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# Cu Doped ZnO Thin Films for $NO_2$Gas Sensing

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## Abstract:

Cu-Doped ZnO Thin Film using Sol Gel-dip coating method has been discussed in this paper. At first for sol preparation, we use Zinc Nitrate Hexahydrate, with (Na-CMC) as a thickening agent,and we use Copper Nitrate as a dopant. The thin size has been varied using XRD, and the morphology also Studied Using Fe-SEM, The Electrical Resistivity, form it we will observe a sharp increased current, same given voltage also get high max in 5v and VI Characteristics are discussed, from that we split up in to three region separately due to the increased variation of temperature high and low and finally the Gas Sensor Results was tested, in a closed chamber method from that computer dynamic gas sensing setups will be used, 200ppm of $No_2$ Concentrated target gas has been injected, and also we observed the changes, the tested result will get suitable good manner.

**Keywords: Dip coating method, Gas sensor, Sol Gel dip coating method, $No_2$ Sensor**

## I. INTRODUCTION

A natural excess of toxic gases are highly flammable in nature and also very dangerous to nature and also dangerous to human and living things, so our research made-up the solution of gas sensor with highly efficient. With best selectivity and selectivity and also quick response/ or quick recovery time with more effective it operate under the target gas it is the most important art of attention, most of the semiconductor are widely used for many type of gas sensor applications. ZnO Semiconductor has large intensity Semiconductor. It is also more widely studied materials for gas sensor applications .It present several advantages like non-toxic nature, high chemical stability , low cost, high catalytic motion, UV Blocking properties.[1]

## II. METHODS AND MATERIALS

ZnO Thin film was prepared on well cleaned glass substrate for sol preparation. Firstly we take 4.86 grams of Zinc nitrate hex hydrate with 100ml of DI- ionized water and stirring for 30 min now add 0.5 mole of copper nitrate with 100ml of DI- ionized water and stirring on separate beaker, Next Mix this above two solution with 2:1 ratio of Na-CMC with starrier and heat with 70ºC for one hour and during the entire process the solution was under constant stirring and also the temperature was maintained at 70ºC. [2] Finally a white viscose solution is obtained. Now wash that solution for 10-20 times with di- ionized water to remove the impurities now the solution is ready for coating.

For dip coating we use digital dip coating machine, on that we set 3 min of dip and 3 min of Dry with 70ºC, this process is repeated for 10 times to get the uniform coating. After that we annealing the substrate at 350ºC FOR 3 hours not the substrate is ready for take results.

## III. RESULT AND DISCUSSIONS

### X-Ray Diffraction

To confirm the crystalline of dip coating technique, thin film was characterized by XRD pattern, we get the peak positions of 31.90ºC and 34.18 ºC and 36.02 ºC and the characteristics perks of ZnO at (100), (200), and (101) plane respectively shown in figure.1. the plane has been verified in JCPDF card. The presence of wruzite structure has been confirmed using {002} plane the crystallite size was varied using Debye Scherrer's formulait was found as 4.41nm [3].

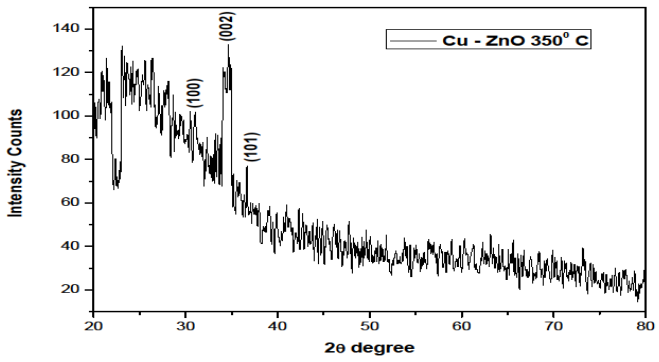


**Fig-1: XRD Pattern of Cu-Doped ZnO Thin film**

### FE-SEM ANALYSIS

The surface morphology and Elemental composition analysis of prepared sample has studied by using Field emission scanning electron microscope.

## FE-SEM image of Cu- Doped ZnO 350ºC

Shown the Cu-doped ZnO sample annealed at 350ºC. This sample structure containing of cluster and depicts the observation of more agglomeration on Cu doped ZnO nanoparticles. It revels the product consist of large quantity on nano-particles and porous in nature.

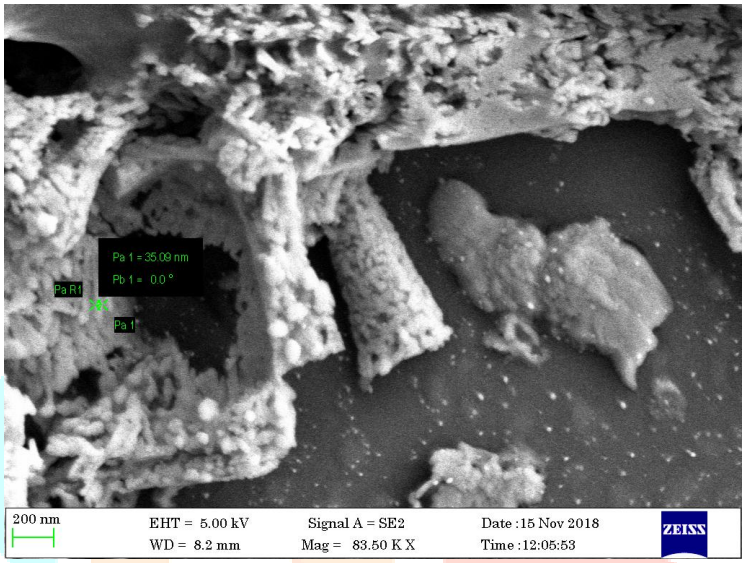


**Fig-2: Fe- SEM IMAGE OF CU-DOPED ZNO THIN FILM**

## ELECTRICAL PROPERTIES

The prepare Cu doped ZnO Sample of 350ºC shows the voltage of -6 volt to +6 volt at current 1.20E-007 for the Electrical properties once the voltage get increase the current also get increase due to in conducting properties, so it is suitable for gas sensing applications [4].

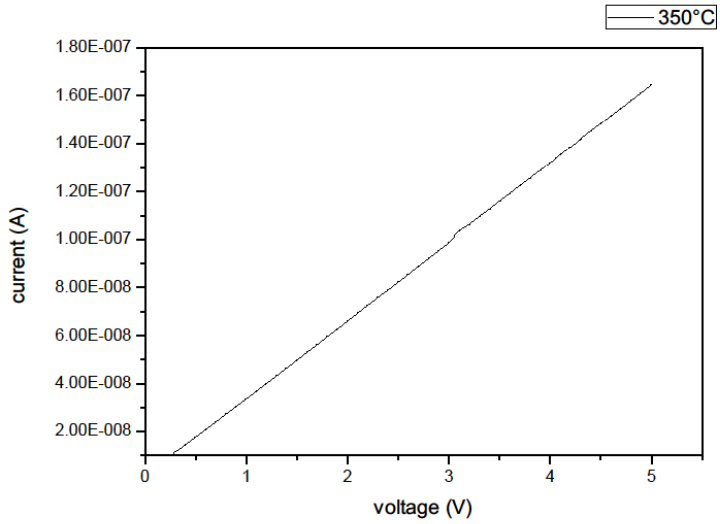


**Fig-3: Electrical properties of Cu-Doped ZnO Thin film**

## ELECTRICAL RESISTIVITY

The prepare Cu-doped ZnO Sample of 350ºC shows A positive Terminal co-efficient agent resistivity of $1.5x10^{-4}$ MΩ and A Negative Terminal co-efficient at 42.80 ºC. It will shown in three different region, At region-1 the resistivity of the sample observe sharply it will increase in temperature of 42.7 ºC. the sample exist positive terminal co-efficient region , on further heating the resistivity of the sample is decreased with the max resistivity of $1.5x10^{-4}$ MΩ around 42.9 in region-II. In region-III a decreased in resistivity with the increased in temperature with (NTCR) behavior it have the present experimental range of $1.5x10^{1}$ MΩx to $1.5x10^{-2.9}$ MΩ [5].

For the resistivity properties, when the film act as a resistor, so when the temperature is increases the resistivity get decreases

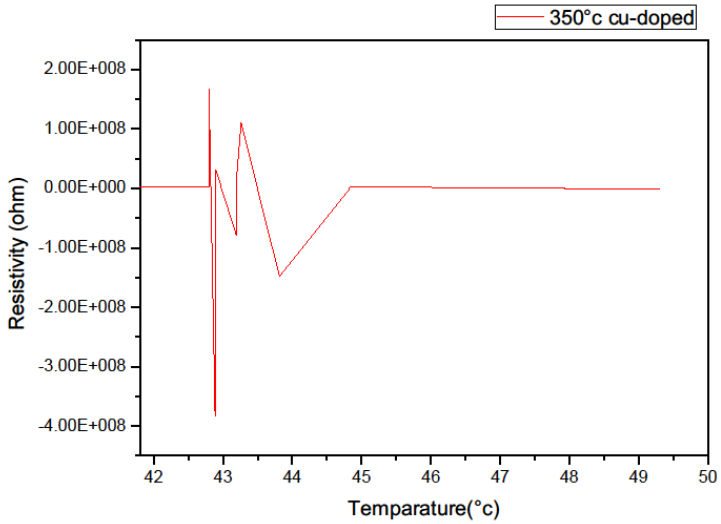


**Fig-4: Electrical Resistivity of Cu-Doped ZnO Thin Film**

## IV. GAS SENSING PROPERTIES

Gas sensor study was made from chemi resistive method. At first 200ppm of $No_2$ gas concentration is injected in to a closed chamber where the coated glass substrate is placed in it. The gas concentration will get reacted on the surface it really act as a resistivity. The maximum resistivity changes were observed, due to the oxidation nature the gas trend to realize the trapped electrons [6]. This will decrease with the height of the potential and from the observation the conduction increase.

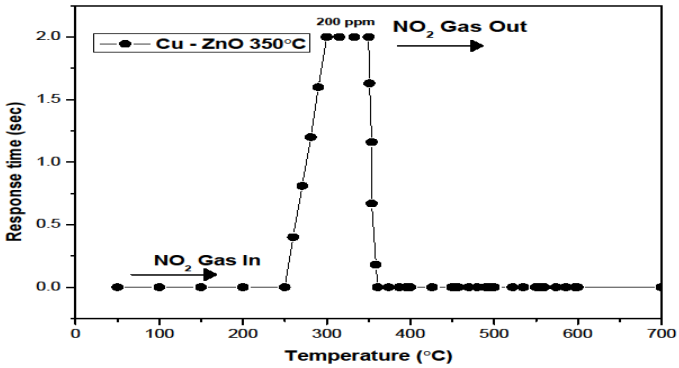


**Fig-5: Gas Sensing of Cu-Doped ZnO Thin Film**

## CONCLUSION

Cu doped sol gel dip coating method its gas sensing analysis was study. The most suitable cluster shape nano particle was confirmed with SEM, The wruzite structure were confirmed with XRD, pattern, Electrical resistivity and electrical properties were studied, and finally the gas sensor test was done on close chamber. The test shows the Cu- doped ZnO thin film can act as a $NO_2$Gas Sensor. With highly sensitivity and selective performance.

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