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FTIR ANALYSIS OF ZINC OXIDE THIN FILMS GROWN AT DIFFERENT SUBSTRATE TEMPERATURE

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Abstract: ***ZnO thin films have drawn a lot of attention because of its variety of application. ZnO has the unique properties such as its wide range of band gap, high binding energy, high melting point and boiling point. So we have taken the ZnO target and using PLD we have deposited thin film on substrate of silicon and corning glass at different – different temperature. After deposition of the thin films the properties of these films were characterized by FTIR spectroscopy. FTIR analysis used for the calculation of bond position (peak) of zinc and oxygen at different wavelength. The analysis exhibits the unique properties of ZnO thin films and provide better understanding to experimental as well as phenomenological techniques.***

Keywords: ZnO, PLD, FTIR

1. INTRODUCTION

The work is based on deposition of Zinc Oxide thin film using Pulsed Laser deposition (PLD) technique. Zinc oxide is an inorganic compound [1, 6, 7]. It is denoted by ZnO. It is a white powder which is basically insoluble in water and exhibits large band gap of around 3.3 eV at room temperature. It crystallizes in mainly two types of structure one is Hexagonal Wurzite and another one is Zinc Blend. Generally, The hexagonal Wurzite structure is the commonly found structure as it is most stable at ambient condition. Reportedly, the c/a ratio is nearly equal to 1.6 which is equal to the ideal value of c/a ratio of hexagonal structure unit cell. Zinc oxide has a linear structure in two dimensions which shows that there is a double bond between Zinc and Oxygen. In transparent electronics, Zinc oxide is mainly used in laser diode and light emmiting diode due to the wide range of its semiconductor bandgap . Because of its wide band gap, low cost, strong radiation hardness and high chemical stability, ZnO is regarded as one of the most promising candidates for UV photo detectors. Zinc oxide gas sensor has a good characteristic like chemical sensitivity to different adsorbed gases, amenability to doping, high chemical stability, non-toxicity, and low cost. Zinc oxide nanorods can detect change in electric current passing through ZnO nanowires due to adsorption of gas molecules. The sensor detects hydrogen concentration down to 10 ppm at room temp, whereas no response to oxygen.

Properties of ZnO

Property	Value
Lattice parameters at 300 K:	
a_0	0.32495 nm
c_0	0.52069 nm
a_0/c_0	1.602 (1.633 for ideal hexagonal structure)
u	0.345
Density	5.606 g/cm^3
Stable phase at 300 K	Wurtzite
Melting point	1975°C
Linear expansion coefficient (/°C)	a_0: 6.5 x 10^{-6}, c_0: 3.0 x 10^{-6}
Thermal conductivity	0.6, 1-1.2
Static dielectric constant	8.656
Refractive index	2.008, 2.029
Energy gap	3.4 eV (direct)

2. EXPERIMENTAL TECHNIQUES

Thin film deposition:-

Thin film means a layer of material in which range of particle be a fraction of nanometers to 100 micrometers. Thin film is a low dimensional material which is created by condensing molecule matter on a substrate. Thin films have some most interesting properties which differ from bulk materials from which they are made of. This happens because properties of thin film depend on number of some interrelated parameter and also depend on the fabrication technique [1]. There is some important parameter which define the optical, mechanical and coated material properties. These properties are: substrate of the material and quality of surface, degree of vacuum inside the coating chamber, during film growth flow of gases inside the coating chamber, evaporation rate and purity of coating material. The film deposition is divided into three major part: -

1. Production of films using physical or chemical deposition technique
2. Transportation to the substrate
3. Condensation for solid deposit

Pulse Laser Deposition:

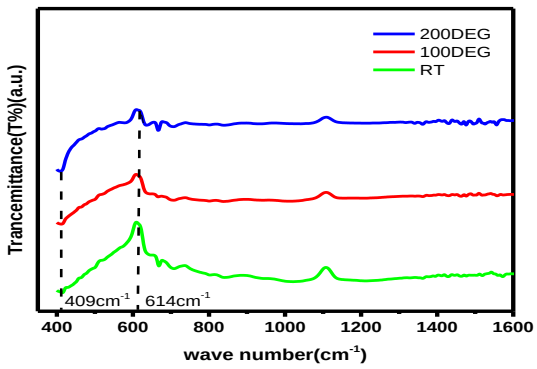
The technique pulse laser deposition has been used to deposit high quality thin films of materials. This technique uses high power laser pulses to melt, evaporate and ionize the material from the surface of a target. The vaporize material, containing neutral, ion and electron etc. known as laser-produced plasma plume. This material is vaporized from the target in a plasma plume which deposit it as a thin film on substrate (substrate is as silicon wafer). This deposition occurs in presence of ultra-

high vacuum or presence of some background gas such as oxygen which is mainly use for background gas. There are large number of variable which affect the properties of thin films such as laser fluence, background gas and substrate temperature [2]. The process of pulse laser deposition technique divided into four stages: Laser ablation of target material and creation of plasma, Dynamic of the plasma, Deposition of the ablation material in the surface of substrate, Nucleation and growth of the film on the substrate surface. Step-flow growth, Layer by Layer growth, 3D growth are three growth mode in PLD technique[3].

FTIR (Fourier transform infrared spectroscopy):-
This technique reveals the infrared spectrum of absorption and emission of a solid, liquid, or gas. This technique use a beam of many frequencies and observes that what fraction is absorbed by the sample. The result of Fourier transformation is a spectrum of the signal at a series of discrete wavelengths. The range of wavelengths that can be used in the calculation is limited by the separation of the data points in the interferogram . The shortest wavelength that can be recognized is twice the separation between these data points [8, 9].

3. RESULT AND DISCUSSION:-

FTIR spectroscopy is an important technique to checking the vibrational spectrum and properties of thin films. Fourier transform infrared (FTIR) spectroscopy is the spectroscopy that deals with the infrared region of the electromagnetic spectrum that is light with a longer wavelength and lower frequency than visible light [5]. The surface to volume ratio (i.e. aspect ratio) for nanoparticles is higher than their bulk counterpart. As more atoms/molecules are arranging do not the surface of nanoparticle, the surface chemistry of these nanomaterials is of immense interest[4]. In order to quickly establish the presence or absence of the various vibrational modes present in ZnO nanoparticle, we performed FTIR spectroscopy of ZnO nanoparticles. In order to analyze spectrum peaks are correlated with FTIR spectroscopy correlation wave number. We have FTIR spectra of as prepared nanoparticles. The absorption and transmittance bands peak obtained of Zn–O bond and also authenticates presence of ZnO .



FTIR spectra of ZnO thin films grown with various temp

The absorption bands at around 409cm-1 and 614cm-1 are attributed to E1(TO) and A1 (LO) bending vibration of ZnO respectively . The observed absorption bands confirm the deposition of ZnO thin films with good structural properties.

4. CONCLUSION

Highly crystalline ZnO thin films were deposited on corning and Si (100) substrate using Pulsed laser deposition technique at varying substrate temperature (RT,1000C, 2000C). The films were found to be c-axis oriented with good crystal quality. The structural analysis of films was performed using FTIR technique. The observed absorption bands confirm the deposition of ZnO thin `films with good structural properties.

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REFERENCES

1. Chattopadhyay, Chattopadhyay K. K., Banerjee A. N., Introduction to Nanoscience and Nanotechnology
2. M. C. RAO, Pulsed Laser Deposition abalated material, Int. J. Mod. Phys. Conf. Ser., 22, 355 .
3. H. Kim et al. / Thin Solid Films 420 –421 .
4. M. Zerdali, S. Hamzaoui, F.H. Teherani, D. Rogers, Growth of ZnO thin film on SiO2/Si substrate by pulsed laser deposition and study of their physical properties, Materials Letters 60 (504–508).
5. B. S. Rathore, Sandeep Sharma and S. S. Rathore. AIP proceedings 2220, 020148(2020).
6. Jagat Chouhan, Mohan kumar, Chetan Joshi, Sandeep Sharma, Mukesh Kumar Sharma. Journal of Advanced Scientific Research, ISSN: 0976-9595, 2021; 12(3): 261-268.
7. Sandeep Sharma, Deepak Kumar Yadav, Kanhaiya Chawla, Nathu Lal, Chhagan Lal. Quantum Journal of Engineering, Science and Technology, ISSN : 2716-6341 Vol. 2 (5) (2021): 1-9.
8. B.S. Rathore, M.S. Gaur, F. Singh and K.S. Singh. Radiation Effects and Defects in Solids, 167, 131-140 (2012).
9. B.S. Rathore, Radiation Effects and Defects in Solids, 169, 767-778 (2014).

