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ELECTRICAL PROPERTIES OF STRUCTURALLY ENHANCED ZNO NANOSTRUCTURES

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ABSTRACT
Electrical conductivity of ZnO nanostructures is demonstrated in current research. The synthesis of ZnO nano compound can be done by simple precipitation method. The prepared material is characterized by X-raydiffraction (XRD), Scanning Electron Microscopy (SEM), Electron diffraction spectra (EDS) and UV–vis spectrophotometer. The SEM demonstrates aggregated sphere-like morphology of ZnO nano compounds with size ranging from 100-300 nm. The electrochemical performance of the ZnO nano compoundsis analysed by measuring I-V characteristics.Theresults of the electrochemical investigations indicate that the ZnO nanostructures improve the electrical conductivity.

KEYWORDS: ZnO nanostructures, electrical conductivity, precipitation method.

INTRODUCTION
In recent few years, nanomaterials have attracted a lot of attention of the researchers because of their excellent chemical and physical properties. The various nanomaterials like TiO_2, ZnO, SnO_2, $WO_3$are used in supercapacitor, gas sensing, lithium ion battery, hydrogen generation, dye degradation in different applications [1-5]. Among the these nanomaterials, zinc oxide is one of the most attractive and widely investigated because of its stable band structure, excellent chemical stability and good crystallinity. Many studies have been carried out on ZnO. ZnO has been widelyexplored by various researchers, mainly for the exploitation of its interesting physicochemical properties, such as the electrical, optical, magnetic, piezoelectric, etc.

Zinc oxide (ZnO) is a wide band gap semiconductor having band gap 3.30 eV, whose properties in bulk and nano form is different. This is because of quantum confinement effects. ZnOhas large exciting binding energy (~60 meV) which results in an intense near-bandgap excitonic emission. Doping of different transition metals as well as coupling with other oxides/polymers the physicochemical properties of ZnO is very into the nanosized which is very effective. These composite nanomaterials have a great potential in the fabrication of optoelectronic devices, such as photoconductors, phototransistor, solar cells, transistors, LEDs and battery. Lin et. al used Zn/ZnO and Ag/ ZnO composites for photocatalytic degradation of lindane under visible light irradiation [6]. Liang et. al demonstrated Light-controlled resistive switching characteristics in ZnO/BiFeO3/ZnO thin films [7]. This composites shows very good results as compare to previous results. Diaoet. al investigated sensing performance and mechanism of CuO nano particle-loaded ZnO nano wires [2].

EXPERIMENTAL

1. **CHEMICALS**

   All reagents were used as the precursors without furtherpurification.Zinc acetatedehydrate ($Zn(CH_3COO)_2 \cdot 2H_2O$), Citric Acid ($C_6H_8O_4$), Ethanol($C_2H_5OH$)and sodium hydroxide (NaOH) were purchased from SRL(India). Double distilled water was used for preparation of all experimental solutions.

2. SYNTHESIS OF MICROSPHERE-LIKE ZNO NANOSTRUCTURES

For the preparation of pristine microsphere-like ZnO nanostructures, separately dissolved 6 gm of zinc acetate dissolved in 40 ml of water and 2.93 gm of citric acid 20 ml of water. These two solutions are admixed together and then add 20ml of 2M NaOH solution dropwise over period of 30 min. The formed precipitated is stirred well for 1 h. The obtained precipitate was centrifuged, washed with distilled water and absolute ethanol several times and dried at 70^{o}C for 24 hrs. The ZnO nanostructures obtained was annealed at 400^{o}C for 4 h.

3. CHARACTERIZATION

The phase identification was done by X-ray diffraction (XRD) recorded using a Rigaku Miniflex X-ray diffractometer with Cu Kα irradiation at λ=1.5406 Å) in the range of (2θ = 20◦–80◦). The surface morphology of as-prepared samples was investigated by field emitting scanning electron microscopy (FE-SEM/EDS) using EI Nova NanoSEM 450. UV–visible absorption spectra of an aqueous suspension were recorded on a Perkin Elmer Spectrophotometer (Perkin Elmer, Lambda 35) by transferring an appropriate volume of sample suspension to quartz cuvette.

RESULTS & DISCUSSION

The impurity detection and phase purity of ZnO nanostructures was carried out using X-ray diffraction. The Figure 1 shows the XRD pattern ofthe as-synthesized ZnO nanostructures. The characteristic diffraction peaksappeared at 2θ values of 31.23°, 34.27°, 46.32°, 56.53°, 61.84°, 66.93°, 69.15° and 75.13°, which arecorresponding to planes of (110),(002), (101), (102), (110), (103), (112), (201) and (202),respectively. All these peaks are well indexed to wurtzite hexagonal structure and in accordance with JCPDS card no. 36-1451 [8]. This XRD indicates that the ZnO nanostructures having high crystallinity,due to their very sharp diffraction peaks. Moreover, any otheradditional impurity peaks are not detected in the XRD pattern,which implies the high purity of synthesized ZnO nanostructures.

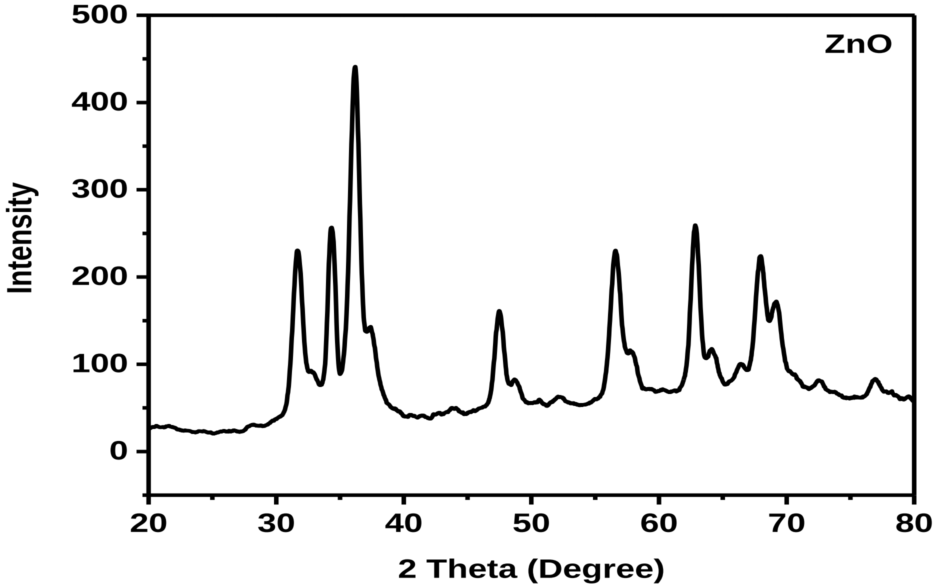

Figure 1: XRD of ZnO nanostructure

The structural study of as-synthesized ZnO nanostructures investigated by scanning electron microscope (SEM). Figure 2 (a, b & c) shows low and high magnification SEM images of ZnO nanostructures synthesized via. precipitation method. From figure, it is observed that the ZnO nanostructures are formed by aggregation of numerous irregular sized nanoparticles with size ranging from 100-300 nm. These nanoparticles aggregated in small sphere-like ZnO nanostructures. Further, the elemental composition of as-synthesized ZnO nanostructures is confirmed by EDS. Figure 2 (d) shows EDS spectra of ZnO. From this spectra, the elemental composition of Zn & O was found to be 54.50 & 45.50 respectively. This confirmed the ZnO nanostructures are composed of only Zn & O.

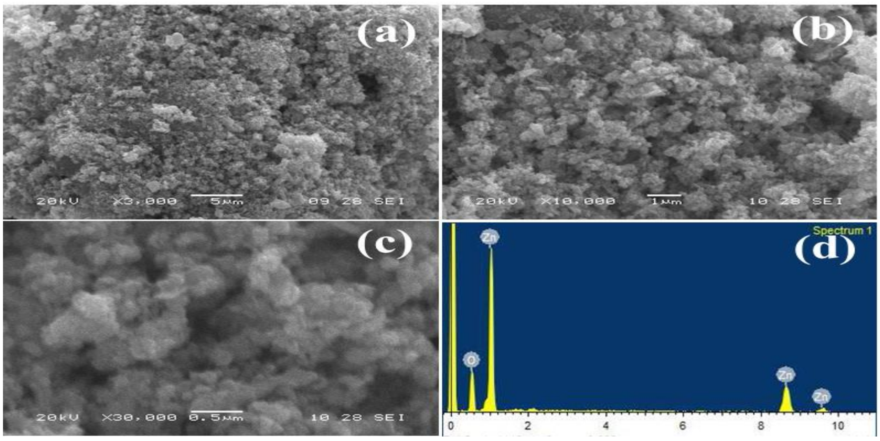

Figure 2: (a,b& c) SEM images of ZnO and (d) EDS spectra of ZnO.

Figure. 3 represents the UV-visible absorption spectra ZnO nanostructures. From figure it was observed that the ZnO nanostructures exhibited broad and strong absorption in UV-visible rang. The optical band gap of ZnO was found to be 3.32eV, which are in good agreement with the reported data [7].

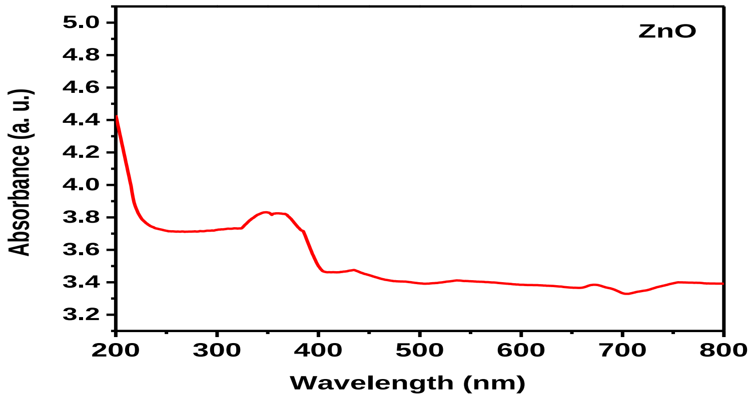

Figure 3: UV-visible spectra of ZnO.

The as-synthesized ZnO nanostructures tested for conductivity experiment (Figure 4). For this purpose thin layer of the ZnO were deposited in between two parallel plates with a spacing of 3 mm. In case of ZnO, the current-voltage (I-V) characteristics obtained at room temperature (RT)is found to be linear, indicating ohmicbehavior. As the voltage increases the current also increases for ZnO nano compounds.

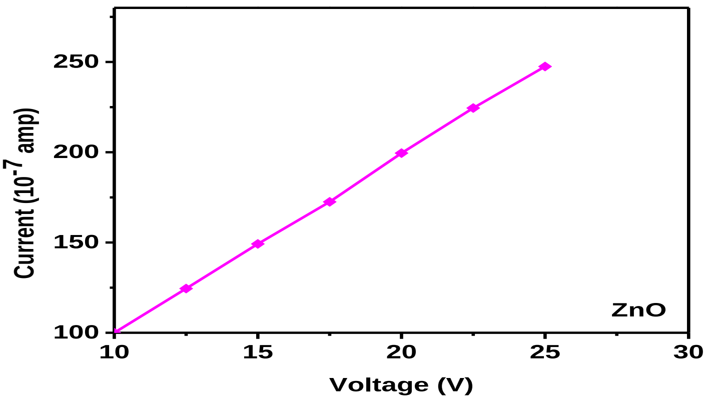

Figure 4: IV characteristic Plot of ZnO.

CONCLUSION

ZnO was prepared by using precipitation method. The synthesized ZnO characterized by different physicochemical and electrochemical methods. The ZnO nanostructures have a wurtzite phase. EDS measurement confirmed the sample only composed of Zn& O. The band gap compound was found to be 3.32 eV. The current- voltage properties of the samples suggest ohmicbehavior of electron transport properties of the material.

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