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ZnO Nanorods by GalvanostaticElectrolysis

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Abstract*:Zinc is abundantly available in nature next to Silicon, ZnO has got popularity due to various applications right from gas sensors, optoelectronics to semiconductor devices. It is reported that the physical and chemical properties of materials change drastically at nanoscale. ZnO nanoparticles can be synthesized by different methods. In this work, simple galvanostatic electrolysis was used for the synthesis of ZnO nanorods. The SEM-EDAX confirms the presence of ZnO nanorods. The energy bandgap was found to be 3.3eV.*
***Keywords*:** *galvanostatic electrolysis, energy bandgap, zinc oxide nanorods,*

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I. INTRODUCTUION

Zinc oxide (ZnO) nanorods have its own importance due to its applications in various areas[1-3].It is an important material for short-wavelength optoelectronic applications because of its wide band gap 3.37eV,more bond strength and large exciton binding energy at room temperature[4,13].Due to wide band gap, ZnO is used in solid state blue to ultraviolet (UV) opto-electronics and in laser developments. Also, due to non-centrosymmetriccrystallographic phase, ZnO shows the piezoelectric property, which is highly useful forthe fabrication of devices, such as electromagnetic coupled sensors and actuators[7-8]. The ZnO nanorods can be synthesized by various methodswhich mostly involve high temperatures and/or complex chemical reactions[5-11]. The galvanostatic electrolysis is the simple method and can be performed in laboratory with least equipment's. It does not require heating and gives high yield with low cost.In this paper, we report the synthesis of ZnO nanorods using simple method of galvanostatic electrolysis. ZnO nanorods are confirmed using SEM-EDAX, XRD and optical bandgap is determined using UV absorption spectroscopy.

II. EXPERIMENTAL DETAILS

Electrolyte was prepared using AR grade Zinc chloride.Zinc chloride powder was dissolved in distilled water to obtain 500ml of a 0.5 Molar solution. As shown in the Fig.(1) carbon and Zinc rods were used as electrodes. A specially designed constant current source was used to pass a current. The constantcurrent of 1mA was passed for four hours. In this process, due to electrolysis $ZnCl_2$ dissociates into Zn^{++} and Cl^- ions. The positive Zn^{++} ions move towards cathode made up of carbon and Chlorine gas bubbles out at anode. The zinc formed reacts with water to form zinc oxide nanorods. Throughout the process the galvanostatic current was maintained constant at 1mA. To maintain the homogeneity of ions in the electrolyte, the solution was constantly stirred by magnetic stirrer at 100 rpm.The slurry was filtered and dried at ambient temperature to obtain ZnO powder in the nanoform.

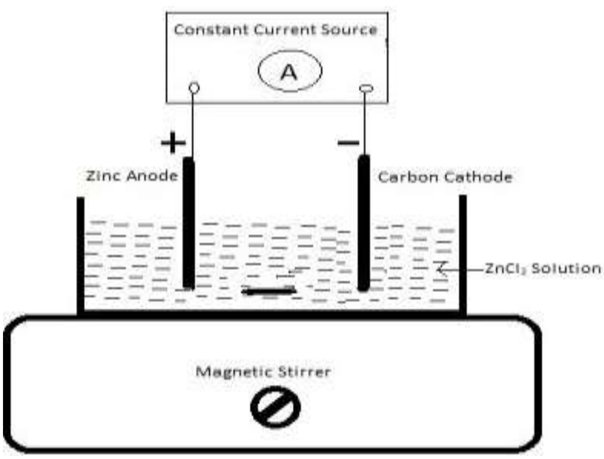


Fig.(1) Experimental set up of galvanostatic electrolysis

III. CHARACTRIZATION AND DISCUSSION

The SEM image shows that the ZnO particles are in the form of rods with the diameter less than 100nm and length in the range of 300 to 750nm. The EDAX confirms the Zinc and oxygen content with Zinc 48.74% by weight and Oxygen 35.66% by weight. The 14.60% by weight impurity of carbon is due to the use of carbon rod as the anode electrode.

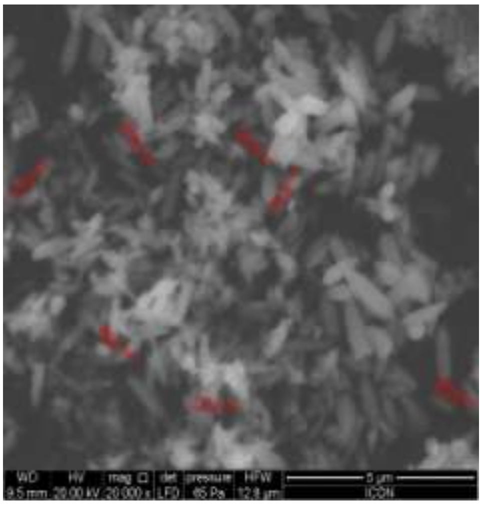


Fig.(2) SEM image of ZnO nanorods

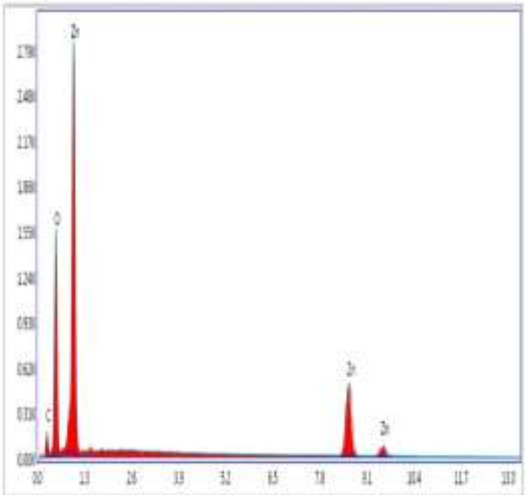


Fig.(3) EDAX of the as-prepared ZnO

The XRD of as-prepared ZnO, reveals a wurtzite crystalline phase of ZnO. XRDpattern was detected and verified with the JCPDSdata fileavailable in literature. The prominent reflections werefound to match well with the standard peaks of ZnO. A definite line broadening of the XRD peaks indicates that the material consist of particles in nanoscale range.

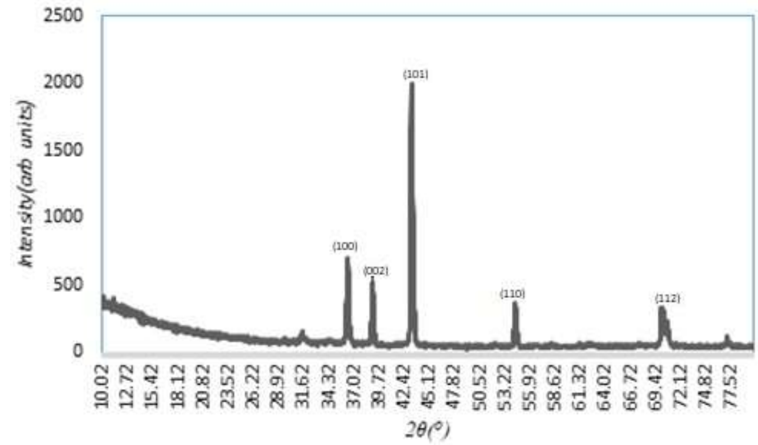
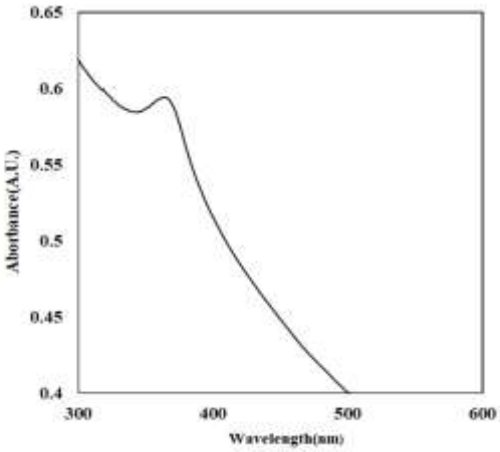


Fig.(4) XRD pattern of ZnO nanorods

In Fig.(5) the absorption spectrum of the ZnO film, the absorption edge locates at around 380 nm, owing to the excitonic absorption of ZnO. The absorption in the UV region is significantly stronger than that in the visible spectrum region, which is essential for its application in high-performance UV photodetectors. The semiconductor nanoparticles have properties between molecules and bulk solid semiconductors. Their physicochemical properties are found to be strongly size dependent. It is well known that the nanoscale systems show interesting physical properties such as increasing semiconductor band gap due to electron confinement. Fig.(6) shows UV-vis spectra of ZnO nanorods. The energy bandgap determined by UV absorption optical spectrais found to be 3.3eV.



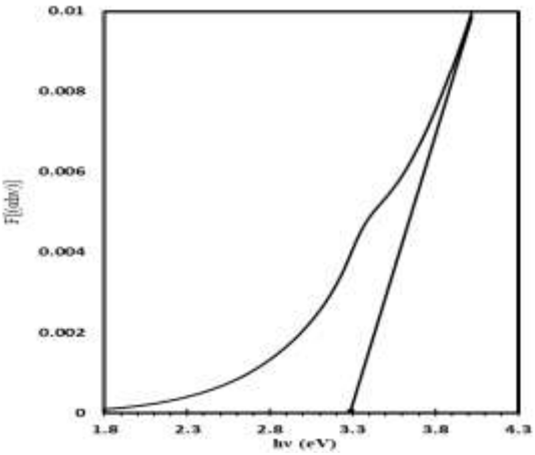


Fig.(5) Room temperature absorption spectra of ZnO nanorods

Fig.(6) UV-vis optical spectra of ZnO nanorods.

IV. CONCLUSION

The ZnO nanorods can be synthesized by galvanostatic electrolysis. The method is simple and cost effective, gives high yield at a very low cost. The ZnO nanorods prepared using this method shows hexagonal crystalline phase and XRD pattern resemble the standard pattern. The optical bandgap is 3.3eV, depictingthe semiconductor properties of the material at nanoscale.Further, ZnO nanorods can be used in different industrial applications, such as, luminescent material for fluorescent tubes, active medium for lasers, different sensors, gas detectors etc.

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