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Study of Surface Morphology of ZnO Nanocrystals

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Abstract: *Zinc oxide of particle size in nanometer range has been paid more attention for their unique properties. They are widely used for solar energy conversion nonlinear optics catalysis, varistors, pigments, gas sensors, cosmetics etc. As wide bandgap semiconductor, ZnO has been widely studied in varistors, transparent conductors transparent UV protection fields chemical sensors etc. There are various methods to synthesis ZnO nanomaterial. Hydrothermal synthesis is one of the most extensively used and co-effective method for the preparation of nonmaterial .ZnO material; are synthesized by reaction of the Zinc acetate and oxalic acid under hydrothermal condition for different time of reaction. The samples are characterized by XRD, EDAX. The average crystal size of the prepared ZnO powder is determined by XRD. The crystallinity of ZnO material samples are confirmed by XRD spectra.*

Keywords: Zinc Oxide, Band Gap, Nanomaterial

I. INTRODUCTION

Nanocrystalline materials may be considered as the challenge of this age. Intensive investigations were stimulated for several applications for these new classes of materials. Zinc oxides of particle size in nanometer range have been paid more attention for their unique properties. They are widely used for solar energy conversion, non-linear optics, catalysis, varistors, pigments, gas sensors, cosmetics etc. As a wide band gap semiconductor, ZnO has been widely studied in varistors, transparent conductors, transparent U.V. protection films, chemical sensors and so on.

Semiconductors with dimensions in the nanometer range are important because their electrical, optical and chemical properties can be tuned by changing the size of particles. Optical Properties are of great interest for application in optoelectronics, photovoltaic's and biological sensing.

Various chemical synthetic methods have been developed to prepare such Nanoparticles. ZnO is wide band gap semiconductor with optoelectronic properties that make it an attractive candidate for a variety of devices applications. Zinc oxide is a versatile material that has achieved applications in photo catalysts, solar cells, chemical sensor, piezoelectric transducers, transparent electrodes (Bauer et al 2001; Duran et al 2002), electctro luminescent devices, and ultraviolet laser diodes. Compared to other semiconductor, ZnO has wide band gap 3.37ev and other large excitation binding energy, which makes excitation stable even at room temperature. There are various method in order to synthesis ZnO nonmaterial viz. solvothermal synthesize ZnO, sol-gel, combustion synthesis spry analysis, thermal hydrolysis, hydrothermal synthesis is one of the most extensively used and cost effective method for the preparation of nonmaterial. In this study, we have synthesized ZnO nonmaterial and their surface morphological properties are investigated.

II. EXPERIMENTAL

Zinc oxide is synthesized in aqueous solutions by taking zinc acetate and oxalic acid under hydrothermal conditions. 0.1 M solution of zinc acetate (AR) is taken in a beaker containing 0.1 M solution of oxalic acid (AR) and stirred for about 12 h, 16h, and 18h. The white precipitates thus obtained are filtered and washed with acetone and distilled water to remove impurities and dried over 120°C for 6 h in order to remove water molecules.

$$Zn(CH_3COO)_2.2H_2O + H_2C_2O_4 \xrightarrow{H_2O} ZnC_2O_4.XH_2O + CH_3COOH + 2H_2O$$

$$ZnC_2O_4.XH_2O \rightarrow ZnO + CO + CO_2 + XH_2O$$

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The calcinations process is carried out over a temperature of 400–450°C in order to remove CO and CO2 from the compound. Thus obtained samples are characterized by powder X-ray diffractometer. The crystalline nature of ZnO samples is confirmed by sharp intense peaks. The surface morphology of the sample is observed by scanning electron microscopy and high-resolution transmission electron microscopy. The composition of elements like Zn, O is confirmed by energy dispersive X-ray spectra (EDX).

III. Result and Discussion

The XRD patterns of ZnO nanocrystalline powder is as shown in Figure 1. The sharp intense peaks of ZnO confirms the good crystalline nature of ZnO and the peaks originated from (100), (002), (101), (102), (110), (103), (200),(112) and (201) reflections of hexagonal ZnO. The size of the particles is calculated by Debye Scherrer's formula. The average crystal size is calculated by the formula

$$D = k (\lambda/\beta\cos\theta),$$

k is a constant equal to 0.89, λ the X-ray wavelength (0.154095 nm), β the full wavelength at half maximum and θ the half diffraction angle. The crystal size of the ZnO nanoparticles calculated as shown in table 1.

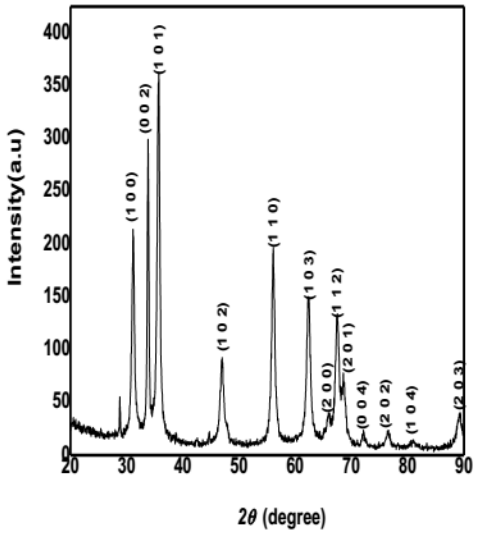

Figure 1: X-ray diffraction (XRD) patterns of the prepared ZnO nanoparticles.

Table 1: Practical size estimated from the diffraction spectrum in fig. 1 by using half maximum widths.

Phase	Width	2 θ (deg)	Particle Size(nm)
ZnO	0.43	31.84	25
	0.35	34.5	24
	0.39	36.3	27
	0.39	47.67	31
	0.4	56.73	37
	0.34	63.01	29
	0.32	66.54	33
	0.44	68.12	26
	0.3	69.28	35

IV. Conclusion

Zinc oxide is one of the versatile and technologically important semi conducting material because of its typical properties such as resistively control over the range 10-3 to 105 ohm cm., transparency in the visible range, high electrochemical stability, direct band gap(3.37ev), absence of toxicity, abundance in nature etc. It is crystalline in wurtzite

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structure and exhibits n-type conductivity. The XRD pattern revels that the synthesized material are crystalline in nature. The size of the particles are determined by XRD is good. Zno nanomaterial has been successfully synthesized by hydrothermal method.

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