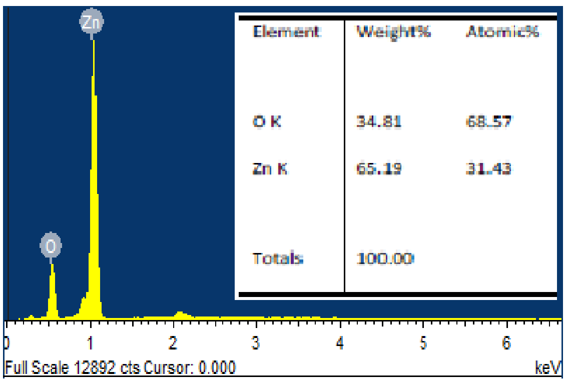

Fig. 2 *Energy dispersive spectra (EDS) of ZnO*

2.3 SURFACE MORPHOLOGICAL STUDY

The surface morphological study has been covered by using Scanning electron microscope SEM. The SEM micrographs of ZnO quantum dots are as shown in the fig. 3. It shows the clearly crystalline structure of the sample, amorphousness was not observed. From the encircled particle in the micrograph clearly shows that the ZnO quantum dots are Hexagonal. The transparent crystals are observed.

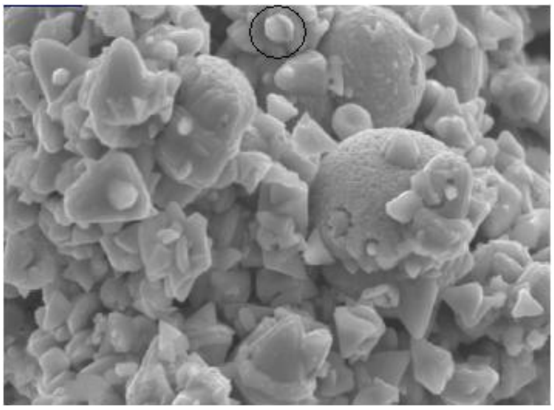

Fig. 3 *Scanning electron microsopic image of ZnO.*

2.4 PHOTOLUMINESCENCE STUDY

Photoluminescence (PL) spectroscopy was employed for optical charecterization of ZnO quantum dots. Fig. 4 shows the PL spectras were measured at room temperature in a closed cycle refrigerator with excitation at wavelength of 325nm. The PL spectra of prepared sample of ZnO quantum dots shows only one emission peak located around 358nm in the ultraviolet region. It is attributed to free-exciton recombination as reported in the litrature [12].

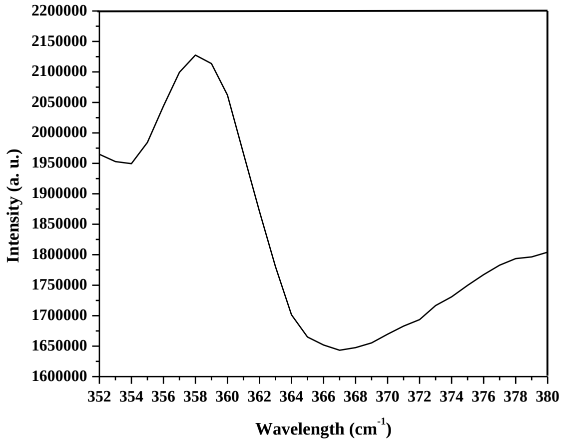

Fig. 4 *PL spectra of ZnO at room tempareture.*

3. CONCLUSION

We have successfully sinthesized ZnO quantum dots with high purity using sol-gel auto combustion route. XRD and EDS study confirms that the ZnO quantum dots are highly pure without any secondary element. Hexagonal (wurtzite) structure of the quantum dots was confirmed from XRD pattern and SEM micrograph. Crystalline size obtained from

XRD data was 4.22nm. Only one emission peak was observed in PL spectra of ZnO quantum dots measured at room temperature. It was due to free exciton combination.

REFERENCES

[1] A. V. Desai, M. A. Haque. "*Mechanical properties of ZnO nanowires*".Sens. Actuator 134 (2007) 169-175.

[2] X. Wang, J. Song, Z. L. Wang. "*Nanowire and nanobelt arrays of zinc oxide from synthesis to properties and novel devices"*. J. Mater. Chem. 17 (2007) 711-720.

[3] M. S. Arnold, P. Avouris, Z. W. Pan, Z. L. Wang. *"Field-effect transistors based on single semiconducting oxide nanobelts"*. J. Phys. Chem. B 107 (2003) 659-663.

[4] J. H. Jun, H. Seong, K. Cho, B. M. Moon, S. Kim. "*Ultraviolet photodetectors based on ZnO nanoparticlesCeram"*. Int. 35 (2009) 2797-2801.

[5] N. Kumar, A. Dorfman, J. I. Hahm. *"Ultrasensitive DNA sequence detection using nanoscale ZnO sensor arrays. Nanotechnology"*,17 (2006) 2875-2881.

[6] X. Liu, M.D. Kaminski, Y. Guan, H. Chen, ,. Lui, J, Rosengart A.J. *"Preparation and charectirization of hydrohpbic supermagnetic magnetic gel."* J. Magn. Magn. Mater., 306 (2006), 248–253.

[7] W. Chen, Y. H. Lu, M. Wang, L. Kroner, H. J. Fecht. *"Synthesis, Thermal Stability and Properties of ZnO2 Nanoparticles."* J. Phys. Chem. C 113 (2009) 1320-1324.

[8] P. Y. Wang, Q. H. Gao, J. Q. Xu. *"Study of photocatalytic activity of nanosized zinc peroxide"* Fin. Chem. 24 (2007) 436-440.

[9] Cheng H, Xu XJ, Hng HH, Ma J. *"Characterization of Al-doped ZnO thermoelectric materials prepared by RF plasma powder processing and hot press sintering"* Ceram Int. 35(8) (2009)3067.

[10] Kumar Mukul , Ando Yoshinori "Chemical Vapor Deposition of Carbon Nanotubes: A Review on Growth Mechanism and Mass Production" J. Nanoscience and Nanotechnology 10 (2010) 3739–3758,

[11] N. Riahi-Noori, Sarraf-Mamoory, F. Alizadeh, A, Mehdikhani. *"Synthesis of ZnO nano powder by a gel combustion method "* J.Cream. Process. Res. 9(2008) 246-249.

[12] T. M. Hammad, J. K. Salem, R. G. Harrison. The influence of annealing temperature on the structure,morphologies and optical properties of ZnO nanoparticles. Superlattice and Microstructures 47 (2010) 335-340