Synthesis and Characterization of Zinc Oxide Nanowires by Electro-Deposition Method

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Abstract: ***This paper present a review of current research activities of ZnO nanorods (or nanowires, nanotubes). We synthesized ZnO nanowire via template method by the process of Electro deposition. For synthesis of one dimensional nanostructure of Zn, template method has been utilized via a simple two electrode electrochemical cell. The electro deposition has been carried out at a pH around 3.0 and at temperature 32±1 degree. The applied potential between two electrodes was 1.2V.After synthesis ZnO nanowires are characterized with the help of XRD spectra recorded, Energy dispersive X-ray (EDX), Scanning Electron Microscope (SEM); XRD graph also clarifies the polycrystalline nature of synthesized nanowires. The I-V characteristic of pristine nanowires has been drawn by using a 2-probe system via Keithly 2400 series source meter.***

Keywords: Synthesis, Zinc Oxide, Nanorods, Crystal structure nanoscale, Optical properties.

1. Introduction

Nanowires play important role in intensive research due to their application is fabricated nanoscale electronic, photonic and electrochemical devices [1,2] and zinc oxide metal is an important material for batteries and Recently rechargeable alkaline Zn air battery was fabricated by using a porous Zn electrode. Zno with diameter less than 15nm were found to have an enhanced thermo power related to electrical and magnetic resistances. Nanoscale has aroused interest for their reduced dimensionality and unique properties. A more practical to further reduce the size of electronic [5] structure in integrated circuits. In the quest of ideal system, much exploration of nanoscale has been used in few previous decades. One dimensional nanostructure is of huge importance in the realization of future integrated circuits. Conductivity plays an important role [6, 7] in the electrical properties of nanowires. Reduction in the electrical conductivity of metal of nanowires is one of the obstacles in the realization of nanoscale electronic devices.

To achieve a reasonable [10] electrical conductivity of nanoscale is always a challenging step. Understanding the physics and mechanism of conduction in nanowires have been a matter of research for years. A great deal of effort has been devoted to study electrical conductivity [12] of metal nanowires. In this paper, a very simple cost effective method for synthesis of Zno nanowires show that electrical conductivity decrease due to the reduction in diameter of nanowires and it was also found to vary shape.

2. Methods & Techniques

Surface Morphology SEM micrograph [12] synthesized Zno nanowires, the polycarbonate membrane was dissolved in solution of Di-chloro-methane and obtained cleaned nanowires with ethanol and de-ionized water. The obtained array of nanowires [14] supportive the uniform growth of nanowires with in the pores of template. An array of free-standing Zn nanowires [7] reveals the cylindrical shape with a cross-sectional diameter 100 nm. The resolution of SEM allowed a good investigation of the shape of the nanowires. The diameter is not uniform throughout the pores. If deposition continues after the pores are filled mushrooming occurs. Upon viewing this cluster it is clear that the mushrooming [8] takes place at the edge of the membrane. The image inside the black rectangle shows a single semi-sphere and the image inside the white rectangle shows where multiple semi-sphere has been grown together.

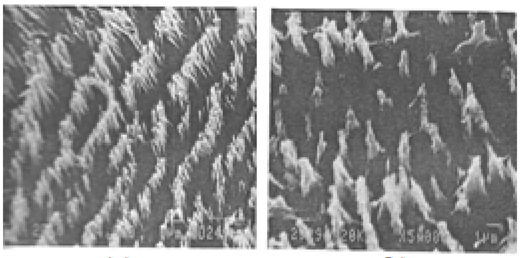

Figure 1: SEM micrograph of synthesized zinc nanowires.

2.1 XRD Spectra

For crystalline nature and crystallographic orientation of ZnO nanowire, it was studied with the help of XRD spectrum, for synthesis of ZnO nanowires [11]; we used polycarbonate track etched membrane of a cylindrical shape. A variation in the intensity of peaks in the XRD pattern in observed with a slight modification in applied potential. The unique pattern of XRD spectra confirms the synthesized nanowires have been the Zn atoms as their constituents. The observed XRD spectrum was compared with standard JCPDS card -04-0831. In XRD pattern, a number of peaks from different family are observed, So Zn nanowires synthesized are polycrystalline in nature and correspondingly peaks are marked with the help of JCPDS card. A few number of peaks correspond to Cu substrate [10] has also observed in the XRD spectra. It is not only the different aspect ratio that determines the application of nanowires of crystal planes in nanowires as well. In the present work, the effect of potential applied to the electrodes applied on grain size and preferred orientation has been studied. A variation in intensity of peaks in the XRD pattern is observed by the slight modification is applied potential. The intensity of lines in the diffraction pattern of XRD spectra is direct reflection of orientation of a Miller plane [12] in the crystal. The work indicates that preference of the orientation of crystal plane can be manipulated from experimental conditions as per the application requirements. However, on the basis of earlier work done by various researchers, it is evident that temperature and potential difference are more influencing parameters. The relative intensity of lines in diffraction pattern of XRD spectra [13] effected by: structure factor, polarization factor, multiplicity, Lorentz factor, temperature factor. All these factor are summarized in the form of an equation.

$$I = F^2 p\left(\frac{1+\cos^2 2\theta}{\sin^2\theta\cos\theta}\right)e^{-2M}$$

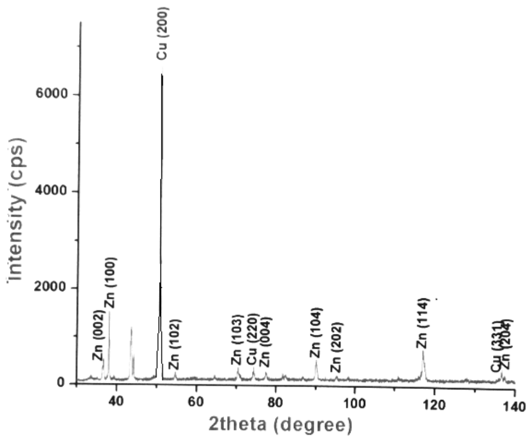

Figure2: XRD spectrum

XRD spectrum as absent at different condition of applied potential between two electrodes from 1.2V. The absorption factor is independent of theta is not so consider here. The two possible factors responsible for the variation in the intensity of lines may be multiplicity factor (p) and temperature factor.

3. Result and Discussion

The estimation of electrical conductivity of ZnO nanowires measured by I-V characteristics for pristine ZnO nanowires by using two probe source meters. Cu substrate was used as one electrode and tip of steel around (radius) 100 microns is another electrode. The source meter used has an upper limit of 1.05 ampere on current measurements. The entire result corresponds to the 300 ZnO nanowires of 100 nm each. I-V characteristics, electrical conductivity looks to be drastically affected, simply because the source meter was not able to achieve a current up to its upper limit i.e. 1.05 A even at an applied potential difference of 5V. However, upper limit of 1.05A was observed in the pristine case at just 0.7V (approx.) limit approx -1.5V to 1.05V observed are linear, but beyond this range an both side the non-linear type of curves are observed and this non-linear features decrease in the I-V characteristics of ZnO nanowires.

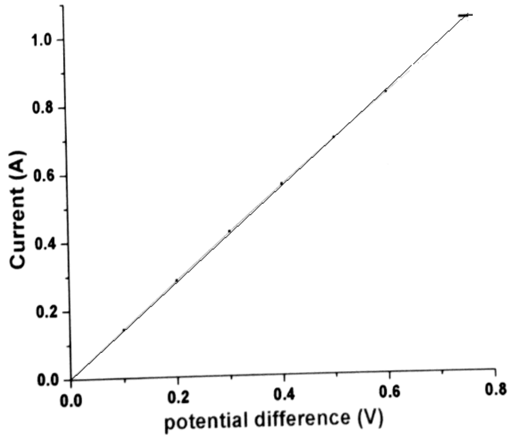

Figure 3: I-V characteristics correspond to the 300 ZnO nanowires of diameter 100 nm each.

4. Conclusion

ZnO nanowires characterized and synthesized by the template technique which shows that decrease in electrical conductivity of nanowires or nanorods. Approximately one-third times decrease in electrical conductivity is expected on the basis of I-V characteristics drawn by using two probe source-meters. The source meter used has an upper limit 1.05A.The electrical conductivity because source meter was not able to achieve a current to its upper limit i.e. 1.05A at applied potential of 5V.Within a certain limit approx. -1.5V to 1.05V observed are linear, but beyond this range non-linear type of curves are observed and this non-linear features decrease in the I-V characteristics of ZnO nanowires. This decrease in electrical conductivity may be due to the increased effect of vibrational motion of atoms on scattering of electron from lattice planes. The common features observed in all cases is a peak around 1.2V .Origin of this peak may be due to the change in the property of grain boundary after that flow of electron from one to another grain in the poly-crystalline ZnO nanowires.

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