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RESEARCH ARTICLE

PREPARATION AND CHARACTERIZATION OF ZNO THIN FILMS BY SOL-GEL METHOD ON GLASS SUBSTRATES

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ABSTRACT

In this work, nanocrystalline ZnO thin films have been created by sol-gel method. The films deposited onto a glass substrate at 50ºC, formed from zinc nitrate, distilled water (pH ≈ 7.0, Conductivity ≈ 36.00µ S/m), Methanol, Ethanol Alcohol, and polyvinyl Alcohol, magnetic stirrer with hot plate. The crystallographic structures of ZnO films and powder were examined utilizing X ray diffraction (XRD). The Scherrer formula was used to calculate the grain size of the films. And Scanning Electron Microscopy (SEM) was utilized to describe structure and morphologies of the saved specimens. The outcome demonstrates that the great film was set up at plunge covering method, the UV-visible spectrum of the sample was obtained using a SL 210 UV-VIS Spectrophotometer-1800, in the wavelength range from 300 to 700 nm. All the tests confirmed the presence of thin film.

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INTRODUCTION

Zinc oxide (ZnO) is an emerging material for a large number of areas(Znaidi *et al*., 2012) .ZnO is inexpensive(Bayram *et al*., 2013), and is one of the most common materials for many applications due to its significant physical and chemical properties (Musat *et al*., 2004). On substrates of glass, using the Sol-gel method, deposition of thin films of ZnO was examined at different rates (Aoun *et al*., 2015; Poornima *et al*., 2016; Bousmaha *et al*., 2016; Klingshirn, 2007; Kaneva, 2011; Ibrahim *et al*., 2013; Kolekar *et al*., 2011).The thin film is usedas in a gas sensor, in electronic displays, in the fabrication of blue light emitting diodes (LEDs), in surface acoustic wave (SAW) devices, and more (Levinboim, 2010; Soosen Samuel, 2009; Peng *et al*., 2006) .It conductive films, solar cell windows, photoelectric cells, nonlinear optics, bulk and surface acoustic wave devices (Wang, 2004; Kulkarn, 2015; Gupta *et al*., 2010), cosmetics(Kulkarn, 2015). Unlike many of its competitors, ZnO is inexpensive, relatively abundant, chemically stable, easy to prepare, non toxic and most of the doping materials that are used with it are also readily available(Yang *et al*., 1998; Tomar *et al*., 2005; Mitsuyu *et al*., 1982).

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Moreover Zinc Oxide is a friend of the environment and easy to synthesize (Wu *et al*., 2007). ZnO films are deposited by using many methods of deposition. These include various sputtering techniques (Sundaram *et al*., 1997), chemical vapor deposition (CVD) (Li *et al*., 2002), molecular beam epitaxy (MBE) (Look *et al*., 2002), pulsed laser deposition (PLD) (Muth *et al*., 1999), sol-gel (Khadher *et al*., 2016), filtered vacuum arc (FVA) (Boxman *et al*., 2003), etc.. Only relatively few reports on the properties of ZnO films deposited with FVA are found in the literature (David *et al*., 2004). In the present investigation the sol-gel method for synthesis of ZnO Thin Filmhas been chosen as it is the simplest method, consumes less power and can be carried out in robust atmosphere. The structural properties of the prepared ZnO nanoparticles were studied by using X Ray Diffraction(XRD) and the morphology of ZnO nanoparticles was examined under Scanning Electron Microscope (SEM). The transparency and absorption of synthesized ZnO nanoparticles were studied using a UV visible spectrophotometer.

Experimental: At the beginning, a solution of zinc nitrate was prepared by dissolving (2.974g) in pure distilled water (pH ≈7.0, Conductivity ≈36.00µ S/m) the volume is diluted to 100mland 1gm of Polyvinyl Alcohol is dissolved in 100ml distilled water .The two solutionsso prepared were mixed in equal volume. It was stirred on a hot plate using a magnetic stirrer for at least 3 hours at room temperature is 29°C and under normal atmospheric pressure.

The temperature is raised to 50°C and stirring was continued for fur than 5 hours. It was cooled and a few drops of ethanol were added after that, a glass substrate with dimension (24x40 mm)was dipped in the solution, and allow to stand for 60 minutes. It was taken out of the solution, hanged in the air, till it gets completely dried. The glass plates, so prepared then heated for 10 min in an microwave oven, which was modified for chemical reach on (65watt) the microwave power was 200°C and at frequency 7 (Hz). The plates were, then characterized bySEM, XRD, etc

≈ 100 Oval shapeml distilled water pH

The Whole experiment can be summarized as:

It was obtained thin film,before using for characterization, the morphology of the ZnO thin film was examined using SEM machine. The structure and size of the ZnO thin film were studied using X-Ray Diffractometer radiations having wavelength 1.504A.U. The UV-visible spectrum of the sample was obtained using a SL 210 UV VIS Spectrophotometer-1800, in the wavelength range from 300 to 700 nm.

RESULTS AND DISCUSSION

Sample Properties analysis

Structural Analysis: The crystal structure and orientation of the ZnO thin films were investigated by X-ray diffractometer. Fig 1 shows XRD patterns of ZnO. The peaks at 2θ = 31.80°, 34.40°, 36.20°, 47.50°, 56.60°, 62.90°, 66.28°, 68°, were assigned to (100), (002), (101), (102), (110), (103), (112), (201), of ZnO, indicating that the samples were polycrystalline wurtzite structure (Zincite, JCPDS 5-0664). No characteristic peaks of any impurities were detected, suggesting that high-quality ZnO were synthesized. The angles that I found were identical to angles which were mentioned in reference (28,29), in which the number (JCPDS 5- 0664) and (JCPDS 36-1451) was mentioned as a reference for angles with (hkl). The XRD peak, obtained for the present investigator is identical as reputed Carlier (30) for (100), (002), (101) peak the ZnO film obtained by Sol-gel method from zinc acetate, isopropanol and diethanolamine shows enhanced the intensity of the peak, corresponding to (101), indicating preferential orientation along c-axis and wurtzite structure (Nagarani *et al*., 2013). The poly crystalline nature Na-doped ZnO is also reported wurtzite structure, indicating no effect of Na- doping on the microsfnction of thin film (Lü, Jianguo, 2010).

In few cares, ZnO thin film gives zincite structure with (002) as enhanced intensity (Ilican *et al*., 2008; Musat, 2004). In order to attain the detailed structure information, grain size along z-axis it was Average the grain size 14.7nm. Was calculated by the Scherrer formula.

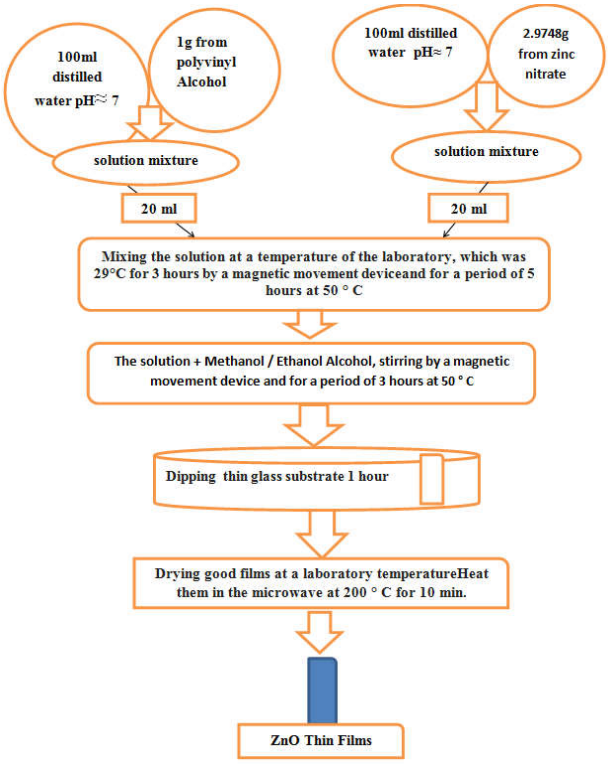
$$D = \frac{0.9\lambda}{\beta \cos\theta} \quad (1)$$

Where λ - wavelength of x-ray (0.154 x 10^{-9}m).

θ - Bragg angle of peaks.

β - Full width at half maximum(FWHM) value.

Morphological Analysis: The surface topography of thin film is a very important tool to investigate the microstructure of the films.



Scheme 1. Showing the process steps for the synthesis of a thin film of zinc oxide

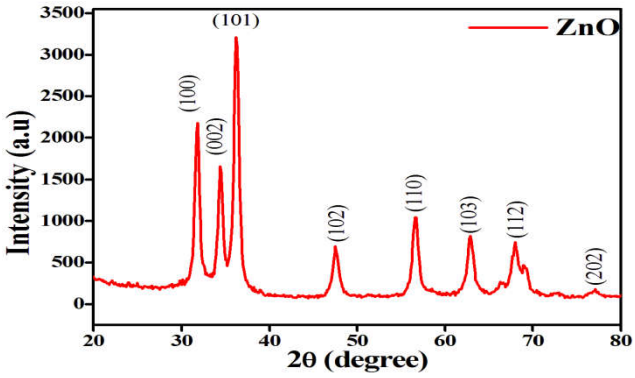


Figure 1. The XRD pattern of the obtained ZnO thin film grown on glass substrate

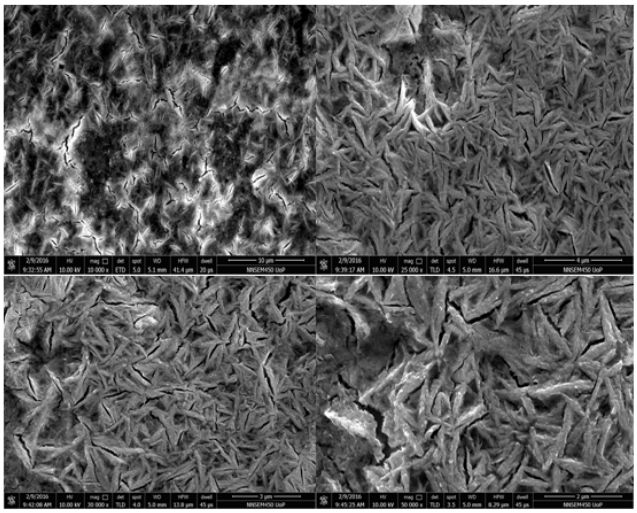


Figure 2. SEM images of ZnO thin layer in the form of nano-sheets deposited on a glass substrate

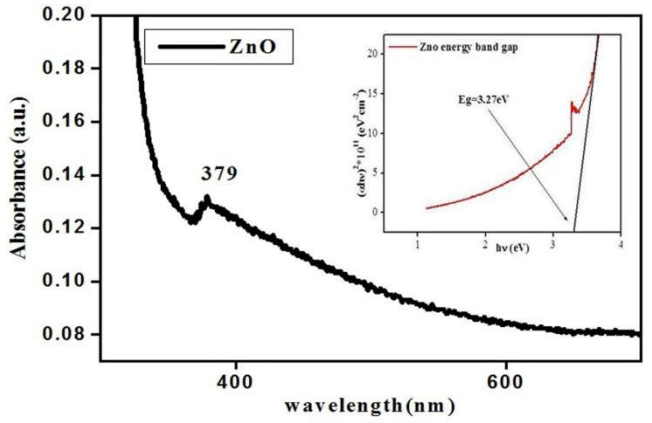


Figure. 3. Optical absorption spectra of ZnO thin films and energy band gap annealed at 200°C

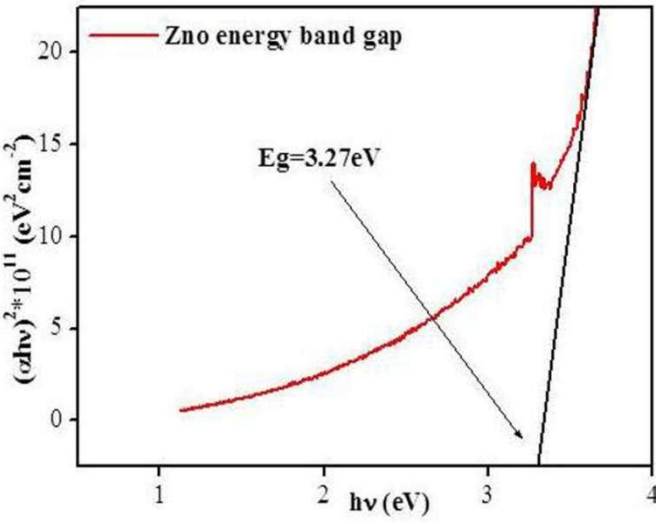


Figure. 4. $(\alpha h\nu)^2$ vs. hν curves of the ZnO thin films annealed at 200°C

Scanning Electron Microscopy (SEM) was used to get micrograph of ZnO thin film as shown figure 2. Shows the surface morphology of ZnO thin films in the form of nano-sheets(Kulkarn, 2015) deposited at 50°C temperature. The SEM image shows a uniform compact surface. The ZnO thin films are crystalline and the average crystallite size of the films is about 14.7nm, the ZnO thin film obtained by Sol-gel, using zinc acetate and monoethanol amine in the solvent 2-methoxyethanol on porous silicon Gines amorphous ZnO thin film (Kim, 2011).

Optical Study: The optical properties of synthesized zinc oxide nanostructures were examined via Spectrum of UV by indenting visible light on the sample as shown in Figure 3. UV-vis spectroscopy is the measurement of the absorption of near and visible, ultraviolet light by using semiconductor zinc oxide nanostructures. The sample absorbs radiation in the ultraviolet region of 300 nm to 700 nm. It ranges up to 379.0nm and move almost all the visible radiation spectrum of zinc oxide molecules. The band gap of the ZnO thin film was calculated by the relationship of the curve bind between (h ν) and $(\alpha\ h\nu)^2$. The band gap energy obtained by extrapolation curve was found to be approximately 3.27eV. As shown in Figure 4which was correspond and strange to the value obtained by research in (Akhtar, 2012; Sundaram *et al*., 1997; Foo, 2014; Ibrahim, 2013; Kolekar, 2011).

Conclusion

In this review, we have developed nanocrystalline ZnO thin films on glass substrate by a Sol-gel strategy utilizing turn covering. It has been utilized X-ray diffraction study to check the creation of zinc oxide thin films. The XRD spectra demonstrated that the films are of polycrystalline structure. Grain size along z axis was calculated by the Scherrer formula, the grain size of the crystallites was found to be in the Average of 14.7nm, the picture of a thin film of zinc SEM was utilized for investigating the morphology of the surface. Oxide obtained was in the form of transparent nano-sheets. The high absorption pinnacle was observed to be at 379 nm, and the band gap energy obtained by extrapolation curve was found to be approximately 3.27eV.

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