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Green Synthesis of ZnO Metal Oxide and FE-SEM and EDS Characterization for Applications in Nanoelectronics

Dayanand B. Jadhav[1]* and Rajendra D. Kokate[2]

[1]*Electronics and Telecommunication Engineering Department, MGM'S College of Engineering and Technology, Navi Mumbai. India.* dbj.mgm@gmail.com
[2]*Instrumentation Engineering Department, Government College of Engineering, Jalgaon. India.*

ABSTRACT—

The chemical synthesis and green synthesis have been useful for the synthesis of metal oxide Nanoparticles. The chemical synthesis method requires care because of the toxicity chemicals are used in the synthesis. Chemicals used in the synthesis are costly, harmful to human health and the environment. Green synthesis of the metal oxide is ecofriendly, no toxicity to the human health and the environment. The green synthesis method is simple, cheap, ecofriendly. In the green synthesis method generally green plants extracts are used in this research aloe vera plant is used and which is more stable, antibacterial agents for the medical applications, larger surface area with smaller size, etc. Present study for application in Nanoelectronics has been based on basic three parts of the nanoparticles material that is preparation of ZnO Nanomaterial from green synthesis method. The plant mediated material is characterized using characterization methods that is FE-SEM, EDS, XPS and FT-IR of the ZnO Nanomaterial for the different applications in Nanoelectronics which is more reliable, eco-friendly & cheap.

KEYWORDS— Nanoelectronics materials, Chemical Synthesis, Green Synthesis, ZnO Metal Oxide, Nanoelectronics Applications.

***Corresponding Author**

Dayanand B. Jadhav*
Electronics and Telecommunication Engineering Department,
MGM'S College of Engineering and Technology, Navi Mumbai. India-410209
Email: dbj.mgm@gmail.com ; Mob. :+91 7977716922

INTRODUCTION

The chemical methods and the green methods are the most important methods of the synthesis of the nanoparticles. The chemical synthesis takes place using the metal particles like sodium tetrahydridoborate ($NaBH_4$) and Sodium citrate etc.[1, 2] and also the chemical reagents also used in the chemical synthesis like N, N-dimethyl formamide ($(CH_3)_2NC(O)H$) (DMF)[3,4], Poly N-vinyl pyrrolidine ($(C_6H_9NO)_n$) (PVP), ethyl alcohol C_2H_5OH (EtOH)[5,6], Tetra-n-butylammonium-tetrafluoroborate ($(CH_3CH_2CH_2CH_2)_4NBF_4$) (TFATEB), Cetrimonium bromide ($C_{19}H_{42}BrN$) (CTAB), etc.[7]. This methods are used for the synthesis of the nanoscale materials but this is the toxic, slow process of synthesis and not suitable for the large scale production.

When the size of the metal oxide particle is tuned to nanoscale level then the surface to volume ratio plays very important role in the sensing application and when the band gap is moderate applicable for the solar cell applications. In the field of nanoelectronics it has been observed that the development of different nanoparticle materials using ecofriendly methodologies for the specific applications. Green synthesis method is proved as beneficial over chemical synthesis methods which are implemented for the nanoscale nanoparticles materials. Green synthesis methods are eco-friendly because toxic chemicals are not used in the synthesis [8,9,10,11] . The use of ecofriendly materials like plant leaf extract, bacteria, fungi and enzymes for the synthesis for many nanoelectronics applications [12,13,14,15,16]. The nanoparticles for the nanoelectronics application are developed using the green synthesis method i.e. using plant leaf extract for the synthesis of metal nanoparticles [17,18,19,20]. Plants are the chief and cheap source for varies applications. Using green synthesis method i.e. using plant abstract the nanoscale materials are prepared with a size of the nanoparticles between 1 nm- 100 nm [21,22,23,24,25].

ZINC OXIDE METAL NANOPARTICLE

ZnO is a metal oxide nanoscale material and it is degenerate, n-type semiconductor and it has the important properties like wide band gap, lower electrical resistivity, higher transmission in the visible region etc; From the different metal oxides much attention has been paid to Zinc oxide nano material. Crystal growth modifier is the main objective of the plant extract in the synthesize of ZnO, We have made nano-sized ZnO by a simple and cost effective plant mediated synthesis. ZnO metal nanoparticle is nontoxic and it is a strong antibacterial agent. Zinc oxide metal nanoparticles have been extensively used in many industrial areas such as Organic solar cells, used to detect the various gases, medicinal applications, lithium ion batteries, cosmetic industry, etc. [26,27,28,29,30,31,32,33,34,35,36,37,38,39,40].

EXPERIMENTAL

In this research paper, we report the plant mediated synthesis of Zinc Oxide nanoparticles by using simple co-precipitation method from Zinc Nitrate. The starting materials (plant: Aloe-Vera easily available) are very cheap and the synthesis procedure is also very simple. The obtained ZnO nanoparticle (powder form) material have been characterized by means of FE-SEM,EDX, XPS,FT-IR and electrical properties and sensing performance. The nanoscale material powder of Zinc oxide (ZnO) is prepared by a simple plant mediated synthesis method and which is cost effective. In this method, the salt zinc nitrate ($Zn(NO_3)_2$) solution is used to for the preparation of ZnO. In this work, the aqueous solution of 0.5 M zinc nitrate prepared in aloe-vera plant extract which prepared in double distilled water. The prepared solution then heated in petry dish at 90°C up to the precursor gets dried. The prepared dried powder then calcinated at 400°C for 2 hours to get the pure nano-scale zinc oxide material.

Aloe-Vera Plant Extract +2 $Zn(NO_3)_2 \rightarrow 2\ ZnO$ (Powder)+ 4 NO_2 + O_2

RESULTS AND DISCUSSION

The characterization methods like FESEM, EDX, TEM, XRD, FTIR and XPS of the materials is done under the approved research project under INUP IITB. The characterization of the synthesized Zinc oxide powder was analyzed using FESEM and EDX analysis is available at NCPRE in IIT Bombay. The make/model available located in IITB at NCPRE FSEM lab hill side, near power house is Zeiss/Ultra 55.The equipment type is Deposition, growth and annealing systems. The characterization of the materials is done under the approved project at INUP IITB. The equipment FTIR with category is litho/analytical and make/model is Perkin Elmer/Spectra 100 (Serial Number 83476) located at Bio sensors lab (NanoE bldg,7th floor) at IITB. The FTIR equipment type is Material and Structural characterization tools. X-ray Photoelectron Spectroscopy (XPS) (Make/model: ULVACPHI/PHI5000 Versa ProbeII) located at Micro2 Lab in INUP IITB.

FE-SEM

The FE-SEM images of the calcinated ZnO powder is shown as below figures. There are different pattern for different magnification (Mag.) of resolution.The Figure 1 & 2 shows FESEM pattern of ZnO calcinated at 400^oC for 2 hrs (Mag = 10.00K X and Mag=100.00K X). The Figure 3 & 4 shows FESEM pattern of ZnO calcinated at 400^oC for 2 hrs (Mag = 200.00K X and Mag=300.00K X) and figure 5 shows the formation of very small nanoparticles for the magnitude 300.00 K X resolution in the different sizes of the particles i.e. non-uniform structure pattern of the particle in size 247nm, 138.3nm,148.5nm and so on.

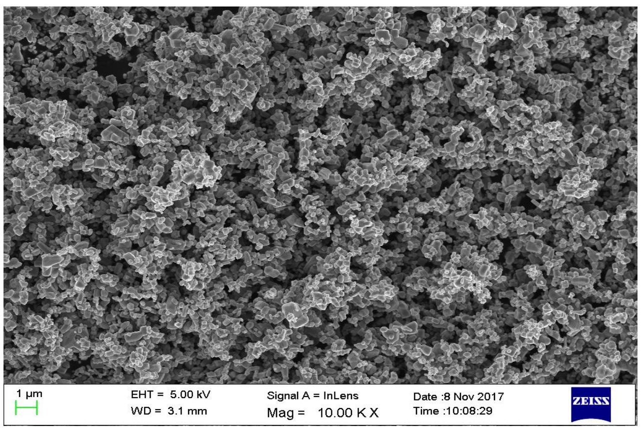

Fig.1 FESEM pattern of ZnO calcinated at 400^oC for 2 hrs (Mag = 10.00K X)

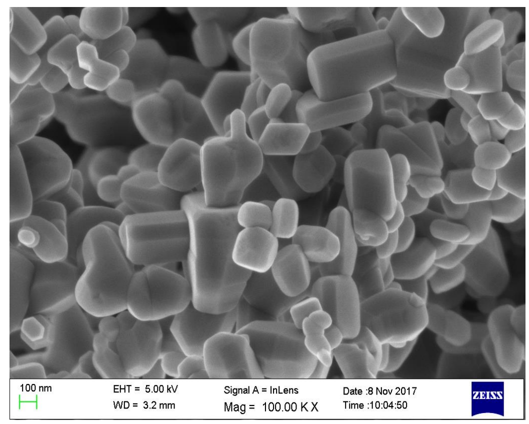

Fig.2 FESEM pattern of ZnO calcinated at 400^oC for 2 hrs Mag=100.00K X)

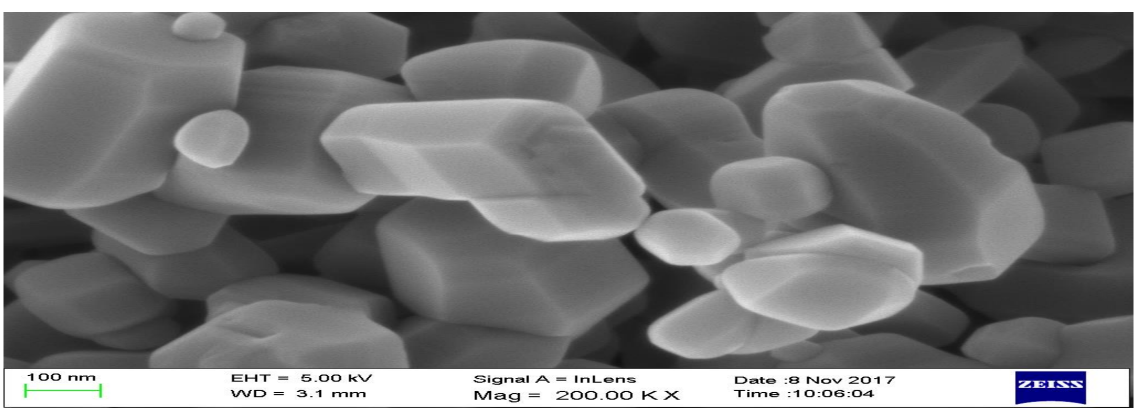

Fig.3 FESEM pattern of ZnO calcinated at 400^oC for 2 hrs (Mag = 200.00K X)

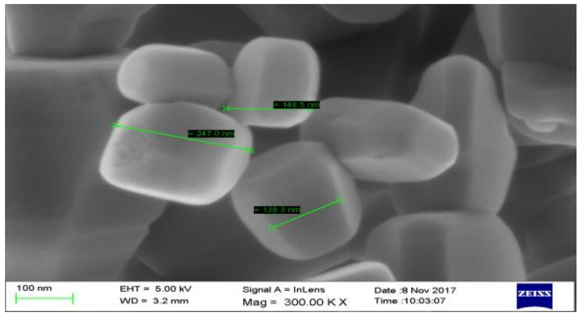

Fig.4 FESEM pattern of ZnO calcinated at 400^{o}C for 2 hrs (Mag=300.00K X)

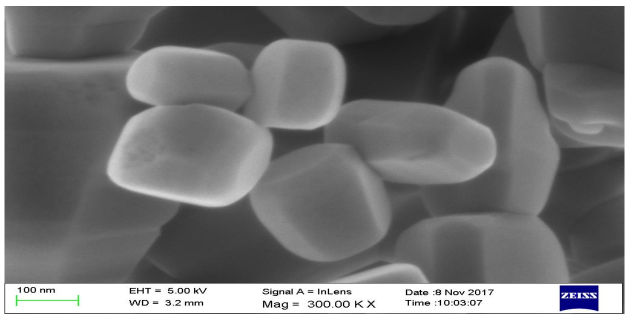

Fig.5 FESEM pattern of ZnO calcinated at 400^{o}C for 2 hrs for Mag=300.00K X (Size 247 nm,138.3nm,148.5nm,etc)

EDS

Spectrum processing :

No peaks omitted

Processing option : All elements analyzed (Normalised)

Number of iterations = 4

Standard :

C CaCO3 1-Jun-1999 12:00 AM

O SiO2 1-Jun-1999 12:00 AM

Zn Zn 1-Jun-1999 12:00 AM

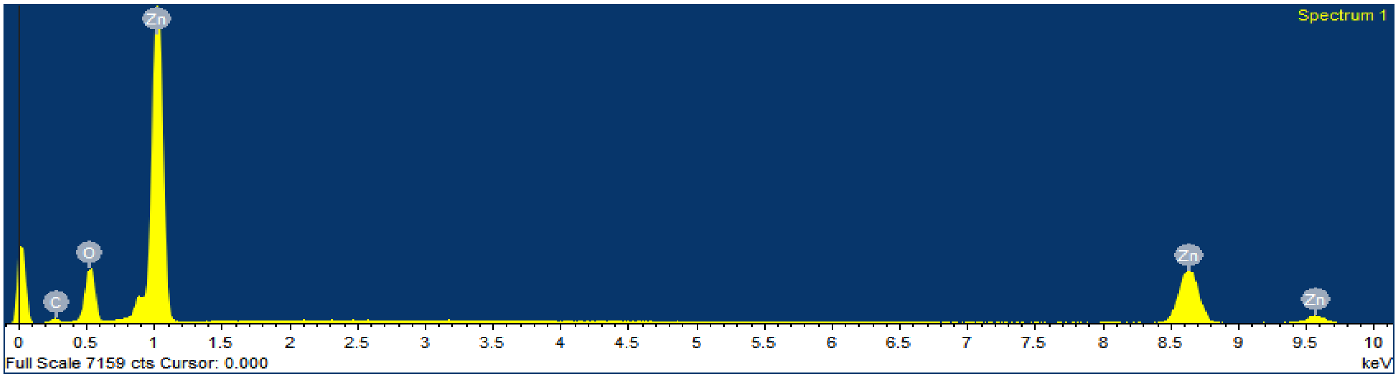

Fig.6 Electron Image Spectrum (No Peak Omitted)

Table. I

Element	Weight %	Atomic %
C K	7.07	18.86
OK	23.52	47.11
ZnK	69.42	34.03
Totals	100.00	

Spectrum processing :

Peak possibly omitted : 0.261 keV

Processing option : All elements analyzed (Normalised)

Number of iterations = 2

Standard :

O SiO2 1-Jun-1999 12:00 AM

Zn Zn 1-Jun-1999 12:00 AM

Standard :

C CaCO3 1-Jun-1999 12:00 AM

O SiO2 1-Jun-1999 12:00 AM

Zn Zn 1-Jun-1999 12:00 AM

Table.II

Element	Weight %	Atomic %
OK	23.79	56.05
Zn K	76.21	43.95
Totals	100.00	

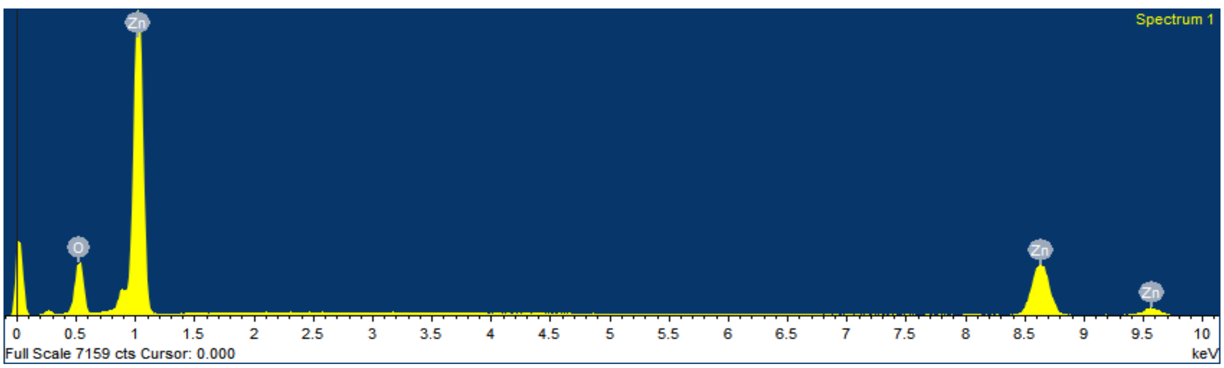

Fig.7.All elements analyzed (Narmalised) (Number of iterations = 2)

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DISCLOSURE STATEMENT

No conflict of interest was reported by the authors.

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