International Journal of Scientific Research in Science, Engineering and Technology (www.ijsrset.com)
© 2020 IJSRSET | Volume 7 | Issue 3 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
DOI : https://doi.org/10.32628/IJSRSET207360

Effective Temperature of ZnO Nanoparticles

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ABSTRACT

In modern science Nanotechnology is the field for the researchers. Nanoparticles have a size of 1-100 nm with a surrounding interfacial layer. Many researchers characterize significantly concerning medical chemistry, atomic physics, and all other known fields. Zinc oxide nanoparticles were synthesized with precipitation method after annealing the precursor at different temperatures. The effects of annealing temperatures for the precursors on the particle size of ZnO NPs were investigated. The structure and composition of the precursor and prepared ZnO NPs will study using X-ray diffraction (XRD), Scanning Electron Microscopic Analysis (SEM), and the optical properties of the ZnO NPs will characterize using UV-visible spectroscopy.

Keywords : ZnO nanoparticles, XRD, SEM and UV-visible Spectroscopy.

I. INTRODUCTION

Zinc oxide is an inorganic compound also known as zincite and occurs rarely in nature, generally in a crystalline form. ZnO is actually a wide-band gap semiconductor of the II-VI semiconductor group. The doping of the semiconductor is n-type which is due to oxygen vacancies. This has several favorable properties like high electron mobility, good transparency, wide band gap for semi-conductivity, high room-temperature luminescence, etc.

These properties are used in applications for electrodes in liquid crystal displays as well as in energy-saving and heat-protecting windows, electronic applications of ZnO as thin-film transistors and light-emitting diodes and also in ceramics plastic Zinc oxide (ZnO) has a stable wurtzite structure with lattice spacing a = 0.325 nanometers and c = 0.521 nanometers. Because of its unique properties and versatile applications, it is used in transparent electronics, ultraviolet (UV) light emitters, piezoelectric devices and chemical sensors. These remarkable physical properties form the basis for motivation of device miniaturization, large effort has been focused on the synthesis, characterization and device applications of ZnO nanomaterial.)

II. EXPERIMENTAL PROCEDURE

The exact physical and chemical properties ZnO NPs depend on the different ways synthesized. ZnO NPs can produce electrochemical depositions, sol-gel method, chemical vapour depositions, thermal decomposition, two-step chemical method and precipitation processes using solution concentration and washing medium. So ZnO NPs can be prepared by a precipitation method. Briefly, two solutions were prepared: Solution A (4.5g of $(CH_3COO)_2.2H_2O$) were dissolved in 200ml ethanol (C_2H_6): solution B (0.75 g of lithium hydroxide (LiOH) and 0.85 g of citric acid ($C_6H_8O_7$) were then dissolved in 200ml. Each of the

mixture was dissolved at constant temperature (65º C) and was magnetically stirred continuously for 2 hours. The mixture of LiOH and $C_6H_8O_7$ were then added drop wise to the first solution and for about 2 hours until was obtained. The precipitate was filtered and washed by distillate water. And then, the precipitate was dried and calcined 80º C and 150º C. Finally, ZnO powder was cooled and rinsed with distillate water, re-dried. The white colour of ZnO Nanoparticles was obtained.

III. RESULTS AND DISCUSSION

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A. Characterization of Zinc Oxide Nanoparticles

X-ray diffraction techniques are useful characterization tool to study, non-destructively, the crystallographic structure, chemical composition, physical properties of materials and nanoparticles. It can be used to measure various structural properties of these crystalline phases such as strain, grain size, phase composition, and defect structure. The crystalinity and phases of the precursor and ZnO NPs were characterized by an X- ray Diffract meter. The crystallite size (D) of selected samples was estimated using the Scherer's equation:

$$D = \frac{0.9\lambda}{\beta\cos\theta}$$

Where, λ=wavelength of X-Rays radiation,

β=FWHM (Full width at Half Maximum) width of the diffraction peak,

θ = diffraction angle.

The morphological feature of the ZnO NPs was observed by a scanning electron microscopy.

The optical properties of prepared ZnO NPs were analyzed via UV_ visible Spectrophotometer.

B. X-ray Diffraction Measurement

The XRD results revealed that the ZnO NPs are highly crystalline, having the hexagonal wurtzite crystal structure. "Fig. 1 and 2" are illustrated a typical XRD spectrum of ZnO nanoparticles prepared by the precipitation method at calcined 80º C and 150º C. This graph showed ZnO nanoparticle and identical to be hexagonal phase with Wurzite structure with space group (186:P63mc). Analysis of XRD peak profiles indicated that full-width at half-maximum (FWHM) is sensitive to the variation in microstructure and stress-strain accumulation in the material. Many researchers have successfully attempted the use of FWHM in different manufacturing processes. The sharp and intense peaks in "Fig. 1" indicate that the samples are crystalline. The FWHM data's are 0.356, 0.338, 0.350, 0.362, 0.401, 0.424, 0.44, 0.488 and 0.482, (deg) at 80º C. The sizes are 243, 257, 249, 250,235, 229, 228, 205 and 209 (ang).Then the FWHM of XRD pattern "Fig. 2" have 0.356, 0.338, 0.350, 362, 401, 424, 44, 488 and 0.482(deg).The particle size are 243, 257, 249, 250, 235, 229, 228, 205 and 209 (ang) at 150º C. which can be assigned to diffraction from (100), (002), (101), (102), (110), (103), (112) and (201) planes respectively.

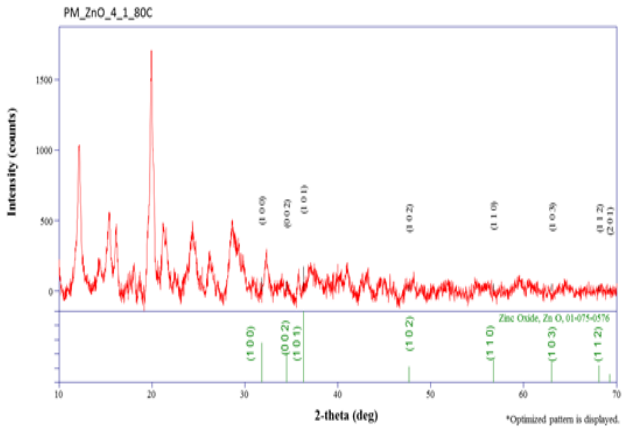


Figure 1: XRD pattern of ZnO Nanoparticles calcined 80˚C.

TABLE I. THE LATTICE PARAMETER AND CRYSTALIZATION OF SAMPLE 80ºC

Sample	a(ang.)	b(ang.)	c(ang.)	c/a ratio
ZnO(NPs) 80˚C	3.2618	3.2618	5.1041	1.5648

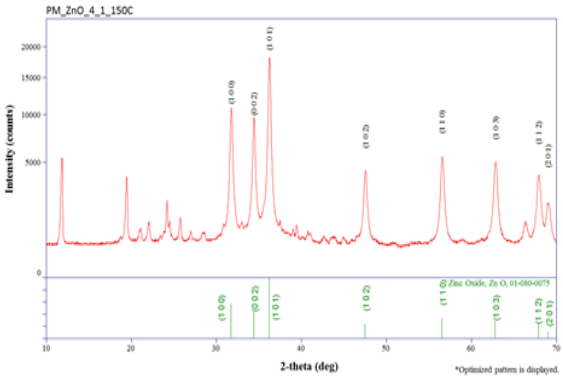


Figure 2: XRD pattern of ZnO Nanoparticles calcined 150˚C.

TABLE III. THE LATTICE PARAMETER AND CRYSTALIZATION OF SAMPLE 150ºC

Sample	a(ang.)	b(ang.)	c(ang.)	c/a ratio
ZnO(NPs) 80˚C	3.2618	3.2618	5.1041	1.5648

C. Scanning Electron Microscopic analysis

We have examined the surface morphology of ZnO nanoparticles by scanning electron microscope (SEM). The images show that there is formation of distinct three dimensional ZnO nanoparticles with microstructure aggregates, the nanoparticles are of varying size "Fig. 3". In this "Fig. 3", SEM image of the ZnO nanoparticle prepared via precipitation route in calcined at 150^{O}C .In figure; the arrow shows the rod shaped structure of ZnO nanoparticles. This result shows that one grain in precipitation derived nanoparticles approximately equal to crystallites. This nano rod structure is expected to form due to the adsorbed citric acid on the ZnO nuclei. When the temperature is high enough, the nuclei will grow. In addition, critic will decompose at the given temperature and lose its function as a capping agent.

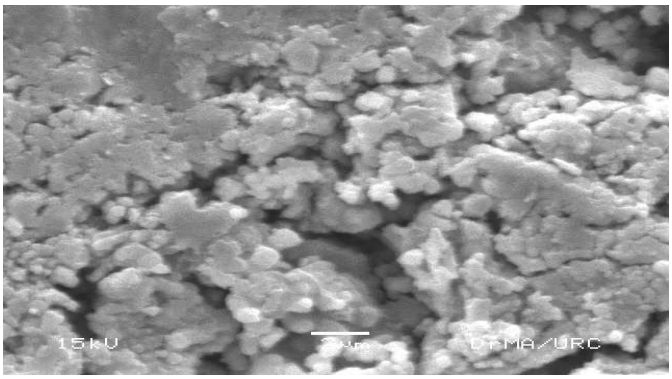
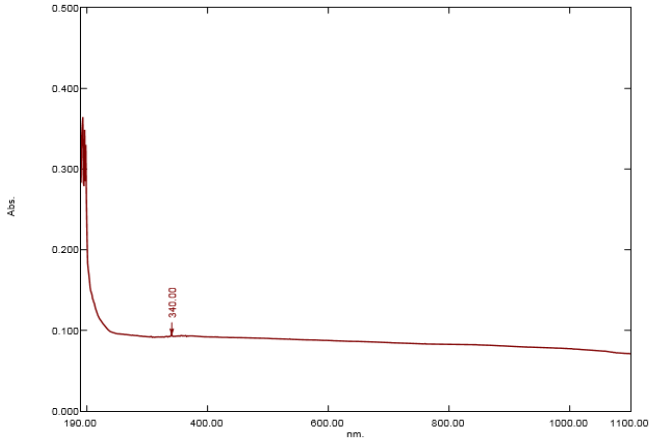


Figure 3: SEM image of ZnO Nanoparticles calcined at 150˚C

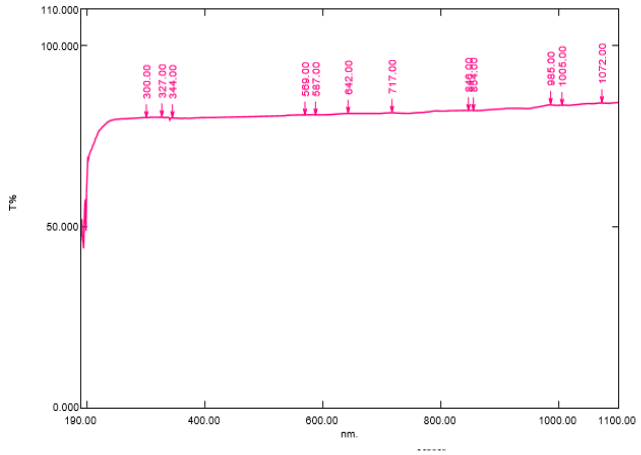
So, it is clear that the nanoparticles seen by SEM image consist of a number of crystallites with sphere shaped structure.

A. Absorbance Spectrum of UV-vis Spectroscopy Analyses at ZnO(NPs) 80˚C and 150˚C



No.	P/V	Wavelength n	Abs.	Description
1		340.00	0.098	

Figure 4: Absorption Spectrum of ZnO Nanoparticles calcined at 80˚C.



No.	P/V	Wavelength n	T%	Description
1		1072.00	84.157	
2		1005.00	83.565	
3		985.00	83.609	
4		854.00	82.101	
5		846.00	82.115	
6		717.00	81.432	
7		642.00	81.261	
8		587.00	80.888	
9		569.00	80.876	
10		344.00	80.049	
11		327.00	80.223	
12		300.00	80.125	

Figure 5: Transmittance Spectrum of ZnO Nanoparticles calcined at 80˚C.

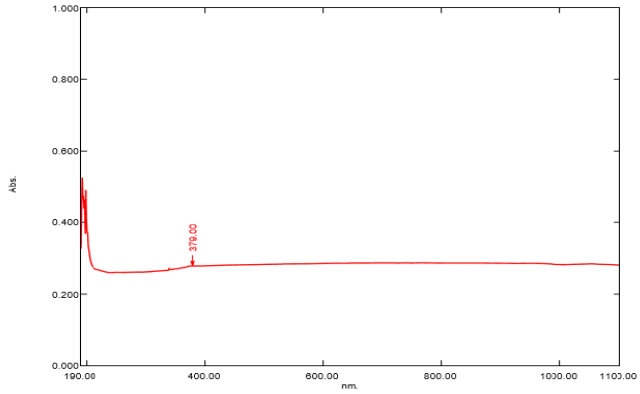
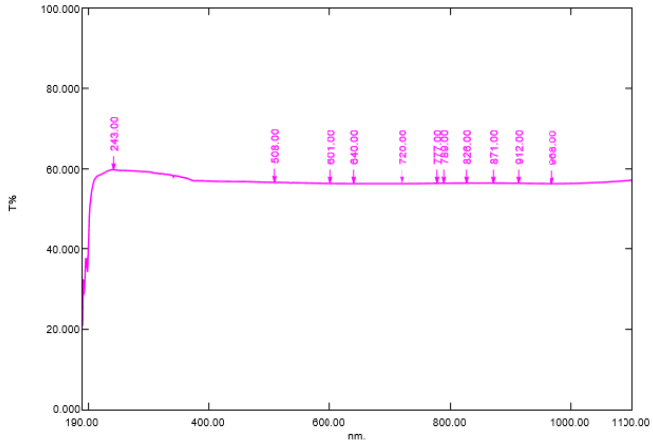


Figure 6: Absorption Spectrum of ZnO Nanoparticles calcined at150˚C.



No.	P/V	Wavelength n	T%	Description
1		968.00	56.297	
2		912.00	56.401	
3		871.00	56.456	
4		826.00	56.445	
5		789.00	56.410	
6		777.00	56.416	
7		720.00	56.337	
8		640.00	56.323	
9		601.00	56.326	
10		508.00	56.625	
11		243.00	59.766	

Figure 7: Transmittance Spectrum of ZnO Nanoparticles calcined at 150˚C.

The results of the UV-vis studies showed that the optical properties of the ZnO NPs depended on the annealing temperature are shown in “Fig. 4 to 7”. A broad absorption peak was observed in each spectrum at 340 - 379 nm which is characteristic band for the pure ZnO. No other peak was observed in the spectrum confirms that the synthesized products are ZnO only. Interestingly, an obvious red shift in the absorption edge was observed for the products

annealed at temperature. Thus, UV-vis results were in good agreement with the XRD results in ZnO particles size prediction. The band gap energy can be determined by substituting the value of the absorption peak at a given wavelength in the following equation

$$E_g = h\nu_g = hc/\lambda_g$$

Where, h = 4.14×10^{-15}eV

c= 2.99×10^{-8} m/s,

λ_g = wave length and the results are 3.36 eV.

According to the bang gap values of two samples by the result, it could absorb of the UV – range.

IV.CONCLUSION

Compare XRD patterns of "Fig.1 and Fig.2", heat treatment causes particles to anneal and from larger grains, thereby increasing the degree of crystallinity of the sample. This effect is often seen as increased peak intensity in the diffraction data. Heat treatment of samples provides an opportunity to compare diffraction patterns of nanoparticles and bulk materials, thereby seeing how the shape and intensity of peaks change between samples of various particle sizes.

There are some important differences between the diffraction patterns of nano and bulk materials. Nano materials have small particle size and this causes the lines in their diffraction peak to broaden. The broadening of the peak is due to a small number of crystal planes from "Fig. 1". This broadening in turn causes a loss of intensity in the signal of their diffraction patterns. Bulk materials, on the contrary, have sharp, narrow and high-intensity peaks from "Fig. 2".

Zinc Oxide nanoparticles (ZnO) have advantages because of its physical, chemical properties, its usage and inexpensive precipitation method. A white colour of ZnO powder was obtained. Characterization study was carried out using XRD, SEM and UV- Vis Spectroscopy. The XRD patterns are used for phase identifications and structure depending on the peaks present. The average crystallize size of ZnO nanoparticles was found to be 22.65~24.7 nm by XRD result. The XRD analysis showed the sample prepared in the reaction temperature. The particle size would be adjusted by controlling the reaction temperature. SEM image "Fig. 3" reveals the information of nanostructure. This SEM result shows nanoparticles form which structure expected to form due to the adsorbed citric acid on the ZnO nuclei. The energy band gap of nanoparticles was 3.2 eV~3.61 eV by the result of UV analysis by form "Fig. 4 to 7", data can calculated. The strongest absorbing peak appeared at around 340 nm~379 nm respectively according to the calcination temperature. By the result of characterization analysis, the ZnO nanoparticles prepared. So the ZnO nanoparticles can be used the modern electronic devices and applications in the future.

V. Acknowledgments

I would like to express my sincere gratitude and special thanks to Rector, Dr. Ei Ei Hlaing University of Computer Studies (Taungoo) for her kind permission to carry out my research paper.

VI.REFERENCES

The heading of the References section must not be numbered. All reference items must be in 8 pt font. Please use Regular and Italic styles to distinguish different fields as shown in the References section. Number the reference items consecutively in square brackets (e.g. [1]).

[1] M. Zheng, F. Davidson, and X. Huang, J.Am. Chem. Soc.125, 7790 (2003).

[2] M. Ferrai, Nat. Rev. Cancer5, 161 (2005).

[3] S. N. Bai, T. Y. Tseng, J, APPl, Phys. 74, 695 (1993).

[4] O. Kluth, B, Rech, L. Houben, S. Wieder, G. Schope, C. Beneking, H. Wagner, A. Loffl, H. W. Schock, Thin Solid Films 351, 244 (1999).

[5] Bari, A. R., Shinde, M. D., Vinita. D. & Patil, L. A. (2009). Effect of Solvents on the Particle Morphology of nanostructured ZnO. Indian Journal of Pure & Applied Physics, 47, 24-27.

[6] Chai, C. (2012). The Global Market for Zinc Oxide Nanopowders 2012. New Report on Global Zinc Oxide Nanopowder Market, 135-140.

[7] A. K. Bandyopadhyay, (2008) Nano Materials: in Architecture, Interior Architecture and Design, New Age International, New Delhi.

[8] Saroj Kumar Patra, (2008) A novel chemical approach to fabricate ZnO Nanostructure, PhD thesis, Indian Institute of Technology Kharagpur.

[9] Introduction to Solid State Physics. CHARLES KITTLE

[10] R. Dogra, A. P. Byrne, M.C. Ridgway, J. of Electronic Material 38, 623 (2009)

[11] Solid State Physics& Electronics (R.K. PURI, V.K. BABBAR)

[12] C. N. R. Rao, A. Muller, A. K. Cheetham, (2004) The Chemistry of Nanomaterials: Synthesis, Properties and Applications Willey, Weinheim. [13] C. Dddd, "research paper Title-3", Journal Name, Publisher, Location, Date/Year, pp-1-5.

[13] A. K. Bandyopadhyay, (2008) Nano Materials: in Architecture, Interior Architecture and Design, New Age International, New Delhi.

[14] Hui Zhang, Xiangyang Ma, Jin Xu, Junjie Niu and Deren Yang, (2003) Arrays of ZnO nanowires fabricated by a simple chemical solution route, Nanotechnology, 14, 423–426

[15] Mazhar Ali Abbasi, Yaqoob Khan, Sajjad Hussain, Omer Nur and Magnus Willander, (2012) Anions effect on the low temperature growth of ZnO nanostructures, Vacuum, 86, 12, 1998-2001.

[16] Tagreed. M. Al-Saadi, Nabeel A. Bakr, Noor A. Hameed, (2014) Study of nanocrystalline structure and micro properties of ZnO powders by using Rietveld method, International Journal of Engineering and Technical Research, 2, 4.

Cite this article as :

San San Htwe, Sanda Win, Myint Myint Swe, Sandar Win, "Effective Temperature of ZnO Nanoparticles", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 7 Issue 3, pp. 213-218, May-June 2020. Available at doi : https://doi.org/10.32628/IJSRSET207360
Journal URL : http://ijsrset.com/IJSRSET207360