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Growth of ZnO Thin Films on Silicon and Glass Substrate by Pulsed Laser Deposition a Thesis

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Abstract

Thin films find a wide application in developing microelectronic devices, sensors, anti-reflective and protective coatings on advanced equipments, transparent electrodes etc. These make equipments versatile and more efficient. Various techniques are being devised to grow high quality thin films. One such advanced technique is the Pulsed Laser Deposition technique which comes under the category of Physical Vapour Deposition technique. In this technique the material to be deposited i.e. the target, is ablated using laser pulses resulting in the plasma formation. This plasma then interacts with the background gases supplied into the vacuum chamber. Finally it condenses on the object to be coated with the material i.e. the substrate, and nucleates to get deposited as a thin film. PLD is a simple, faster and economical technique. High quality films with desired crystalline structure can be grown using this technique. However a number of factors are involved which determine the film quality like pressure optimization, target composition and form, substrate temperature and laser pulse features. The project deals with deposition of zinc oxide on silicon and quartz substrates by PLD technique and to study the characteristic of the thin film by UV Visible spectroscopy. Zinc Oxide is considered to be a future material due to its multifunctional properties. It crystallizes in two structures viz. Hexagonal wurtzite and Cubic zinc blend. Its high conductivity and low thermal expansion leads to its wide application in ceramics. The striking feature of ZnO is that it is a wide direct band gap semiconductor with a band gap of 3.25eV which corresponds to energy in the UV range. It is a potential material to develop optoelectronic devices that would emit radiations in UV range. Besides the binding energy of excitons is 60 meV. This makes the excitons stable at room temperature (energy equivalent of which is 25 meV) and hence is an essential feature for lasing action. Developing ZnO oxide thin films facilitates research to develop ZnO optoelectronic devices. The project involves the study of the PLD technique and its various aspects like optimization conditions and film growth. A study has been made on the objective behind developing ZnO thin films. The study has inspired me to get involved in developing higher quality thin films for manufacturing optoelectronic devices made up of ZnO.

Keywords: Optoelectronic devices; Stoichiometry; Krypton Fluoride

Introduction

Thin-film deposition and the techniques involved

Thin Film Deposition is the technology of applying a very thin film of material-between a few nanometers to about 100 micrometers, or the thickness of a few atoms-onto a “substrate” surface to be coated, or onto a previously deposited coating to form layers. The controlled synthesis of materials as thin films (a process referred to as deposition) is a fundamental step in many applications. Thin

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films find a wide application in developing advanced and versatile equipments. Starting from building microelectronic devices to accurate sensors, from protective layers on various objects to anti-reflective coatings on solar cell, thin films have proved their importance. With increase in demand for advanced technology, efficient techniques are being devised for thin film deposition. For development of complex composition films various techniques are being designed [1].

Thin film deposition techniques are broadly classified into two categories:

- Physical vapour deposition
- Chemical vapour deposition.

The basic procedure remains the same in both the techniques **FIG. 1**. That is formation of the vapour of the material to be deposited (target) and then its growth or condensation on the surface to be coated (substrate). However there lies a significant difference between the two as in CVD more of chemical reactions cause the growth of thin film on the substrate unlike PVD where mostly the physical phenomena take place [2].

They further have their own types of deposition techniques which are given in the flowchart below.

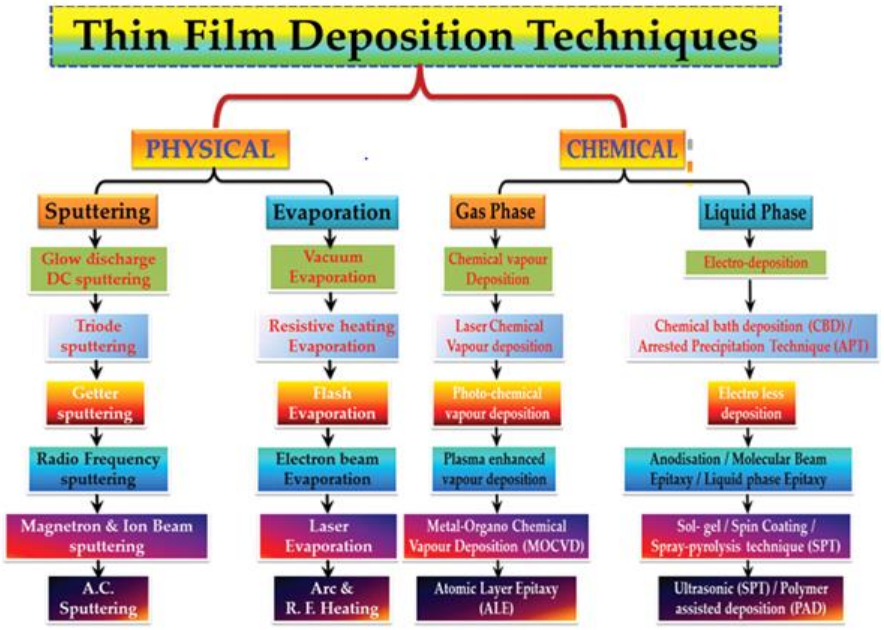

FIG.1. **Flowchart of the Thin Film Deposition Techniques.**

One such technique which comes under the PVD category is the laser evaporation technique properly named as Pulsed laser deposition technique. It is a simple and versatile technique and has opened a vast area of research for developing higher quality thin films [3].

Pulsed Laser Deposition Technique

Laser-assisted film growth started soon after the technical realization of the first laser in 1960 by Maiman. Smith and Turner utilized a ruby laser to deposit the first thin films in 1965, three years after Breech and Cross studied the laser-vaporization and excitation of atoms from solid surfaces. However, the deposited films were still inferior to those obtained by other techniques such as chemical vapour deposition and molecular beam epitaxy. In the early 1980s, a few research groups (mainly in the former USSR) achieved remarkable results on manufacturing of thin film structures utilizing laser technology. The breakthrough came in 1987 when Dijkkamp, Xindi Wu and Venkatesan were able to laser deposit a thin film of YBa2Cu3O7, a high temperature superconductive material, which was of superior quality to that of films deposited with alternative techniques. Since then, the technique of pulsed laser deposition has been utilized to fabricate high quality crystalline films. In the 1990s the development of new laser technology, such as lasers with high repetition rate and short pulse durations, made PLD a very competitive tool for the growth of thin, well defined films with complex stoichiometry.

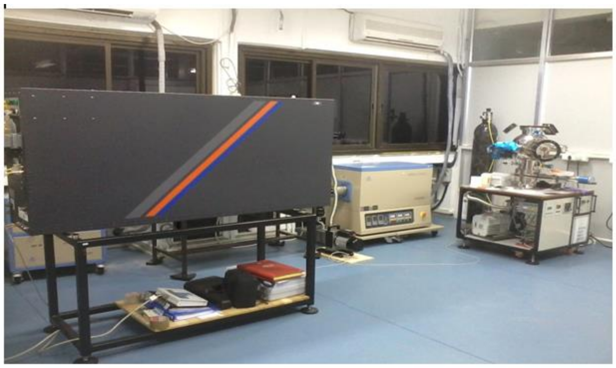

FIG.2. **This figure shows the Pulsed laser Deposition Laboratory at Institute of Physics, BBSR.**

The **FIG. 2** shows the typical set-up of a PLD technique. It is quite apparent from the figure that it has two main components *viz*. the Excimer laser and the vacuum chamber [4].

The technique can be understood with a simple analogy. When we throw a heavy stone into a pool of water, we observe a small hill of water splashing up from the surface of the water. This is because the energy of the stone is imparted to the small volume of water which in turn rises up from the surface up to a certain height. Similarly, in this technique, the laser pulses play the role of the stone while the target material represents the pool of water. The material removed from the surface of the target is then deposited on the substrate surface. Let us study each step in detail.

Excimer lasers

With the advancement in technology lasers that emit radiations in the UV range have been devised. Excimer lasers are a special class of lasers that emit radiations in UV range. The name Excimer is the short for ‘excited dimer’. It is sometimes referred to as exciplex derived from ‘excited complex’.

The gain medium consists of mixture of noble gases like krypton and argon and reactive gases like fluorine or chlorine. Under the appropriate conditions of electrical stimulation and high pressure, a pseudo-molecule called an Excimer (or in the case of noble gas halides, exciplex) is created, which can only exist in an energized state and can give rise to laser light in the ultraviolet range. Laser action in an Excimer molecule occurs not because it has a bound (associative) excited state, but a repulsive (dissociative) ground state. This is because noble gases such as xenon and krypton are highly inert and do not usually form chemical compounds. However, when in an excited state (induced by an electrical discharge or high-energy electron beams, which produce high energy pulses), they can form temporarily bound molecules with themselves (dimers) or with halogens (complexes) such as fluorine and chlorine. The excited compound can give up its excess energy by undergoing spontaneous or stimulated emission, resulting in a strongly repulsive ground state molecule which very quickly (on the order of a picoseconds) dissociates back into two unbound atoms. This emitted energy in the form of radiation lies in the UV range.

For the deposition of ZnO thin film the Excimer laser used was Krypton Fluoride Excimer laser. A krypton fluoride laser (KrF laser) is a particular type of Excimer laser, which is sometimes (more correctly) called an exciplex laser. With its 248 nanometer wavelength, it is a deep ultraviolet laser which is commonly used in the production of semiconductor integrated circuits, industrial micromachining, and scientific research [5].

The working of such an Excimer laser can be explained as follows.

A krypton fluoride laser absorbs energy from a source, causing the krypton gas to react with the fluorine gas producing the exciplex krypton fluoride, a temporary complex in an excited energy state:

$$2\,Kr + F_2 \rightarrow 2\,KrF$$

The complex can undergo spontaneous or stimulated emission, reducing its energy state to a metastable, but highly repulsive ground state. The ground state complex quickly dissociates into unbound atoms:

$$2\,KrF \rightarrow 2\,Kr + F_2$$

The result is an exciplex laser which radiates energy at 248 nm, near the ultraviolet portion of the spectrum, corresponding with the energy difference between the ground state and the excited state of the complex.

Vacuum chamber

The vacuum chamber is a finely electro polished stainless steel chamber. It is typically spherical in shape or may be at times cylindrical too. The chamber consists of a target carousel that could hold multiple target materials. The carousel could be rotated using stepper motors. Such a rotation is implemented for uniform utilization of the target material due to laser evaporation. The vacuum chamber consists of the substrate assembly which essentially consists of the substrate holder and the heater to heat the substrate to a suitable temperature. The substrate assembly is placed parallel to the target carousel at a suitable distance apart. In some set-up even the substrate holder is provided with stepper motors so that the substrate could be rotated at a regulated speed for uniform deposition of the material to be deposited. The entire chamber is evacuated using vacuum pumps to a suitable pressure. This is done to make the chamber free from unnecessary molecules which would otherwise affect the stoichiometry of the deposited film **FIG. 3**.

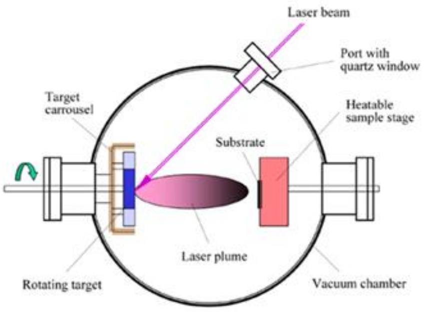

FIG.3. **The figure depicts the schematic set-up of the Pulsed Laser deposition technique. The left-hand set represents the target carousel from which the laser plume is ejected after the beam has interacted with the target material. While the right-hand set represents the substrate assembly with substrate holder and heater.**

Steps involved in pld

In a typical PLD process, film growth occurs in three different stages:

- The laser beam strikes a solid target of known composition and produces a highly forward directed plume of gas material
- The plume interacts (chemically and physically) with a background ambient
- Finally the ablated material condenses on to a suitable substrate where it nucleates and grows

The adjustable experimental parameters are the laser fluence, substrate to target distance, background oxygen pressure, and substrate temperature. Film quality is determined by the selected laser wavelength, target composition, its structure and density identity of the substrate (amorphous, or single crystal, and lattice matching) [6].

Discussion of Each Step

Laser pulse-target interaction

The laser pulses strike the target at a controlled frequency and for a fixed number of times depending on the required film thickness. The energetic UV photons strike the target surface and break the bonds in the material to remove a thin layer of the material from the surface. This process is referred to as photo ablation. The material gets vaporized at the point where the pulse strikes the surface and produces a forward directed vapour of particles. However the ablation process involves a lot of dynamics. The free electrons oscillate within the strong electromagnetic field of the laser light and can collide with the atoms of the bulk material thus transferring some of their energy to the lattice of the target material within the surface region. This happens within a fraction of time of the laser pulse duration. The surface of the target is then heated up and the material is vaporized.

The penetration depth of the pulse depends on the wavelength of the laser beam and the refractive index of the target material. Mostly UV lasers are used because most solids show a high absorption rate in this region. Besides the energy of the beam is appreciably higher than the threshold energy so that the material could be vaporized. The laser fluency (intensity) determines the amount of material ejected from the surface and is set as per the requirement.

Plasma dynamics

The vaporized material consists of energetic electrons, ions, neutral atoms and molecules. This plume of energetic particles is referred to as the laser plume. It is highly forward directed plasma along the normal to the target surface. The plume can be studied in three stages. Firstly, the hot particles are ejected from the surface and are energetic enough to be scattered by the background gases. In the second stage, the plume spreads out in the forward direction due to coulomb repulsions among the contents and interacts with the background gases. Here the more energetic particles are separated from the less energetic ones. In the final stage, the plume diverges further and condenses on the substrate surface.

The plasma dynamics is highly influenced by the vacuum pressure and the background gases. Besides, the interaction of the plasma with the background gases affects the stoichiometry of the deposited film [7].

Growth or condensation of the film

The growth of the thin film depends on the type of material being deposited. The nucleation mode of the material is determines the film quality. As, if the force of cohesion between the plume contents exceeds the adhesive force between the plume contents and the substrate surface then the growth of film is not uniform and the substrate surface roughens. There are typically three growth modes observed in PVD processes.

- Step-flow growth or Stranski-Krastnow mechanism-All substrates have a miscut associated with the crystal. These miscuts give rise to atomic steps on the surface. In step-flow growth, atoms land on the surface and diffuse to a step edge before they have a chance to nucleate a surface island. The growing surface is viewed as steps travelling across the surface. This growth mode is obtained by deposition on a high miscut substrate, or depositing at elevated temperatures.
- Layer-by-layer growth or Frank-van-der Merwe mechanism-In this growth mode, islands nucleate on the surface until a critical island density is reached. As more material is added, the islands continue to grow until the islands begin to run into each other. This is known as coalescence. Once coalescence is reached, the surface has a large density of pits. When additional material is added to the surface the atoms diffuse into these pits to complete the layer. This process is repeated for each subsequent layer.
- 3D growth or Volmer-Weber mechanism-This mode is similar to the layer-by-layer growth, except that once an island is formed an additional island will nucleate on top of the 1st island. Therefore, the growth does not persist in a layer by layer fashion, and the surface roughens each time material is added.

The deposition rate is governed by the Mass Deposition Rate relation known as the Langmuir-Knudsen relation:

$$R_m = C\ (M/T)^{(1/2)} \times cos\ p \times cos\ q \times \left(P_e(T) - P\right)/r^2$$

Where R_m=Mass Deposition Rate

$$C = 1.85 \times 10^{-2}$$

M= evaporant gram-molecular mass (g)

T = source temperature

p= is the angle between the normal to the target surface and plume direction

q= is the angle between the normal to substrate surface and plume direction

P_e(T)= Vapour pressure of the evaporant which is a function of temperature (torr)

P= is the chamber pressure (torr)

r = source substrate distance (cm)

This relation explains why the source and substrate are kept parallel so that p~0 and cos p=1. Besides lower the chamber pressure greater is the value of R_m. However keeping the pressure too low affects the film quality due to resputtering of already deposited particles. This is because the plume contents hardly collide with any particles to lose their energy and slow down when pressure is kept too low. So the subsequent particles tend to resputter the already deposited contents. Hence optimization of pressure plays a crucial role in determining the film quality.

Experimental Procedure

- The target material chosen was Zinc Oxide (ZnO). The target was in pure powdered form which was then compressed into a disc of finite thickness. The target material was placed on one of the target holders

- The substrate material (first small silicon wafers and then quartz slices) where mounted on the substrate holder. Here care is to be taken while placing the substrate to avoid falling of the substrate from the holder and that it is kept parallel to the target surface

- Then the chamber was sealed. Vacuum pumps were turned on to evacuate the chamber. The chamber was evacuated to 10^{-5} milli bar pressure and the substrate was heated to 500°C (as per the required condition)

- The laser fluency was set (160mJ/mm^2) and verified using a calibrating instrument. However the laser fluency can be varied depending on the growth requirements. The laser was aligned with the vacuum chamber so that the pulses strike the target surface at about 45° to the normal to the target surface after being focused by the lens fixed on the chamber along the beam direction

- First the number of laser pulses (laser shots) was kept at a low value. The substrate was shielded and the pulse was allowed to strike the substrate surface. This step is done to remove a thin layer off the target surface which would otherwise contain impurities. This is necessary to ensure that the depositing material is devoid of impurities.

- The number of laser shots was then set to 3000. The shield on the substrate was lifted up. Oxygen gas was released into the chamber at a controlled pressure. The laser was then run and the pulses were allowed to strike the target surface.

- After all the shots had struck the target, the laser was turned off. The substrate was left in the chamber for the temperature to fall down before it was removed from the holder [8].

Parameters that Influence the Film Growth:

Effect of laser fluency

The laser energy fluency has a significant influence on the growth kinetics of the ZnO film. At lower levels of laser fluency, the deposition rate is low and this allows the growth of ZnO *via* a 3D-island mode, and since the kinetic energy of the species is low their reduced surface mobility leads to an island growth mode. On the other hand, too high a laser fluency quickly degrades the film properties due to bombardment of the growing film by energetic species. Laser fluency range needs to be optimized.

Effect of oxygen supplied into the chamber

Oxygen pressure influences both the deposition rate and the kinetic energy of the ejected species. The kinetic energy of the ablated species reduces with the increase in pressure due to large number of collisions with the background gas molecules and is observed that the size of the plume decreases with increase in oxygen pressure. In this case the distance between target and substrate is kept low. The pressure and the distance between the target and substrate are related by the relation Pd^y=constant for processing good quality oxide film by PLD., where y is the ratio of the specific heats of the elements in the plume, and depends upon the oxide target composition, P is the background pressure and d is the plume length. If the substrate is located beyond a plume size d, the adhesion coefficient for the ejected species that arrive at the substrate surface is substantially decreased and therefore the film quality of ZnO films becomes worse as the ambient pressure increases beyond an optimum value. Oxygen incorporation into a growing film originates both from the oxide target and the background oxygen gas. Excess amount of zinc observed on the surface of the oxide target is observed due to high volatility and the loss of oxygen due to vacuum pumping, and thus a high background oxygen pressure is necessary to maintain the equilibrium composition of the target, and to avoid the oxygen deficiency in the film [9].

Effect of substrate temperature

The substrate temperature in PLD is very crucial because it activates the surface mobility of the ejected species deposited onto the substrate surface and since kinetic energy of the ablated species in PLD is relatively higher than that observed in thin films deposited by other techniques. The nucleation process depends on the interfacial energies between the substrate surface and the condensing species, and is governed by the substrate temperature. A high substrate temperature favours rapid oxidation of Zn atoms and optimum diffusion of the species, whereas a low substrate temperature results in the growth of a poorly crystallized film. With the increase in substrate temperature and oxygen pressure, the crystallinity of the thin film is enhanced and allows development of a smooth, dense and uniform microstructure with a good adhesion to the substrate.

Effect of target features

Since the quality of thin film is directly related to the target material it is important to start with low impurity chemicals. For ZnO thin film deposition a variety of target materials including sintered ceramic discs prepared from pressed powders are used. The presence of droplets on the film surface is more or less a direct consequence of the physical nature of the target and related thermal effects occurring within the target during the laser-matter interaction. This is because if the density of the target material is low then its thermal conductivity is low. So the neighboring areas of the point where the laser pulse strikes the target gets heated up more quickly before it dissipates the heat to the neighboring regions resulting in ejection of droplets from the surface.

Advantages of pld Technique

Pulsed laser deposition for thin film growth has several advantages which are listed below:

- The flexibility in wavelength and power density allows the process to ablate many material or materials combination by selecting the appropriate laser wavelength in order to match the absorption properties of materials
- Large pressure range to deposit materials: from <10-7 mbar (vacuum without additional background gas) up to 1mbar
- The laser is not part of the vacuum system. Therefore a considerable degree of freedom in the ablation geometry is possible
- The use of a pulsed laser beam enables precise control over the growth rate (sub-monolayer per pulse)
- The congruent transfer of the composition can be achieved for many ablated material or materials combinations
- Moderation of the kinetic energy of evaporated species to control the growth properties and growth modes of a film. In addition, a background gas can provide an appropriate reactive atmosphere using e.g. oxygen to create oxide species in the plasma, when growing oxide films
- Controlled preparation of Nano-particles by fs-PLD

Disadvantages of pld Technique

There are also disadvantages to associated with the PLD process. Some of them are of a technical nature; some are intrinsic to the ablation process and the electromagnetic interaction between photons and matter:

- The large kinetic energy of some plume species causes re-sputtering and likewise defects in the substrate surface and growing film.
- An inhomogeneous energy distribution in the laser beam profile gives rise to an inhomogeneous energy profile and

angular energy distribution in the laser plume.

- Light elements like oxygen or lithium have different expansion velocities and angular distributions in a plume as compared to heavier elements. To obtain the desired film composition, e.g. an adapted target composition or a background gas is required.
- Due to the high laser energies involved, macroscopic and microscopic particles from the target can be ejected which can be detrimental to the desired properties of films and multilayer's

Choice of Zno as the Film Material

Zinc Oxide (ZnO) exhibits an interesting combination of multifunctional properties, including optical, semiconducting, piezoelectronic and optoelectronic properties. In the thin film form ZnO films find immense applications in many electronic devices such as sensors, actuators, transducers, and high frequency Surface Acoustic Wave (SAW) devices. Research and development efforts on ZnO thin film growth are underway since four decades and device quality films have been deposited successfully by a variety of deposition techniques. Primarily the interest in ZnO was due to its wide direct band gap and optical properties (refractive index). Subsequent improvements in the growth techniques offering a better control over the crystallographic properties and electrical conductivity has led to its varied applications.

ZnO is a direct band gap semiconductor with $Eg = 3.37 eV$ having hexagonal wurtzite structure with lattice parameters $a = 0.325 nm$ and $c = 0.521 nm$. Intensive research is being carried out o ZnO thin films due to the observation of excitonic lasing, when excitonic stimulated emission was observed from epitaxial ZnO film at room temperature. Research is being carried out to develop epitaxial films on lattice matched substrates for optoelectronic device applications. Lately with the availability of epitaxial quality ZnO films , single crystal ZnO wafers, and large exciton binding energy of 60 meV in ZnO compared to 25 meV for wide band gap GaN, the prospects for using ZnO in optoelectronic devices has increased enormously. However developing ZnO diodes has still remained a challenge for the science community. ZnO behaves as an n-type semiconductor inherently due to any of the reasons as zinc interstials or oxygen atom vacancies or zinc atom vacancies. But for developing a ZnO diode p-type ZnO is essential which requires a good deal of research. Results of preparation of p-type ZnO have shown defects like decrese in carrier concentration due to prolonged use. Hence, efforts are being taken to achieve p-type doping in ZnO for manufacturing transparent optoelectronic devices for lasing action in UV region [10].

UV-Visible Spectroscopy

Ultraviolet-visible spectroscopy or ultraviolet-visible spectrophotometer (UV-Vis or UV/Vis) refers to absorption spectroscopy or reflectance spectroscopy in the ultraviolet-visible spectral region. This means it uses light in the visible and adjacent ranges. The absorption or reflectance in the visible range directly affects the perceived color of the chemicals involved. In this region of the electromagnetic spectrum, atoms and molecules undergo electronic transitions by absorbing radiations of appropriate wavelength.

The method is most often used in a quantitative way to determine concentrations of an absorbing species in solution, using the Beer-Lambert law. The Beer-Lambert law states that the absorbance of a solution is directly proportional to the concentration of the absorbing species in the solution and the path length. Thus, for a fixed path length, UV/Vis spectroscopy can be used to determine the concentration of the absorber in a solution. It is necessary to know how quickly the absorbance changes with concentration. This can be taken from references (tables of molar or extinction coefficients) or more accurately, determined from a calibration curve.

$$A = log\ \left(I / I'\right) = \ \varepsilon Lc$$

Where *A* is the measured absorbance [n Absorbance Units (AU)], I is the intensity of the incident light at a given wavelength, I' is the transmitted intensity, *L* the path length through the sample, and *c* the concentration of the absorbing species. For each species and wavelength, ε is a constant known as the molar absorptivity or extinction coefficient. This constant is a fundamental molecular property in a given solvent, at a particular temperature and pressure, and has units of $\frac{1}{M}cm$.

The absorbance and extinction *ε* are sometimes defined in terms of the natural logarithm instead of the base-10 logarithm.

UV-Visible Absorption Spectra of ZnO Thin Film Deposited on Quartz Substrate

The absorbance spectra of the ZnO thin film give us knowledge about its band gap and presence of excitonic levels in the deposited film. This is crucial in determining the efficiency of the deposition technique. That is, if the film has a proper stoichiometry and crystallinity then it would be displayed in the absorbance spectra as peaks at the expected wavelengths **FIG. 4**.

Sample: ZnO Thin Film on Quartz substrate

Reference: Air

Wavelength range: 200 nm-600 nm

Least count of the wavelength range: 0.5 nm

The graph of wavelength *vs* absorbance:

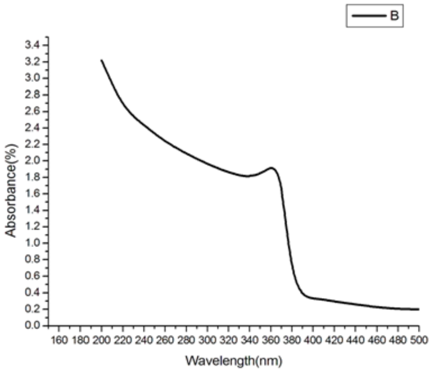

FIG.4. **The UV-Visible absorption spectra of ZnO thin film. From the spectra the band gap energy can be calculated and the excitonic levels can be approximated.**

Analysis

- The absorbance rises in the ultraviolet region. This explains that ZnO does not absorb light in the visible region and hence appears white in color

- We obtain a peak at around 360nm wavelength. This corresponds to the presence of excitonic levels in ZnO thin film. The sharp peak implies the carriers get excited by absorbing radiation of the particular wavelength to one of the excitonic levels

- The absorbance curve rises continuously beyond 340nm from which the band gap energy can be calculated which is about 3.3eV

Discussion

- Excitons are bound state of an electron and hole due to coulomb interaction between them. These are quasiparticles responsible for transfer of energy across the crystal lattice but not charge as they are neutral in nature.
- Excitons behave like a hydrogen atom i.e. much like a bound state of electron and a positron. So they have their own discrete energy levels which lie just below the conduction band of the material. These levels prove to be a potential state to attain metastable equilibrium under favorable conditions for an efficient lasing action.
- These are of two types depending on the material properties like its dielectric constant:
  - Frenkel excitons in which the distance between the hole and electron is much less than the lattice constant and the binding energy is of the order of 1eV.
  - Wannier-Mott excitons in which the distance between the hole and electron is greater than or comparable to the lattice constant and the binding energy is of the order of 10 meV-100 meV.
- ZnO behaves as a semiconducting material. The excitonic binding energy for it is 60meV. Thus the excitons in the material are stable under room temperature conditions as the energy equivalent of room temperature is about 25 meV.
- These stable excitons would be useful in achieving population inversion under room temperature. Thus a lasing action could be achieved that would emit radiations in the UV range since the band gap of ZnO corresponds to the UV region.
- The presence of sharp peaks in the spectroscopy curve signifies the presence of excitonic levels in the thin film that was grown using the PLD technique. Thus the thin film could be used to construct laser diodes as advanced equipment which emits radiation in the UV region.

Conclusion

Thin films have proved their caliber in developing versatile and efficient devices for future. Pulsed Laser Deposition Technique has proved its excellence in developing high quality and complex structured thin films to meet the demands of the advancement in technology. However, research is being carried out to implement the technique for large scale deposition on objects with complex geometry. Modified PLDs like the Aurora PLD which uses a magnetic field to control the plume dynamics for customizing the film quality. Various other techniques are being implemented like use of additional laser beam to vaporize the target, releasing gases at high energy to control the plume divergence and use of femto seconds laser to reduce the defects density in the grown film. As PLD is a promising technique, it is being implemented to develop new types of thin films made up the tagged ‘future material’ Zinc Oxide (ZnO). This multifunctional metal oxide has inspired a great deal of research for developing cheap, economical and efficient semiconducting devices. ZnO is a direct wide band gap semiconducting material which could be used for making optoelectronic devices. The high excitonic binding energy of ZnO has made it a potential candidate to be used for building laser diodes that emit radiations in the UV range. Using PLD technique, ZnO thin films with required stoichiometry and structure could be developed. A number research is going on in developing ZnO thin films under various background conditions. ZnO, by inheritance behaves as an n-type semiconducting material. But the development of p-type ZnO, that could suffice the construction of ZnO diodes, still proves to be challenge for the scientific community. Manufacturing diodes of ZnO diodes would help to develop lasers with intense, finer beams in the UV range. PLD could provide a potential gateway to build ZnO diodes by developing high quality thin films.

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