# Preparation and electrical characterisation of ZnO nano structured thin films by two step chemical bath deposition technique

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**Introduction**

A thin film is a layer of material ranging from fractions of a nanometer( mono layer) to several micrometers in thickness. Electronic semiconductor devices and optical coatings are the main application benefiting from thin film construction. Thin films are very important materials in microelectonics, optoelectronics and several other technologically important fields. Properties of thin film often differ significantly from those bulk due to surface and interface effects, which may dominate the overall behaviour of these films.

Any coating less than about 1μm(1000nm) can be called as a thin film. Films having thickness more than these are called thick films.When a coating is to called a thin fulsome necessary conditions have to be satisfied. The material or coating should be on a clean surface,called substrate. In other words, a layer of substance having a thickness less than one micrometer on substrate can be called as a thin film. If there is no substrate, then it is called a foil.

A thin film can be treated as a two dimentional specimen because us third dimension namely, the thickness is very small compared with the other two dimensions. Similarly in material science Nano wires are called one dimensional materials.

In semiconductor production, doping intentionally introduces impurities into an extremely pure (also reffered to as intrinsic) semiconductor for the the purpose of modulating its electrical properties. The impurities are depend upon the type of semiconductor.

A familiar application of thin film is the household mirror which typically has a thin metal coating on the back of a sheet of glass to form a reflective interface. A very thin film coating (less than a nanometer) is used to produce two-way mirrors. In thin films, the quantity of the material assosiated is smaller than for bulk material. This makes the material lighter and less costlier. Besides these, other technologicallyimportant thin film application are in the magnetic sensors, gas sensors,antireflection coatings,corrosion,protection paintings,wear resistance etc.

**Deposition Techniques**

The act of applying a thin film to a surface is thin film deposition i.e, any technique for depositing a thin film of material onto a substrate or onto previously deposited layers. “Thin” is a relative term, but most deposition techniques control layer thickness within a few tens of nanometers. Molecular beam epitaxy allows a single layer of atoms to be deposited at a time.

Thin films can be made self supporting or may be deposited on suitable substrates like glass, silicon, quartz etc to support the film. Thin films can be deposited from a variety of materials like metals, semiconductors and insulators. A variety of deposition techniques such as physical vapor deposition, chemical vapor deposition, electro deposition, sputtering, close spaced sublimation, spray pyrolysis, rolling etc have been developed for the growth of high quality thin films.

Practically, any thin film deposition involves three basic steps, which are (a) creation of atomic or molecular or ionic species of the required material, (b) transport of the species to the substrate and (c) condensation of the transported species on the substrate. The choice of deposition technique is decided by several parameters like the melting point of the material to be deposited, desired purity of the thin films, the required thickness, the application of the thin film deposited etc. It is to be realized that the deposition techniques and their process parameters have strong effects on the thin film properties. Also, depending on the type of materials used and the deposition parameters used, the thin films deposited can be crystalline, polycrystalline or amorphous.Deposition techniques fall into two broad categories, depending on whether the process is primarily chemical or physical.

**Properties of Thin Film**

There are several factors that decide the properties of a thin film like the rate of film deposition, deposition ambient, substrate temperature, purity of the materials used and the impurities added during deposition. Thin films are most commonly prepared by condensation of atoms from the vapor phase of the material. The atom condensation is determined by its interaction with the impinged surface and gets deposited on the substrate surface by adsorption. The impinging atom is attracted to the substrate surface by the instantaneous dipole and quadrapole moments of the surface atoms. It may be noted that, the adsorbed state is not a thermally equilibrated state, instead the adsorbed atoms (adatoms) move over the film surface because of the thermal activation from the surface or because of its kinetic energy parallel to the surface. An adatom has a finite stay time on the substrate to form a stable cluster (agglomeration) or island and can be chemically adsorbed with the release of a heat of condensation.

**Objectives of the study**

- # To synthesis pure and doped ZnO nano-structured thin films by two step chemical bath deposition technique
- # To determine the electrican conductivity of the films using two probe method. And to compare the conductivity of films at different doping concentrations.
- # To Determine the Band gap of the films by taking the UV spectrum of the films and to compate the Band gap of films at different doping concentrations.
- # To study the morphology of the films by taking the SEM image of the samples.

**Resuls and Discussion**

1.Electrical

Pure and doped Zinc Oxide thin films were prepared by chemical double dip method and the resistance variations with temperature are noted and tabulated. The data are given in the following table.

| Temp. in K | Up to 463 | 473 | 483 | 493 | 503 | 513 | 523 | 533 | 543 | 553 | 563 | 573 | 583 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Res in MΩ | Above 20 | 18.6 | 14.2 | 7.66 | 4.51 | 2.3 | 1.77 | 1.01 | 1.05 | 1.02 | 0.2 | 0.2 | 0.2 |

2.Band gap

Pure and doped Zinc Oxide thin films were prepared by chemical double dip method and the experiment was repeated for Aluminium doped samples and also for different doping concentrations. The figures 1 to 4 shows the variation in band gap of the samples at different doping concentrations starting from 3at.% to 12 at.%.

Table 1 gives the Band Gap Values of the samples

| Name of the sample | Doping Percentage | Band gap observed |
|---|---|---|
| Sample 1 | 3 % Aluminium | 3.04 eV |
| Sample 2 | 6% Aluminium | 3.084 eV |
| Sample3 | 9% Aluminium | 3.09 eV |
| Sample 4 | 12% Aluminium | 3.11 eV |

Table 2 gives the conductivity of the samples at 210 °C

| Name of the sample | Doping percentage | Maximum conductivity observed at 210 °C |
|---|---|---|
| Sample 1 | 3 % Aluminium | 327.5 micro Siemens |
| Sample 2 | 6% Aluminium | 448 micro Siemens |
| Sample 3 | 9% Aluminium | 518 micro Siemens |
| Sample 4 | 12% Aluminium | 553 micro Siemens |

## 5.CONCLUSION

ZnO thin films were prepared by Silar method and doping with Aluminuum was also done. The smaples are then annealed at 450⁰C. The resistance variation with temperature is noted and tabulated. The results of this experiment can be concluded as follows.

# The high resistance of the film at low temperature shows that the film is intrinsic in nature.

#The lattice parameters of the film are determined as a=b= 3.235Å and c=5.1876 Å.

# The particle size of the film was calculated from the SEm image as 80-100 nm.

# The thickness of teh film was also calculcted as 0.9276 µm.

The UV absorption spectrum of the samples were taken to determine the band gap of the samples.The XRD of the samples were also taken. From the UV absorption spectrum it is clear that the band gap in ZnO thin films prepared by silar method can be increased by increasing the doping concentrations of the transition metal. Also an increase in band gap cause an increase in conductivity. So in ZnO thin films prepared by silar method, the doping concentration is directly proportional to band gap and conductivity.

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