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ZNO Nanostructures & Microstructures: Synthesis using Different Materials

Ravi Shankar Saxena, Ashish Singh

***Abstract*: Thermal decomposition and heat treatment method is used for the preparation of ZnO and the precursor are used for this is zinc oxalate, zinc nitrate and zinc sulfate after preparation of ZnO study on its optical and electrical properties has also been performed then its photoconductivity in air and two minutes rise and fall curve also measured. Which is very useful in study of switching characteristic of materials. XRD clearly shows that prepared material has good quality of ZnO, SEM indicates that synthesized materials of wurzite structure. Two minutes rise and fall curve shows that zinc oxalate has the best switching time among all three materials.**

***Keywords*: Zinc Oxide, XRD, Photoconductivity, Rise and decay**

I. INTRODUCTION

Zinc Oxide play an important role among various industries in electronics the potential applications of ZnO are photodetector, electrodes, thin film transistor and many more. In electronics industry the classification of ZnO is as semiconductor and in material group it belongs to II-VI group. Peculiar chemical and physical property of zinc oxide make it particularly important for many different applications. The synthesis of ZnO with different precursor has been done in several dimension structures. The size of synthesized material could fall in between few nanometers to several thousand micrometer. In terms of dimensions we can say the synthesized material could be of single dimension, two dimesion and three dimension nano or microstructure [1-4].

In nanoscience the dimension begins with 0D (All dimensions in the nanoscale), 1D (Two dimensions at the nanoscale one dimesion at the microscale), 2D (one dimension at the naoscale 2 dimensions at the macroscale) and 3D (No dimensions at the nanoscale all dimensions at the macroscale).

At nano dimensions we can clearly see the difference in properties like when the particle size decreases it will produce different color for different size similarly other property of nanomaterial's are also changed at nano dimension which make them unique and the reason behind it it that greater number of atoms is found on the surface of nanomaterial when it is compared to the atom that are present inside the nano and micro dimensions this is the reason why nanomaterials are so unique and going to play important role in future in design from airplane to space elevator.

In this paper we have synthesized ZnO with different precursors and then study its optical and photoconductivity properties. There are number of techniques are available for preparation of ZnO but here the method chosen heat treatment and thermal decomposition method for preparation of ZnO. Since these technique provide ZnO of different shapes as per our requirement.

The photoconductivity study for the synthesized ZnO nanostructures & microstructures prepared by different precursors has been performed. The materials which is synthesized could play major role in design of photodetector which is the main outcome of this work [5-7].

II. EXPERIMENTAL SECTION

A. Chemicals

The different types of chemicals used in synthesis of ZnO nano and microstructure are zinc-nitrate, zinc Sulfate and zinc oxalate for which chemical formula are $Zn(NO_3)_2.6H_2O$, $(ZnSO_4.7H_2O)$ and $(ZnC_2O_4{\cdot}2H_2O)$ respectively. These materials are used directly in the form which is available in the market after procuring it from company like Merck Ltd. etc.

B. Sample Preparation

The Zinc Oxalate, Zinc nitrate and zinc sulfate is used to prepare zinc oxide nano & microstructures. First we have taken small quantity of these three material around 3 to 4 g of each then put it in a crucible and fired it in a furnace at the temperature of 500 °C for three to five hours or even more.

Obtained zinc oxide nano and micro structures were obtained in powder form and this sample is to be used for further Characterizations, Similarly we have obtained ZnO from each of above materials.

C. Instrumentation

For characterization of obtained Synthesized ZnO nano & microstructures there are different techniques used such as for study of the surface of the material the technique used is scanning electron microscopy which gives the idea of morphology of the prepared material and then we can judge the synthesized material is of nano dimension or micro dimension.

Then Xray diffraction technique is used to find out that the obtained material is pure zinc oxide or not actually the peak in x-ray diffraction give us the information about purity of the synthesized material that's why in material characterization x-ray diffraction plays a key role, It's also gives the idea of obtained crystal structure.

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***Correspondence Author(s)**
Ravi Shankar Saxena*, ECE department, GMRIT, Rajam, Srikakulam 532127, India, Email: ravishankar.s@gmrit.edu.in
Dr. Ashish Kumar Singh, Assistant Professor, NMAM Institute of Technology, Manglore

Synthesized ZnO UV-vis. Spectroscopy is also performed in which light has passed through the material then we see the possible transition of electrons from one state to other state it also identify if any organic compound is present in the material.

The photoconductivity measurement which has performed in lab for that taken the small quantity of synthesized material on a special kind of cell which has a space of 1mm between two copper electrodes and the after pressing it with a glass and connected to computer via Rish multimeter we start measuring the photoconductivity in which we are going to measure rise and decay curve which gives important idea of Swithing charateristics of the synthesized material. The fig. 1 shows the basic cell which we are using for the measurement of the photoconductivity. This cell is put inside the dark chamber till the dark current stabilized.

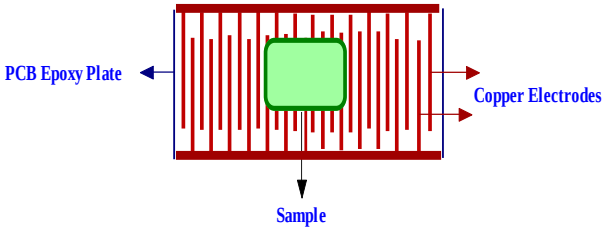

Fig.1. Cell for measurement of photoconductivity.

III. RESULTS AND DISCUSSIONS

STRUCTURAL STUDY

From fig. 2 XRD pattern of synthesized zinc oxalate nano particles is observed. The major peaks are indexed as (202), (002), (402) and (021) at 19º, 23º, 30o and 35º respectively. Peak broadening indicates formation of nanoparticles. Crystallite size calculated for the peaks (202), (002), (402) and (021) is 18 nm, 29 nm, 15 nm, and 28 nm respectively.

In fig. 3 XRD plot of ZnO is shown, this ZnO has been syntheses using $Zn(NO_3)_2$ thermally decomposed at 500ºC for 3 hours. The maximum peak is observed at 36º of intensity 1000 (a.u.).

Fig. 4 shows XRD of synthesized ZnO nanoparticles. From XRD we can say that the microstructures synthesized by zinc sulfate are of good shape crystalline structure

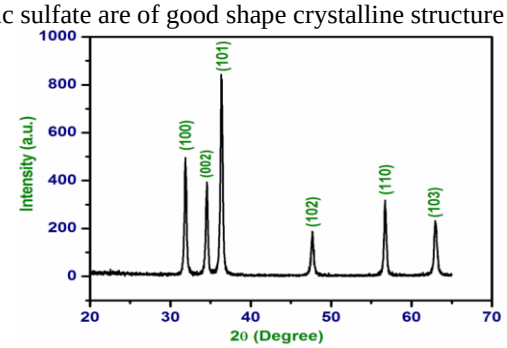

Fig. 2: X-ray diffraction (XRD) pattern of ZnO synthesized by thermal decomposition of zinc oxalate.

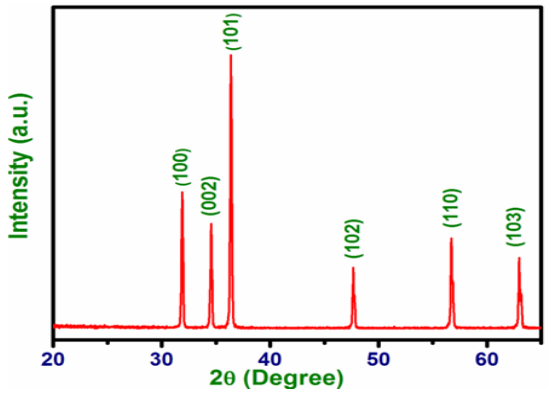

Fig. 3. XRD of ZnO synthesized by zinc nitrare

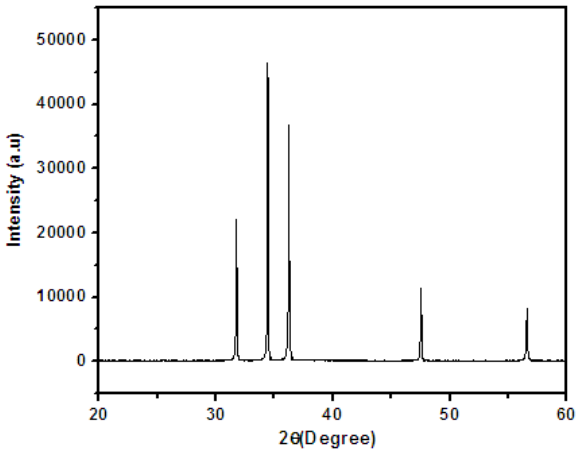

Fig.4. XRD of ZnO synthesized by zinc sulfate.

MORPHOLOGICAL STUDY

Fig. 5, Fig. 6 and Fig. 7 shows the ZnO Synthesized by different precursors. From these figures it can been seen that synthesized ZnO particles are from nano to microdimensions. These structure look is like a diamond shaped in Figure 6 and 7 whereas it looks like rice particles in Figure 5.

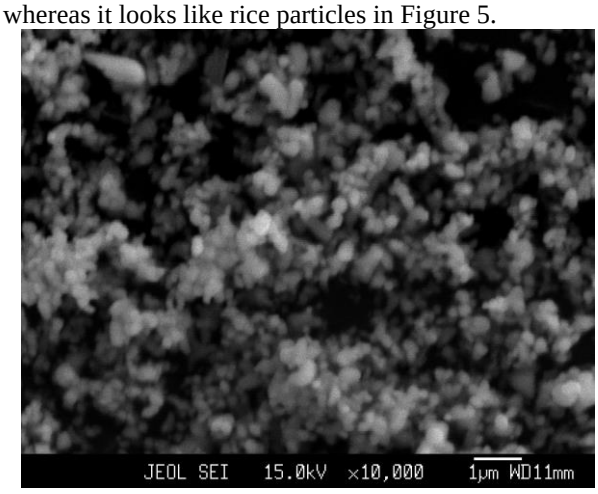

Fig.5. SEM image of synthesized ZnO by zinc sulfate.

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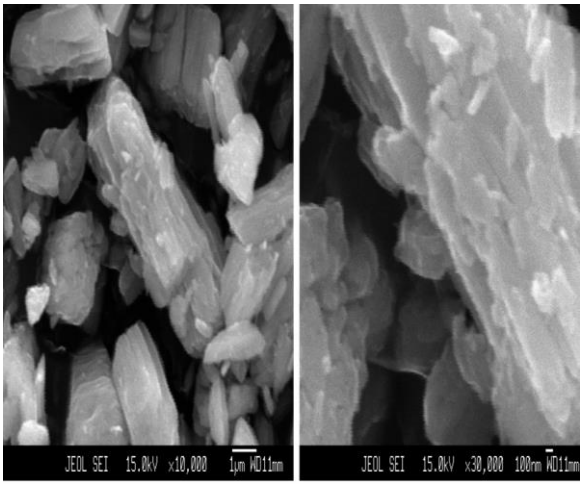

Fig. 6. SEM image of Synthsized ZnO by Zinc oxalate.

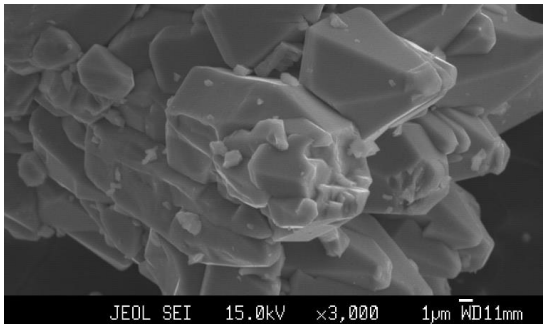

Fig.7. SEM image of synthesized ZnO from zinc nitrate.

UV VISIBLE ABSORPTION STUDY

Fig. 8 shows UV-visible spectrum of zinc oxide nano and micro structures at the room temperature. These molecules are thermally decomposed using catalyst as zinc oxalate. These ZnO particles have band edge at 370 nm as Blue shift can be seen in figure.

Fig. 9 shows UV-visible spectrum of prepared using $Zn(NO_3)_2$ thermally decomposed at 500°C for 3 hours which shows peak at 381 nm. Almost the same absorbance was observed by Singh et al. [10].

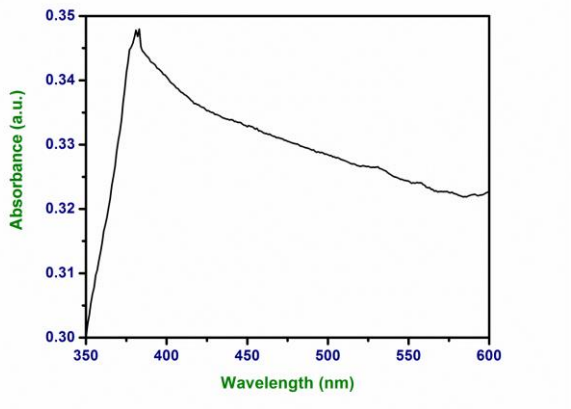

Fig.8. UV vis. Of ZnO synthesized by zinc oxalate.

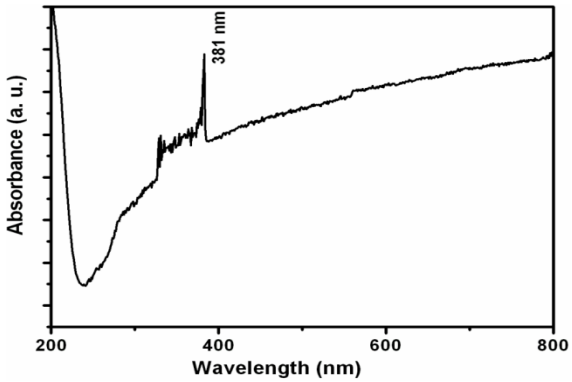

Fig. 9 . UV Vis. Of ZnO synthsized by zinc nitrate

PHOTOCONDUCTIVITY STUDY

Figure 10 shows the setup used for measurement of photoconductivity for obatained ZnO nanostructures and macro structures from different precursors. The equivalent circuit can be seen in figure. The circuit comprise of voltage source V_a that connected to light intensity (bulb) focusing on the ZnO particles thereafter load resistance is connected across with photoconductivity is measured using RISH multi-meter.

Fig. 11 shows the rise and fall curve of when light is in switched on and swithced off state. This occurs because as UV light fall on the proposed ZnO particles the UV light is focused on the ZnO nano and microstructures since the water and oxygen molecules play important role in governing the internal mechinsm of the synthesized material.

After stabilizing the current in dark when the light particles (photons) suddenly fall on synthesized material there will be large number of generation of electron and hole pair occurs and phenomenon of absorption takes place generated photons is absorbed after attaining a peak rapidly there is fall in the current due to the presence of oxygen molecules.

Fig. 12 shows the rise and fall curve for two minutes while switching on and off UV light over synthesized zinc oxide particles prepared using zinc oxalate, zinc nitrate and zinc sulfate has been measured. Since photoconductivity give sthe idea of the conductivity which happens from absorption of the ligth, It give sthe idea how electrons are moving from one band to other which is very important phenomenon in optoelectronic devices because this switching characteristic play majorrole in reponse time which is the key principle behind many electronics devices.

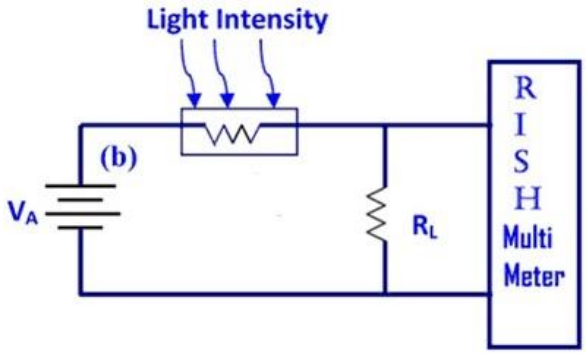

Fig. 10. Photoconductivity measurement setup.

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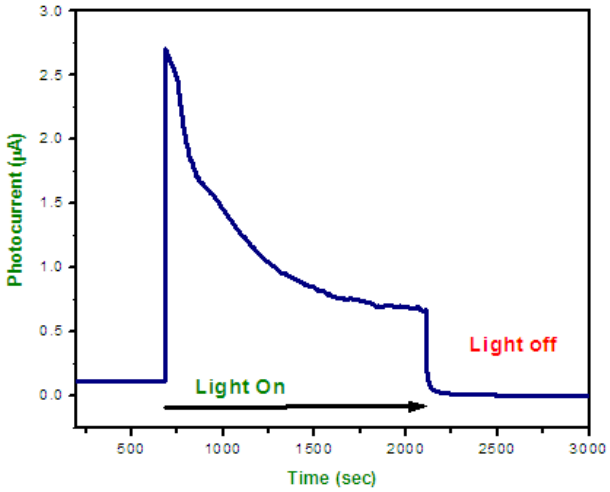

Fig. 11. Rise and decay curve of Synthesized ZnO structure by zinc nitrate.

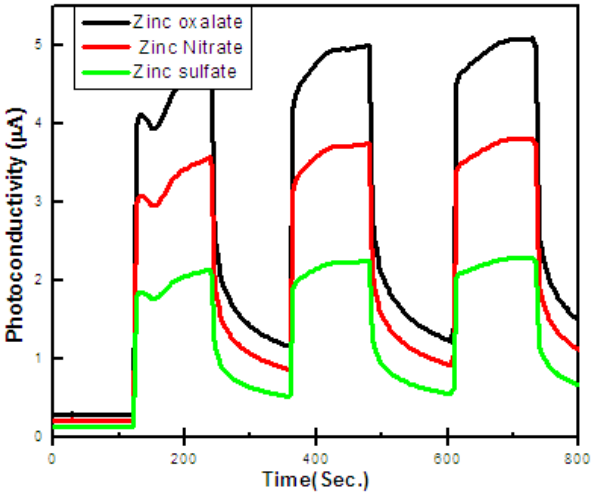

Fig. 12. Two minutes rise and decay curve of synthsized ZnO prepared by zinc oxalate, zinc nitrate and zinc sulfate.

IV. RESULT AND DISCUSSION

V. CONCLUSION & FUTURE SCOPE

The current paper gives the various methods for preparing of ZnO by different precursors. The synthesized ZnO is inexpensive, reproducible and mass yielding method used is thermal decomposition method for various precursors.

The zinc oxalate particles are prepared using heat treatment then XRD was performed on it. The XRD shows high peak at 35º for zinc oxalate. The SEM results are from nano to micro dimensions which is good for analysis the morphological behavior of particles. The photoconductivity of the proposed particles was done that has shown in rise and fall curve with UV spectrum of light. Here we have compared the response time of all three prepared materials and the best material could further used for photodetector based application.

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AUTHORS PROFILE

Dr. Ravi Shankar saxena, Professor GMRIT, RAJAM Completed M.tech from MNNIT then D.Phil from university of Allahabad in the field of optoelectronics and devices. His area of research is design of photodetector with ZnO nanostructure with good response time. Already published papers in several SCI Publications.

Dr. Ashish Kumar Singh, Assistant Professor, NMAM Institute of Technology, Manglore has done his Ph.D on Linearly Polarized Dual Band Microstrip Patch Antenna at University of Allahabad in 2015 he has experience in handling advance simulation and characterization tools employed with fabrication of patch antenna like as Zeland IE3D, HFSS, AWR also Microwave Anechoic Chamber, Vector Network Analyzer, Noise Figure Meter, RF and Microwave Test accessories. Already published papers in many SCI Journals ashishsingh@nitte.edu.in