Rod Like ZnO Nanoparticles Synthesized by Simple Cost Effective Chemical Rout

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Abstract: Chemical synthesis of nanoparticles is thought to be an efficient and cost effective technique. Chemical synthesis of nanoparticles offers good control of morphology and particle size. ZnO nanoparticles with rod like shapes have been synthesized by using simple chemical method. Zinc acetate was used as source of Zn, ethanol was used as solvent and NaoH was used as oxidizing agent. The synthesized nanoparticles were characterized by using SEM, EDS and XRD. Characterization result reveal the perfect phase transformation of ZnO nanoparticles with rod like morphology.

Keywords: ZnO, nano rods, chemical method, semiconductors.

INTRODUCTION

Nanomaterials have got the importance because of men's quest for reducing the size of the devices for compactness as well as for increasing their efficiency. In nanomaterials, we can manipulate the electronic properties of the material to our desired level by tuning the size of the material. As we decrease the size of a particle, its surface to volume ratio tends to increase resulting in increase of the surface atoms in comparison with the bulk, hence making the particle behave more and more like surface [1]. Semiconducting nanoparticles have got immense importance because of their unique optical, electrical and mechanical properties manifested by quantum confinement effect [2]. Nano particles come in different and fascinating size and shapes like dots, nano rods, nano disks, flowers etc [3-6] and they all carry the physical properties completely different from their bulk counter parts.

ZnO is a direct band gap compound semiconductor belonging to II-VI group having room temperature band gap energy of 3.37 eV.ZnO possesses stable wurtzite structure having *a* = 0.325 *nm* and c= 0.521*nm.*ZnO is an intrinsic n-type semiconductor possessing wurtzite structure with hexagonal unit cell belonging to C^4_{6v} space group [7]. Because of its large excitation binding energy i.e. 60meV, ZnO is considered more useful ultra voilet light emitting phosphor than GaN resulting in greater UV light emitting efficiency at room temperature as well as reduced UV lasing threshold [8]. ZnO absorbs UV light very efficiently that makes it very suitable to be used in sunscreen lotions protecting the skin from being affected by the harms of UV light. ZnO nanoparticles can be synthesized by using different methods like hydrothermal process, vapor condensation, laser ablation etc but chemical method presents simple, low cost but quite efficient method of nanoparticle synthesis with controlled morphologies in comparison with all other method.

MATERIALS AND METHODS

Chemical used in this study were Zinc Acetate as source of Zn, NaoH oxidizing agent and ethanol was used as solvent. All the chemicals were 99% pure and were purchased from Merck. All chemicals were used as purchased without further purification.

To prepare 0.1M solution, with NaoH and ethanol with 1:2, initially two solutions were prepared and were named as solution A and solution B. For solution A, 3.2g of NaoH was dissolved in 200ml of ethanol to get a completely transparent solution. For solution B, 8.78g of zinc acetate was dissolved in 200ml of ethanol to get a clear solution. Now both sol A and sol B were mixed to form a milky solution C. The reaction was allowed to proceed for next 5hrs at 70^{o}C that yielded white precipitates at the bottom. These precipitates were collected by centrifuge and were place in furnace for about 15hrs for drying at 85^{o}C followed by annealing at the temperature of 450^{o}C for 5hrs.

RESULTS AND DISCUSSIONS

The obtained sample was characterized by using SEM, XRD and EDS. SEM of the sample shows rod like morphology of nanoparticles.

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Figure **1**, represents the SEM micrograph of the ZnO nanoparticles showing elongated rod like morphology of the samples.

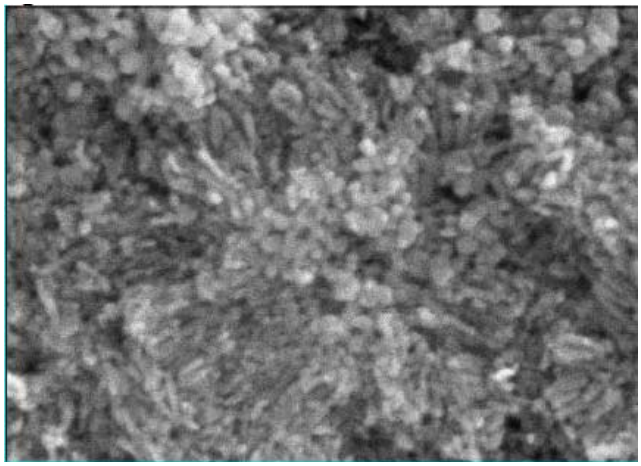

Figure 1: SEM micrograph of ZnO nanoparticles.

EDS of the ZnO nanoparticles shows energy spectra of ZnO nanoparaticles indicating the existence of 80% (weight %) of zinc and 19% of oxygen in the ZnO nanoparticles. Four peaks of zinc and oxygen can be identified from EDS spectra that reveals high purity of the prepared samples.

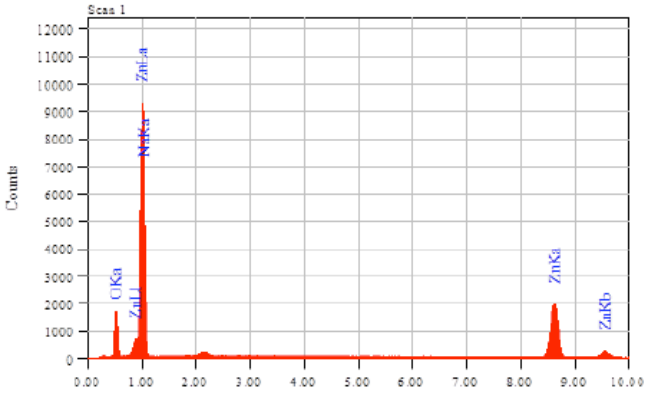

Figure 2: EDS of nanoparticles synthesized by chemical method.

XRD spectra is shown in Figure **3** and it shows characteristic peaks at (100), (002), (101), (102), (110), (103), (200), (112) and (201) in agreement to the JCPDS 5-0664. XRD spectra contains no impurity peak indicating the high purity of the sample and perfect phase transformation.

Particle size is computed by using Debye-Scherrer formula [9].

$$D = \frac{K\lambda}{B\cos\theta}$$

Where D is the particle size, K is the constant, λ is the x-ray wavelength, B is FWHM and θ is the Bragg's angle. The average computed crystalline size is 21.3 *nm*.

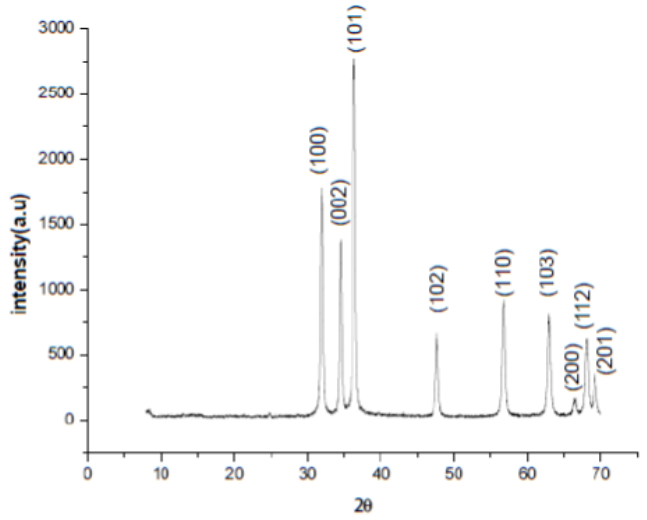

Figure 3: XRD spectra of ZnO nanoparticles.

CONCLUSION

ZnO nanoparticles have been successfully synthesized by using chemical method. The X-ray diffraction results show the perfect phase transformation of ZnO nanoparticles as well as purity of samples. EDS reveals the high purity of the prepared sample and SEM confirms that nanoparticles with rod like morphology have been synthesized. This study reveals that chemical synthesis can be a promising tool to synthesize nanoparticles with many other morphologies as well

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REFERENCES

[1] Ju-Nam Y. Lead JR. Science of the Total Environment 2008; 400: 396-414. http://dx.doi.org/10.1016/j.scitotenv.2008.06.042

[2] Kumar SS, Venkateswarlu P, Rao VR, Rao GN. International Nano Letters 2013; 3: 30. http://dx.doi.org/10.1186/2228-5326-3-30

[3] Gao PX, Wang ZL. J Am Chem Soc 2003; 125(11299): 11305.

[4] Baruah S. Dutta JD. Sci Technol Adv Mater 2009; 10: 013001-0130019. http://dx.doi.org/10.1088/1468-6996/10/1/013001

[5] Wang ZL. Mater Today 2004; 7(26): 33.

[6] He G, Cai JH, Ni G. Mater Chem Phys 2008; 110(110): 114.

[7] Cao G. Nanostructures and nanomaterials, First ed.; Imperial collage press: London 2004.

[8] Han Yng-Jin T, Worsley MA, Baumann TF, Satcher J. Journal of Material Chemistry 2011; 21: 330-333.

[9] Scherrer P. Göttinger Nachrichten 1918.

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