Chemical Concepts

International Journal of Chemical Concepts
ISSN:2395-4256 www.chemconsai.com
Vol.04, No.01, pp 47-51, 2018

Thin Film Solar Cells Novel Approaches by Different Method of Techniques

[1]S.Muthukrishnan, [2]T.A.Venkatsubramaniam

[1]Department of Electronics and Communication Systems, Karpagam University, Coimbatore, India..
[2]Department of Electronics and Communication System, PSG College of Arts and Science, Coimbatore,India.

Abstract : In these approaches of research articles is giving my review of work, ZnO thin films were derived by sol-gel using two method of techniques; dip coating and spin coating technique. The films through deposited onto glass substrate at room temperature using sol-gel composed from zinc acetate dehydrate, ethanol alcohol, and de-ionized water, the films were preheated at 225°C for 15 min.The crystallographic structures of ZnO films were investigated using X-ray diffraction (XRD) and scanning electron microscopy; the result shows that the good film was preparing at dip-coating technique, it was polycrystalline and highly co-orientation along (002) plane. The structure of thin films, prepared by dip-coating technique method have good transmittance of about 92% in the visible region, it can be noted from the fluorescence spectrometer two broad visible emission bands entered at 380 nm and 430 nm.

Keywords: ZnO, Thin Film;Sol-gel;Dip Coating Technique.

1. Introduction

The thin film solar cells based conducting the dip coating is interesting piezoelectric, electrical, optical, and thermal properties, which are already applied in the fabrication of a number of devices, such as gas sensors, ultrasonic oscillators and transparent electrodes in solar cells. Several techniques were employed to produce pure and doped ZnO films, including chemical vapor deposition, sputtering, spray pyrolysis, and the sol-gel process. The manufacturing of transparent conducting thin film as transparent conducting electrodes for thin film solar cells has encountered zinc oxide as one of the best options due to high chemical stability against reducing environment, a textured surface, the simultaneous concurrence of high transparency in the visible region and high conductivity[1-5].

Different Experimental Techniques[1-5]:

(Zinc Oxide with Magnesium Oxide) Thin films of ZnO and ZnO: Mg with different indium concentrations were prepared by the combination of the dip coating technique and thermal decomposition process. The precursor has been prepared from zinc acetate dehydrate and dissolved in ethanol (50 ml).The dopant source of Magnesium was Magnesium Oxide. Magnesium oxide was mixed with zinc acetate taking in consideration in atomic percentage of In/Mg atoms in the solution to be in the range of 0.0-0.09%.The solution stirred for one hour at 75°C to a yield a clear and homogeneous solution.Pre cleaned glass micro-slides were coated with a precursor using an automated and homemade dip coater with dipping rate in the range 2-40mm/s.This dip coater is based on falling of the precursor from the dipping tank to another tank by gravity and the flow rate of the precursor was controlled by several diameters of the connecting tube,consequently,the flow rate of the precursor through the connecting tube govern the falling rate of the precursor level in the deposition tank. Falling the precursor level in the deposition tank was calibrated for several rates according to different diameters of the connecting rubber tube between the two tanks.

(Zinc Oxide) ZnO thin films derived by sol-gel method on quartz substrate using dip coating technique. The substrate sol-gel solution was prepare by mixing zinc acetate dehydrate (Zn(CH3COO)2.2H2O), monoethanolamine (MEA) and deionized water,the mixture was added to 15 ml isopropanol alcohol.The molar ratio of MEA to zinc acetate was maintained at 1:1 and the concentration of zinc acetate was 0.6 mol/L.The solution was heated at 60°C with continuous stirring using magnetic stirrer for two hour under reflux until it become clear and homogeneous.The prepared solution was aged at room temperature for one day before coating.The glass substrate was cleaned before using for precipitation process by washing it with de-ionized water using ultrasonic for 5 min, then the substrate was cleaning again using isopropanol alcohol ultrasonic for 10 min. The cleaned glass slide of dimensions (35 mm × 25mm × 1 mm) was dipping in the sol-gel by a controlled withdrawal speed of 1mm/min;the glass slide was carried out,in the same speed, in the air at room temperature. The dipping process was repeated 4 times to get thin layer of ZnO films, the films were preheated at 225°C for 15 min. The thicknesses of ZnO films are calculated by two using two methods; the "weighting method" and the "optical interference fringes method", the average thickness of the prepared films were 340 nm and 200 nm for dip coating and spin coating techniques respectively.

(Zinc Oxide with Nanorods) Surface acoustic wave filters ZnO films have already been used for video and radio frequency circuits. Piezoelectric ZnO thin film has been fabricated into ultrasonic transducer arrays operating at 100MHz. Bulk and thin films of ZnO have demonstrated high sensitivity for toxic gases. Vanadium doped n-type ZnO films also demonstrate a curie temperature above room temperature.

(Zinc acetate dehydrate with Al) High electrical conductivity, optical transparency in wide range and resistance to hydrogen plasma exposure of ZnO films doped with III group elements (B, Ga, In) makes them prospective materials for application in transparent electrodes, optoeectronic devices and solarcells.Doped zinc oxide thin films are a promising alternative for indium tin oxide transparent conducting films due to high conductivity and excellent optical properties. ZnO/Al thin films can be produced by many methods such as chemical vapour deposition, radio frequency sputtering, and spray pyrolysis.

Zinc oxide is one of the most promising materials from the view point of its exceptional physical and optical properties. It is a II-VI semiconductor with a direct wide band gap of 3.37ev (λ=368 nm) at room temperature and a large exciting binding energy of 60meV.Such unique properties of ZnO make it a good candidate for short wavelength photonic devices. Success of ZnO as a semiconductor also depends on the possibilities of band gap engineering. ZnO has ability to make alloys with ZnO and MgO. In particular alloys made from MgO and ZnO give wide band gap semiconducting material with a high tunable band gap which can be easily controlled over a wide range making by making alloy thin films investigated due to UV luminescence ranging from 150-400 nm or alternatively wide band gaps from 3.3ev to 7.8 ev.

In recent years, considerable attention has been given to wide gap materials with optical transparency and metallic conductivity in the development of transparent electrodes in liquid crystal displays and solar cells. Recently; they have received greater attention because of their various technological applications such as solar cells, optoelectronics, heat mirrors, gas sensors, wear resistant applications and thin film resistors. Aluminum doped ZnO thin films received extension due to their excellent optical and electrical properties.Al doped ZnO coatings exhibit high transparency and low resistivity which is suitable for device applications. The preparation techniques for Al doped ZnO thin film are many such as chemical vapor deposition, pulsed laser deposition, radio frequency magnetron sputtering, electrochemical bath deposition, chemical spray process and sol gel spin coating method. However, all these techniques require sophisticated instruments and/or a high temperature of deposition. Among the thin film deposition methods, chemical bath deposition from aqueous solutions is the simplest and most economical one. CBD method also offers the opportunity of doping the host ions with impurities on different kinds, shapes and size on substrate. The evaluation of optical dispersions and other optical constants of semiconductors are of considerable importance for applications in integrated optic devices such as switches, filters and modulators etc., where the refractive index of a material is the key parameter for device design.

(ZnO Spin coating) The ZnO thin film is prepared using various methods such as spray pyrolysis, sputtering sol-gel spin coating, pulsed laser deposition (PLD), chemical vapor deposition (CVD0. In spite of few studies regarding to the sol gel method, the sol gel method has some merits, such as the easy control of chemical components, and fabrication of thin film at a low cost to investigate structure and optical properties of ZnO thin films.

In recent years, Zinc Oxide based thin films have attracted much attention due to their potential application in solar cells, gas sensors, optical waveguides, surface acoustic devices, piezoelectric transducers and varistors.The ultraviolet radiation from the excited ZnO thin film is detected, which makes it possible to manufacture ultraviolet laser devices. This kind of short-wave laser device will be a substitute for infrared laser memory. In addition, various light emitting devices (for example, blue light, green light and burble light) can be produced by ZnO films.

The optical properties of ZnO thin film are much influenced by not only the growth methods but also the film structure. In particular, the (002) – oriented ZnO film exhibits best optical properties. ZnO has also gained much attention due to the many advantages over other oxide thin films such as In2O3, CdSnO4 or SnO2.These advantages include non-toxicity, good electrical, optical behaviors, stability in hydrogen plasma atmosphere and low price. One of the most important characteristics of ZnO is that has large exciting binding energy (60 mev).

X-Ray Diffraction Techniques[1-5]:

Currently high efficiency thin film photovoltaic solar cells devices are being created in variety of crystallographic forms: epitaxial, polycrystalline, microcrystalline or amorphous. Critical structural and micro structural parameters of these devices are directly related to the performance of the solar cell. Taking into account the large range of materials and structures used in building the solar cells there are a large variety of x-ray diffraction and scattering techniques and geometries that can be used for characterization of solar cell device. The present contribution is providing an overview of the available x-ray scattering methods and geometries available for characterization of this type of structures: x-ray diffraction for phase ID, texture analysis, high resolution x-ray diffraction, diffuse scattering, x-ray reflectivity. The advantages and limitations of the various techniques are discussed.

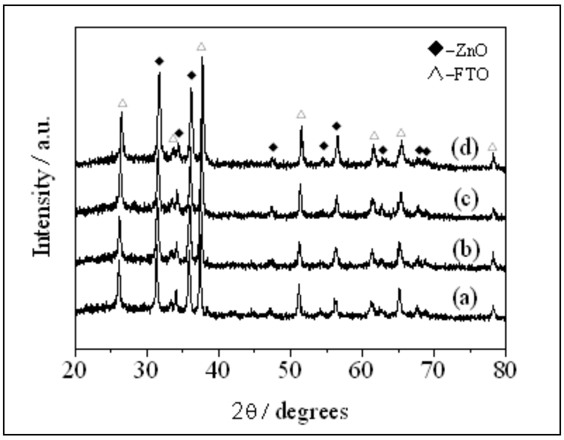

Figure b. XRD patterns of the ZnO and Zn1-xMgxO films obtained from electro deposition baths containing 0.05 mol/L Zn(NO3)2 and different Mg(NO3)2.

Thin Film SEM Techniques[1-5]:

A scanning electron microscope is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition. The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. SEM can achieve resolution better than 1 nanometer.

Specimens can be observed in high vacuum, in low vacuum, in wet conditions (in environmental SEM), and at a wide range of cryogenic or elevated temperatures.

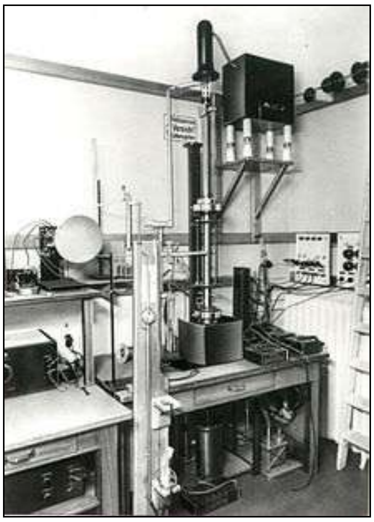

Fig (a): Scanning Electron Microscope

For conventional imaging in the SEM, specimens must be electrically conductive, at least at the surface, and electrically grounded to prevent the accumulation of electrostatic charge at the surface. Metal objects require little special preparation for SEM except for cleaning and mounting on a specimen stub. Nonconductive specimens tend to charge when scanned by the electron beam, and especially in secondary electron imaging mode, this causes scanning faults and other image artifacts. They are therefore usually coated with an ultrathin coating of electrically conducting material, deposited on the sample either by low-vacuum sputter coating or by high-vacuum evaporation. Conductive materials in current use for specimen coating include gold, graphite. Additionally, coating with heavy metals may increase signal/noise ratio for samples of low atomic number (Z). The improvement arises because secondary electron emission for high-Z materials is enhanced.

Thin Film TEM Techniques[1-5]:

Transmission electron microscopy (TEM) is a microscopy technique in which a beam of electrons transmitted through an ultra-thin specimen, interacting with the specimen as it passes through. An image is formed from the interaction of the electrons transmitted through the specimen; the image is magnified and focused onto an imaging device, such as a fluorescent screen, on a layer of photographic film, or to be detected by a sensor such as a CCD camera.

TEMs are capable of imaging at a significantly higher resolution than light microscopes, owing to the small de Broglie wavelength of electrons. This enables the instrument's user to examine fine detail—even as small as a single column of atoms, which is thousands of times smaller than the smallest resolvable object in a light microscope. TEM forms a major analysis method in a range of scientific fields, in both physical and biological sciences. TEMs find application in cancer research, virology, materials science as well as pollution, nanotechnology, and semiconductor research.

At smaller magnifications TEM image contrast is due to absorption of electrons in the material, due to the thickness and composition of the material. At higher magnifications complex wave interactions modulate the intensity of the image, requiring expert analysis of observed images. Alternate modes of use allow for the TEM to observe modulations in chemical identity, crystal orientation, electronic structure and sample induced electron phase shift as well as the regular absorption based imaging.

Theoretically, the maximum resolution, d, that one can obtain with a light microscope has been limited by the wavelength of the photons that are being used to probe the sample, λ and the numerical aperture of the system, NA.

$$d = \frac{\lambda}{2n\sin\alpha} \approx \frac{\lambda}{2\,\mathrm{NA}}$$

Early twentieth century scientists theorized ways of getting around the limitations of the relatively large wavelength of visible light (wavelengths of 400–700 nanometers) by using electrons. Like all matter, electrons have both wave and particle properties (as theorized by Louis-Victor de Broglie), and their wave-like properties mean that a beam of electrons can be made to behave like a beam of electromagnetic radiation. The wavelength of electrons is related to their kinetic energy via the de Broglie equation. An additional correction must be made to account for relativistic effects, as in a TEM an electron's velocity approach the speed of light.

$$\lambda_e \approx \frac{h}{\sqrt{2m_0E\left(1+\frac{E}{2m_0c^2}\right)}}$$

Where, h is Planck's constant, m_0 is the rest mass of an electron and E is the energy of the accelerated electron. Electrons are usually generated in an electron microscope by a process known as thermionic emission from a filament, usually tungsten, in the same manner as a light bulb, or alternatively by field electron emission. The electrons are then accelerated by an electric potential and focused by electrostatic and electromagnetic lenses onto the sample. The transmitted beam contains information about electron density, phase and periodicity; this beam is used to form an image.

Conclusion:

In conclusion, we reviewed recent progress in the growth of ZnO based materials and fabrication of ZnO-based devices. We covered difficulties of doping ZnO p-type, which is known as a major obstacle for the fabrication of low turn-on-voltage light emitting and laser diodes and p-n junction photo detectors. We presented and discussed novel and extremely promising approach to achieve highly p-type doped layers via anion substitution, replacing oxygen with other group-VI elements (S, Se, and Te).We also suggested that anion substituted alloys are of particular interest for the use in the photovoltaic devices, such as highly efficient thin film solar cells.

References:

1. U. Ozgur, Y.I. Alivov, C. Liu, A. Teke, M.A. Reshchikov, S. Dogan, V. Avrutin, S.J. Cho, H.Morkoc, A comprehensive review of ZnO materials and devices, J. Appl. Phys. 98 (2005) (041301-041301-103).
2. D.C. Look, Recent advances in ZnO materials and devices, Mater. Sci. Eng. B Adv. Funct. Solid-State Mater. 80 (2001) 383.
3. R. Yousefi, A.K. Zak, F. Jamali-Sheini, The effect of group-I elements on the structural and optical properties of ZnO nanoparticles, Ceram. Int. 39 (2013) 1371.
4. C.X. Guo, Y. Dong, H.B. Yang, C.M. Li, Graphene quantum dots as a green sensitizer to functionalize ZnO nanowire arrays on F-doped SnO2 glass for enhanced photoelectrochemical water splitting, Adv. Energy Mater. 3 (2013) 997.
5. E. Fortunato, P. Barquinha, A. Pimentel, A. Goncalves, A. Marques, L. Pereira, R.Martins, Recent advances in ZnO transparent thin film transistors, Thin Solid Films 487 (2005) 205.

*****