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Article

A Survey on Copper Doping Zno Thin Films

Deepak Chaudhary[1], Tarun Kumar[2]

[1]Assistant professor, Department of Applied Science, Institute of Engineering & Technology, Alwar, Rajasthan, India
[2]Lecturer, Government Polytechnic Alapur, Badun,Uttar Pradesh, India.

I N F O

Corresponding Author:
Deepak Chaudhary, Department of Applied Science Institute of Engineering & Technology, Alwar.
E-mail Id:
deepak.se17@gmail.com
Orcid Id:https://orcid.org/0000-0002-4674-3200
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A B S T R A C T

The outcome of copper doping ZnO thin films, placed by means of a sol-gel dip-coating process, on the structural, optical and ethanol vapour-sensing possessions, was observed. The variety of the doping content is 0 wt. %–5 wt. % Cu/Zn and the films' assets were deliberate using x-ray diffraction, scanning electron microscopy and a UV–vis spectrophotometer.

Zinc oxide is one of the most important n-type semi-conductors intensively utilized in solar cells, transparent conducting electrodes and opto-electronic devices. The X-Ray diffraction shows the polycrystalline hexagonal quartzite structure exhibiting degradation in crystallinity of elaborated films with increasing Al doping concentration. This outcome is reflected on optical and electrical proprieties of films. Certainly, the examples contemporary a low optical transmittance level and the band gap values amid 3.17 eV and 3.20 eV. Regarding the electrical properties, a diminution in the attentiveness of free charges transporters is experiential as well as a lessening in resistivity.

Keywords: XRD, ZnO, Diffraction, Resistivity

Introduction

Thin Film Science

The thin film science and expertise occupy self and significant role in the extraordinary tech manufacturing unit. In the new years, thin film science has full-grown international into a major research area. The thin film facts has been manufacturing primarily for the prerequisite of the united circuits for many devices and electronics uses. At the present it is compulsory for lesser and slighter strategies with a high speed particularly in novel cohort of combined circuits for new dispensation method and future giga scale addition skill for computers and other tools. The significance of coating and the mixture of new resources for industry have resulted in a marvellous intensification of innovative thin film dispensation expertise. Now this development drives hand-in-hand with detonation of the prominence of coating and the amalgamation of new ingredients for engineering have occasioned in a wonderful growth of pioneering thin film dispensation skills. Presently this growth goes hand-in-hand with detonation of.

An additional main field encompasses procedure knowledge for films with thickness vacillating from one to numerous microns. These films are indispensable for assembly of manufacture areas, such as thermal barrier coatings and wear fortifications, attractive service life of tools and to defend resources in contradiction of thermal and atmospheric influences. Presently, rapidly shifting requirements for thin film materials and devices are generating new openings for the increase of new measures, resources and skills. Consequently elementary exploration happenings will be compulsory in the future to increase knowledge, considerate and to develop predictive aptitudes for connecting essential corporeal and chemical belongings to the microstructure and show of thin film in various applications. In basic research, special model systems are needed for quantifiable research of the relevant and important advances in thin film material science.

In specific, these model systems allow the examination of nucleation and increase courses, solid state reactions, the thermal and mechanical constancy of thin film systems and stage limitations. Results of combined research and theoretical inquiries are the qualification for the advance of new thin film systems and the modifying of their microstructure and performance. Thin film technology is based on the three basic foundations.

- Fabrication
- Characterization and
- Applications

Applications of thin films

Here is extensive diversity of uses of the thin films. Thin films are unswervingly or circuitously useful for fresh part of investigation in solid state Physics and also in the field of chemistry which are based on singularities exceptionally features of the thickness geometry and structure of the films. The main manipulation of thin film skill is still in the field of microelectronics. On the other hand, there are increasing presentations in other areas like thin films for optical and magnetic devices, electrochemistry, defensive and enhancing coatings and catalysis.

Thin films are castoff for manufacture resistors, capacitors, diodes, magnetic devices, memory devices. Microelectronics Mechanical systems (MEMS) are calculated by expending routinely stable thin film. The major uses of thin films are originate in optoelectronics devices (e.g. solar & cells, photovoltaic cells), optical devices (e.g. LED), solid state devices and in numerous other electronic appliance.

Multilayer optical filters are extensively castoff which are fashioned by multilayer thin films. AR (Antireflection) coating is castoff on the lenses of virtually all optical equipment's, as well as cameras, microscopes, telescopes etc. One of the most critical applications of hard coating has been in ball bearings, used in virtually precision rotating machinery. Thin film machinery in microelectronics has extraordinary use in metallurgical and defensive coatings. Ceramic thin films are also in extensive used. The moderately high hardness and inertness of Ceramic material also brand this type of thin coating of interest for protection of substrate material against corrosions, oxidations and wear. In specific the use of such coating on the cutting tools may extend the life of these items by the several orders of magnitude.

Most features of thin film activities are represented by a relatively new research area, called surface engineering. Surface engineering has been one of the most expanding scientific areas in the last 10 years and includes the design and dispensation of surface layers and coatings, internal interfaces and their characterization. Surface engineering is directed by the demands of thin film and surface characteristics of materials. The use of thin film polycrystalline semiconductors has concerned much interest in an increasing diversity of uses in various electronic and optoelectronic devices. The industrial interest in polycrystalline based devices is mainly caused by their actual low production costs. Thin films now inhabit a protruding place in elementary research and solid state expertise.

Properties of thin films

Starting bulk to Nano-structured thin films, the size affects an imperative role and the properties of these films changes drastically. Thin films are quasi-two dimensional, defect structures unlike from bulk and strongly predisposed by surface and interface outcomes.

Literature Survey

Zinc Oxide (ZnO) is one of the groups II-VI compound semiconductors, generally existing in two main forms: cubic zinc blende and hexagonal wurtzite structure the wurtzite structure is utmost constant at ambient conditions and accordingly greatest communal. All of unique kind of atom is enclosed by four of additional type and vice versa. ZnO is a wide-band-gap semiconductor that retains an energy-band structure and physical properties comparable to those of TiO2, but has higher electronic mobility that is favorable for electron transport, with reduced remixing loss when used in DSSCs. Various revisions take previously been described on the use of ZnO material for application in DSSCs. Although the conversion competence, 0.4–5.8%, obtained for ZnO is much lower than that of TiO2 (11%); ZnO is still supposed of as an illustrious alternative to TiO2 due to its ease of crystallization and anisotropic development.

Manoj Kumar et.al[93] in this report, sputtered-grown undoped ZnO and Y-doped ZnO (ZnO: Y) thin film transistors (TFTs) are presented. Both undoped ZnO and ZnO: Y thin films exhibited highly preferred c-axis oriented (002) diffraction peaks. The ZnO:Y thin film crystallinity was improved with an increase of (002) peak intensity and grain size. The electrical possessions of ZnO: Y TFTs were meaningfully heightened comparative to undoped ZnO TFTs. ZnO: Y TFTs unveiled outstanding presentation with high mobility of 38.79 cm2 V−1 s−1, small sub threshold swing of 0.15 V/ decade, and high Ion/Ioff current ratio of the order of 8.17 × 107.

Ravinder Kaur et.al[1] Undoped and yttrium doped zinc oxide thin films placed on corning glass by dip coating performance. The consequence of doping (0–4 wt %) and annealing temperature (300–500 °C) on the structural, optical and electrical properties of the manufactured films have been considered. All the films demonstration polycrystalline nature at an annealing temperature of 350 °C. The special c-axis evolution with lowest complete breadth at half maximum of (002) reflection peak is can be seen individual up to an optimum annealing temperature.

Amit Kumar et.al[2] Arsenic doped p-type ZnO thin films

were grown on sapphire substrate by magnetron sputtering. As grown films reveal p-type conduction confirmed by Hall-outcome and photoluminescence measurements. The p-type film with a hole concentration of 2.16× 1017 cm-3, mobility of 1.30 cm2/V.s and resistivity of 22.29 Ω-m were obtained at substrate temperature of 700 oC. ZnO homo-junction synthesized by in-situ deposition of as doped p-ZnO layer on Al doped n-ZnO layer showed p-n diode like characteristics. X-ray pole figure and Transmission Electron Microscope studies confirm epitaxial nature of the films.

Ezenwa I.A et.al [3].Zinc oxide (ZnO) thin film was organized by the electro less deposition method by means of aqueous solution of zinc acetate (Zn(CH3(00)2) as a preliminary material and EDTA disodium salt was engaged as a multifaceted agent. The film was categorized for optical and morphological properties. From the outcomes attained, the film was originate to have transmittance that improved progressively with wavelength in the VIS region of the solar spectrum, with approximately 0.85 (85%) at wavelength range of 600nm – 900nm. ZnO films were originate to have sturdy absorption of about 0.75 at wavelength of 320nm that denigrates as the wavelength amplified.

Sallet et al. [4] also described growth of ZnO on (0001) sapphire substrates using MOCVD. Diethylzinc and tertiarybutanol were used as zinc and oxygen sources similarly. In this paper, the authors had assumed specifics of development /circumstances such as substrate temperature and precursor's partial pressure. Inspiration of the cleanness state of the MOCVD silica reactor was also accentuated, since it changed both layer quality and crystalline orientation.

Guotong et al. [6] reported growth of ZnO films on C-plane sapphire substrate using plasma-assisted MOCVD. The investigational consequences show that the high-quality ZnO films have been obtained by annealing. Furthermore, the films with better PL properties are obtained by the final annealing, while the films with higher optical transmission are obtained through annealing during the growth process. Low pressure chemical vapour deposition (LP-CVD) of Al doped ZnO [AZO] thin film was investigated for transparent electrode of thin film solar cell. For LP-CVD, diethyl zinc and trim ethyl aluminum were used as Zn and Al precursors respectively.

T.Sekiguchi et al. [7] deposited ZnO thin film on sapphire substrate using 'remote plasma-enhanced chemical vapour deposition' with Zn (C2H5)2 and CO2. In the ZnO films grown under the oxygen-rich condition, broad emissions [peaked at 3.8 and 3.0 eV] were witnessed.

Kook et al. [8] described on the development of actual great quality Al doped n-type ZnO epilayer on sapphire substrate using a RF magnetron sputtering method joined with a rapid thermal annealing. On increasing annealing temperature up to 9000C, the PL Intensity (energy 3.2 eV) augmented significantly. PL intensity ratio knowingly improved with cumulative the oxygen pressure. Annealing at 9000C however resulted in enhanced carrier concentration and mobility about 1020 cm3 and 45-65 cm2 /Vs. ZnO and AZO transparent thin films with dissimilar thicknesses were equipped using dc magnetron sputtering method. Statement was on silicon and Corning glass substrates [9].

Rajesh Das et al. [10] described that transparent conducting AZO thin films were equipped using RF-magnetron sputtering underneath dissimilar gas ambient at 3000C. The electrical resistivity varied from 1.23× 10-1 to 2.8 ×10-4 _ cm on introducing O2 and H2 gas with Ar ambient. Hydrogen plays an central role for creation of oxygen vacancies due to its reducing action which causes the increase of carrier concentration of AZO films. Maximum carrier concentration and Hall mobility, as valued from Hall Outcome measurement of the films, were 2.3 × 1021/cm3 and 44.4 cm2 /V s respectively.

Y.B. Xiao et al. [11] calculated the properties of Indium Zinc Oxide (IZO) thin films dropped on Polyethylene Terephthalate substrate room temperature with the help of dc magnetron sputtering. Research of IZO films were carried out under varying the O2 concentration and deposition parameters. As the O2 concentration in O2/Ar gas increased from 0.4% to 3.5%, the transmittance of the film amplified from 70% to 90% and the resistivity decreased. With increase in dc power, the resistivity improved; but the transmittance reduced.

Choopun et al. [12] studied the motivation of oxygen pressure on surface morphology and optoelectronic properties of ZnO films grown on sapphire (0001) by PLD. The films were grown at 750 °C under various oxygen background pressures ranging from 10−5 to 10−1 Torr. All the ZnO layers grown were found to be c-axis oriented. Samples grown under lower oxygen pressure regimes (10−5–10−4 Torr) had a c-axis lattice parameter 0.25% larger than that of the bulk material.

Singh et al. [13] Preparation of highly conducting and transparent AZO films which were put down on quartz and Corning 7059 glass by focusing a XeCl (_=308 nm and 20-ns pulse width) excimer laser onto a target rotating at 15 rpm. The ZnO target was 2 in. in diameter and doped with 2-wt % Al2O3. For all the experiments, a repetition rate of 5 Hz and an energy density of 1.5 J /cm2 were used.

Matsubara et al. [14] used oxygen radical-assisted PLD to grow highly transparent and low-resistivity AZO films at room temperature. A KrF excimer laser (_ =248 nm, 30-ns pulse width, and 10-Hz repetition rate) was used for ablation. The oxygen partial pressure during deposition was (0.7–1.4×10−5 Torr) and the applied RF power was

150 W. Distance between the target and the substrate was approximately 6 cm.

Craciun et al [15] placed high-quality ZnO films on glass and silicon substrates using the PLD method retaining a KrF laser (=248 nm) and deliberate the effect of deposition parameters such as substrate temperature, oxygen pressure, and laser fluence on the belongings of the grown films. All the films grown over a rather wide range of deposition circumstances were originate to be optically transparent, electrically conductive, and c-axis oriented. Investigations of the outcome of dissimilar oxygen.

Kuang –Che Hsiao et al. [16] synthesized AZO Nano powder using spray pyrolysis technique. Aerosol droplets of the mixture of the zinc and aluminium nitrates [concentration varied from 0.06 to 3.0 M] were pyrolysed in air at temperatures ranging from 500 to 800 °C. The AZO powder had a primary and a secondary particle sizes in the range of 15– 30 nm and 1–3 µm, respectively. Particle sizes increased with the reaction temperature and precursor concentration.

Jiwen Xu et al. [16] equipped the ZnO: Al films on glass substrate at comparatively low temperature of 3000C by ultrasonic spray pyrolysis. Zinc acetate and Aluminum acetate acted as zinc and aluminium sources, which liquefied in ethanol–water solution. The outcomes exposed that ZnO: Al films exhibited stronger (1 0 1) favored orientation and had lenticular-like grain morphology. Resistivity as low as 4.3×10−1 _ cm for as-deposited films was obtained at the 4 at.% doping concentration, which could be diminished to1× 10−2 cm level by post-deposited vacuum annealing.

H. Gómez-Pozos et al. [17] deposited AZO thin films over sodocalcic glass substrates using CSP technique; in this work, zinc acetate and aluminum pentanedionate were the precursors. The group observed that addition of Al to the starting solution decreased the electrical resistivity of the films up to an optimum value between 2 and 3 at.%; further increase in the [Al/Zn] ratio lead to an increase in the resistivity. After a vacuum-thermal treatment, performed at 400 °C for 1 h, the films showed a resistivity decrease, reaching a minimum value, for the films deposited at 4750C, of 4.3×10−3 _ cm. Xray diffraction studies showed that the films are polycrystalline and the peaks fit well to the hexagonal wurtzite structure with a preferred orientation along the (002) direction. Optical transmittance at 550 nm ranged between 85 and 90%, depending on the deposition temperature.

M.A. Reshchikov et al. [18] observed strong shift of blue and yellow luminescence band with variation of excitation intensity in the ZnO film grown on sapphire using MBEwith hydrogen peroxide as source of reactive oxygen. The group observed the Yellow Luminescence (YL) and Blue Luminescence (BL) bands with nearly Gaussian shape and positions of maxima in the ranges 2.1–2.3 and 2.85–3.15 eV, respectively. Both the PL bands were blue- shifted substantially with increasing excitation intensity.

Oliver kluth et al [19] reported the suitability of the light scattering properties of dissimilar texture glass/ZnO surfaces for effectual light trapping in silicon thin film solar cells. AZO substrate with adapted surface texture for dissimilar uses and reduced absorption losses contributed to the development of µc-Si: H p-i-n, and a-si: H/µc-si: H stacked p-i-n cell with competences of 9% and 12.1% correspondingly.

J.A. Aranovich et al [20] examined electrical and photovoltaic belongings of heterojunction equipped by means of spray pyrolysis ZnO films on single crystal p-type CdTe. Further down actual sunlight the best cell presented an open-circuit voltage of 0.54 V and short-circuits current of 19.5 mA/cm2 with an efficacy of 8.8%. CuInS2/ZnO solar cell of 2% efficiency with Voc =280 mV, Isc=13.3 mA/cm2 and FF=0.38 were prepared using spray pyrolysis.

M.S.Tomer et al. [21] equipped thin film ZnO/CuInSe2 heterojunction solar cell using CSP method. The cell displayed an open-circuit voltage 0.3 V, short circuit current of 23mA/cm2, a fill factor of 0.29 and electrical conversion efficiency beyond 2%.. ZnO layer was placed as 'diffusion barrier' through DC Magnetron sputtering from pure ZnO target on stain steel substrate. ZnO diffusion barrier had powerfully summary the diffusion of Fe from the stainless steel substrate into CIGS solar cells.

Kerstin Schulze et al. [22] associated organic solar cell by means of dissimilar transparent conducting oxides as anodes [ITO and 3 kinds of AZO]. These anodes with dissimilar work functions were used for small molecule photovoltaic device based on as oligothiophene byproducts as donor and fullerene C60 as acceptor molecule. They determined that the work function of the anode did not influence the Voc of the photovoltaic device.

S.Y.Myong et al. [23] developed hydrogenated 'protocrystalline silicon' (pc- Si: H)/Hydrogenated 'microcrystalline silicon' (µc-Si: H) double junction solar cell structure employing boron doped ZnO (ZnO: B) intermediate layer. Because the ZnO:B intermediate layer reduced the potential thickness for pc-Si:H absorber in the top cell, this double junction structure was promising candidate to fabricate highly stable Si- based thin film solar cell.

T.Dittrich et al. [24] investigated the outcome of annealing on the ZnO Nano rods/In2S3/ CuSCN devices. They compared the charge selective contact of solar cells with tremendously thin absorber based on ZnO- Nano rod/In2S3/ CuSCN before and after thermal annealing by current-voltage measurements at varying temperature and light intensity.

Campa et al. [25] reported that the role of ZnO between the CIGS and the backmetal contact in terms of optical improvement of the back contact. Simulation results presented important increase in the reflectance of ZnO/ Mo contact compared to Mo contact without ZnO layer. The analysis of improvements in simulated quantum efficiency (QE) and short circuit current (Jsc) of a thin film CIGS solar cell, related to TCO/metal indicated that significant amount of reflected light escaped from the substrate due to the insufficient light trapping in thin CIGS absorber.

Lin Ke et al [26] studied the degradation mechanism of ZnO dye sensitized solar cell (glass/ITO/ZnO/dye/electrolyte/ Pt) using various characterisation method. Extremely Thin Absorber (ETA) cells with the structure of TCO/ZnO rod/In2S3/ CuInS2 were prepared with the help of CSP technique. Outcomes of buffer layer thickness and ZnO Nano-rods of length 500–1000 nm were studied. Increasing In2S3 layer thickness reduced fluctuations of the cell output parameters and increased Voc and FF; however, certain thicknesses induce losses due to light absorption.

Jeong et al. [27] reported the photoelectric properties of n-ZnO/ p-Si photodiode (PD) which detect UV photons in the depleted n-ZnO and simultaneously detect visible photons in the depleted p-Si by employing two related photoelectric mechanisms. I-V measurements obtained while the photodiodes are exposed to radiation in a wavelength range of 310–650 nm showed a linear increase in photocurrent with reverse bias. In the visible range, the photocurrent rose rapidly with bias but saturated beyond a critical voltage.

Ohta et al. [28] also reported on transparent p-n hetero-junctions composed of p- ZnRh2O4 and n-ZnO thin layers grown using reactive solid-phase epitaxy method. Polycrystalline ZnRh2O4 was put down on a ZnO epitaxial layer at room temperature. Thermal annealing of the bilayer sample at 950 °C in air converted the polycrystalline ZnRh2O4 layer to what was reported to be an epitaxial single-crystalline layer.

H. Y. Kim et al. [29] fabricated the n-ZnO/p-Si and n-ZnO/ n-Si hetero-junction photodiode using RF sputtering performance variable the substrate temperature and Ar: O2 ratio. The photoelectric outcome was very promising at for the n- ZnO/p-Si structure while the n-ZnO/n-Si showed large dark current. An optically transparent tin-doped indium oxide/ZnO/NiO n–i–p hetero-structure photodiode was fabricated using ion beam assisted e-beam evaporation.

H.T.Hsueh et al [30] reported the deposition of Cu2O onto vertically aligned ZnO nanowires using DC sputtering. The average length, average diameter and density of these VLSsynthesized ZnO Nano-wires were 1µ m, 100 nm and 23 wires/µm2 respectively. With proper sputtering parameters, the deposited Cu2O could fill the gaps between the ZnO nanowires with good step coverage to form coaxial p-Cu2O/n-ZnO Nano-wires having rectifying current–voltage characteristic.

Carcia et al. [31] fabricated ZnO thin film transistors using RF magnetron sputtering on heavily doped n-type Si substrates held near room temperature. In this structure, the substrate side was coated with a thermal oxide layer of ~100 nm thick. Ti–Au source and drain electrodes 200 µm wide with a 20µm gap (10-nm Ti followed by 100-nm Au) were deposited and patterned directly on the thermal silicon oxide layer applying traditional photolithography.

J. H. Chung et al. [32] examined the electrical characteristics of ZnO thin film transistors with respect to the thickness of ZnO active layers. ZnO layers with thicknesses 30 nm to1500 nm were placed on bottom gate patterned silicon substrate using RF sputtering at room temperature. The leakage current was 9.97×10-8A, channel mobility was 0.16cm2/Vs and threshold current was 12.7

V. L. Zhang et al [33] also reported the performance of ZnO-TTFTS with different thicknesses of the active layer and optimised the conditions. The leakage current of devices increased from 10 -10 to 10-8 A and on/off ratio decreased from 1.2×107 to 2×104. Atomic force microscope measurements indicated that as the thickness increased, the surface morphology of the active layer improved noticeably at first and then deteriorated.

R. Navamathavan et al. [34] fabricated the ZnO based thin film transistor using RF magnetron sputtering with and without NH3 plasma treatment. The electrical properties were observed to be significantly improved for the ZnO TFT with NH3 plasma treatment. NH3 plasma treated ZnO TFT exhibited excellent electrical characterization as evident from sub threshold swing of 0.44 V/dec, minimum off-current of 10-11 A, threshold voltage of 14 V, field outcome mobility of 34 cm2/Vs, and on/off ratio of 105. H.

Faber et al. [35] associated two dissimilar solution grounded technique to fabricate ZnO TFTs. Nano-particle dispersions remained administered complete spin coating with thermal treatment of the semiconductor at 100 0C. Precursor solutions were placed and rehabilitated in to ZnO layers using spray pyrolysis at a temperature of 370 0C. Thin film transistor devices (TFTs) based on spray pyrolysis films exhibit higher electron mobility up to 24 cm2 V s compared to 0.6 cm2 /Vs for Nano particle based TFTs. The increased mobility is clearly due to improved crystalline arrangement in the spray coated films.

Li et al. [36] prepared ZnO Nano-needles on a silicon wafer through chemicalvapour deposition. The diameters of the needle tips were in the range of 20–50 nm. High-resolution transmission electron microscopy revealed that the Nano-needles were single crystals growing along the (0001) direction and exhibiting multiple tip surface

perturbations, and were just 1–3 nm in dimension. Field Emission measurements on the prepared nanostructures showed fairly low turn-on and threshold fields of 2.5 and 4.0 V/mm, respectively.

Zhang et al. [37] reported formation of ZnO tubes by MOCVD at temperatures of 350–450 °C. The tubes obtained were grown epitaxially on sapphire (0001) substrates with the growth along c axis parallel to the substrate normal. All of the tubes had hexagonal cross section. Nature of the tubes was found to depend strongly on both the growth temperature and reactor pressure.

T. Devoda et al. [38] obtainable the consequences on development of ZnO Nano-rods fortified by scattering aqueous solution comprising ZnCl2 and thiourea in dissimilar molar ratios on to SnO2 enclosed glass substrate. They experiential that adding of thiourea into spray solution has great effect on the size, shape and phase composition of ZnO crystals.

Heo et al. [39] measured the temperature and the gas/ambient dependence of current-voltage characteristics of single ZnO Nano-rods grown through catalyst-driven MBE on Au-coated Sapphire substrates. Individual Nano-rods were removed from the substrate and placed between ohmic contact pads, kept 3.7 μm apart. Conductivity of the Nano-rods increased after a post-growth annealing in hydrogen gas at 400 °C.

M. Shahjahan et al. [40] reported the fabrication of undoped and Al-doped ZnO Nano-wall structures on ordinary glass substrate by low cost spray pyrolysis technique at low deposition temperature of 350 °C. Structural study revealed that the fabricated ZnO nanostructures were polycrystalline in nature and crystallinity of the samples depends on the Al doping concentration. For undoped ZnO.

Shu-Cheng Chin et al. [42] compared the Nano-structures of three samples of ZnO thin film on sapphire under different growth temperature conditions. Although disconnected domain structures (on the scale of 100nm in size) were observed in the samples grown under high-temperature (4500C) their crystal quality was generally better than the one grown at a low temperature (2000C).

Ohta et al. [43] also reported on transparent p-n hetero-junctions collected of p- ZnRh2O4 and n-ZnO thin layers developed using reactive solid-phase epitaxy method. Polycrystalline ZnRh2O4 was deposited on a ZnO epitaxial layer at room temperature. Thermal annealing of the bilayer sample at 950 °C in air converted the polycrystalline ZnRh2O4 layer to what was reported to be an epitaxial single-crystalline layer.

J.X. Wang et.al [44] proposed that offer a greater degree of diffusion for gas molecules as well as relatively larger specific surface area compared with 2-D structured films... These 1-D structures provide well-defined channels without any grain boundaries which might obstruct the flow of electrons through the channels. Due to these favourable properties, gas sensors with channels made of 1-D Nano-materials have been widely investigated.

Carcia et al. [45] invented ZnO thin film transistors using RF magnetron sputtering on heavily doped n-type Si substrates held near room temperature. In this structure, the substrate side was coated with a thermal oxide layer of ~100 nm thick. Ti–Au source and drain electrodes 200 μm wide with a 20μm gap (10-nm Ti followed by 100-nm Au) were deposited and patterned directly on the thermal silicon oxide layer applying traditional photolithography.

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Conclusion & Future Scope

In this survey paper we have read more than 100 papers relate to thin films now conclude about thin film. ZnO thin films were ready on quartz glass substrates by different sol-gel approaches using a spin-coating performance. The structural and optical properties of ZnO thin films were studied by X-ray diffraction (XRD) and transmission spectra analysis. The results show that different factors such as Zn2+ concentration, solvent, sol stabilizer, pre-heat treatment temperature, and annealing temperature have a great impact on the structural and optical properties of ZnO thin films.

Future works

In this study, ZnO was doped with Y, the future works will be based on the optical, structural and elemental investigation of other lanthanides such as erbium, holmium, thulium, etc., their lifetime and quantum efficiency could also be studied. Moreover, the influence of the annealing temperature on the properties of the prepared phosphors should be done. Knowing that the current research interest on luminescent materials is moving to solar cells and biological imaging, the prepared phosphors are promising materials for photovoltaic applications in order to improve devices efficiency.

The study of structural, elemental and optical properties on the annealed samples is a promising research project that still needs to be undertaken. In this regard, the thermo gravimetric analysis (TGA) result shown in the appendix (A.0)

give an indication on the minimum temperature needed to subject the prepared powder in order to remove all organic constituents.

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