Electronics

UGC Journal Details

Name of the Journal :	International Journal of Chemical and Physical Sciences
ISSN Number :	23196602
e-ISSN Number :	23196602
Source:	UNIV
Subject:	Biochemistry;Chemical Engineering(all);Chemical Health and Safety;Chemistry(all)
Publisher:	IJCPS
Country of Publication:	Netherlands
Broad Subject Category:	Science;Social Science

Print

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Study of Optical and Electrical Properties of Post Annealed Lithium Doped ZnO Nano Film

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ABSTRACT

Li doped ZnO nanostructure films were grown by the sol-gel spin coating method on a glass substrate. Spin coating technique is employed to prepare thin films with optimization of deposition parameters. The effect of post annealing treatment on optical and electrical properties was investigated for 10 atomic percentage of Lithium. The deposited films were characterized by X-ray diffractometer, UV-Visible spectrophotometer, photoluminescence and Field Emission Scanning Electron Microscope (FESEM). Deposited nanostructured nanofilms shows more than 87% average transparency in the visible region (400-700nm). Increase in annealing temperature exhibits gradually increase in average transmission. The X ray diffraction spectrum reveals that synthesized sample have hexagonal wurtzite structure. Crystalline sizeis calculated from Debye Scherrer formulae and it is measured to be 33.24nm.Field emission scanning electron microscopy exhibits uniform granular structure of the deposited samples which is shown in fig.

Keywords: Nano-Film, XRD, FESEM, Sol-Gel

INTRODUCTION

Zinc oxide is a special material because it has low electrical resistance with high optical transparency in the visible rang. Zinc oxide with a wide bandgap of 3.37ev and high exciton banding energy (60 mev) at room temperature is important properties in the optoelectronic applications. It is having unique structural and photoluminescence properties [1]. Indium tin oxide (ITO) is most investigated region by the researchers,but due to the cost of fabrication and its toxic nature is hazardous to human and environment; there is necessity to attempt new combination of TCO. The electronic and optical properties of zinc oxide nanomaterial are attractive for optoelectronic application such as electronic material in light emitting diode,solarcells,flat panel display and transparent filed effect transistor [2,3]. It is possible to evaluate optical constants by analyzing transmittance spectrum [4]. ZnO is semiconductor material having n-type electrical conductivity,due to intrinsic defects such as oxygen vacancies and zinc interstitials. Doping of different elements from group I (Li,Na&K) for Zn site and group V elements(Sb,Bi) for oxygen sites forms P-type ZnO. Although Lithium acts as an accepter impurity inZnO matrix its accepter behavior depends on the position of lithiuminZnO matrix [5].Li has the smallest ionic radius (0.76Å) of group I elements, which is very close to that of Zn (0.74 A°) and this is most important factor to obtain high optical quality ZnO [6]. Group I elements are better dopants materials than group V elements in terms of the shallow acceptor levels [7].Comparative study of the effects of group I elements on the structural and optical properties of the ZnO nanoparticle is reported [8].ZnO thin films have been deposited using different techniques, such as spray pyrolysis, molecular beam epitaxy (MBE),pulsed laser deposition (PLD) and sol-gel [9-13]. In the present investigation, sol-gel technique is used to prepare thin films of ZnO because the technique is simple and low cost. Moreover, the deposition rate, thickness of the films can be easily controlled over a wide range by changing deposition parameters.Sol-gel technique

high intensity peak corresponding to angel 34.08 ° is of deposited nanostructure. No peak was observed due to doping of lithium. With the help of Debye Scherrer's equation the average crystalline size was determined.

$D=0.9\lambda/\beta\cos\theta$

Where D is the average crystalline size, λ is the wavelength of X-ray diffraction, β is the full width at half maximum of the diffracted peak and θ is the angel of diffraction.

The crystalline size of Li doped ZnO nano particles was estimated to be 33.24 nm. High resolution X ray (002) diffraction peak is obtained in Li doped ZnO thin films [14].

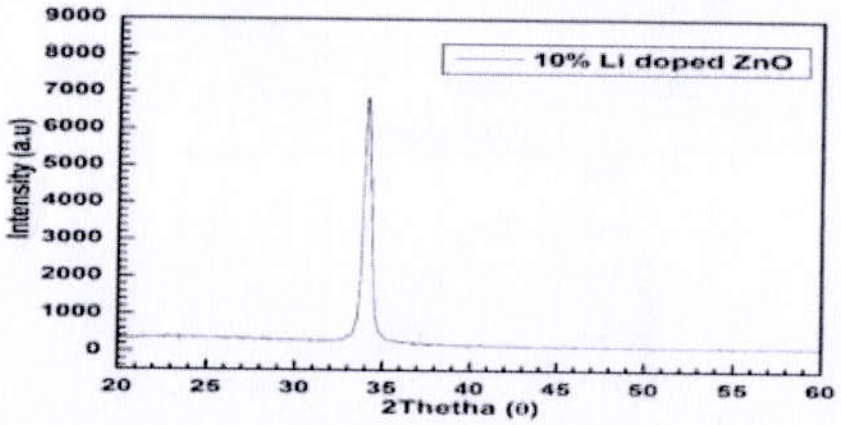

Fig.1 XRD pattern of Li doped ZnO

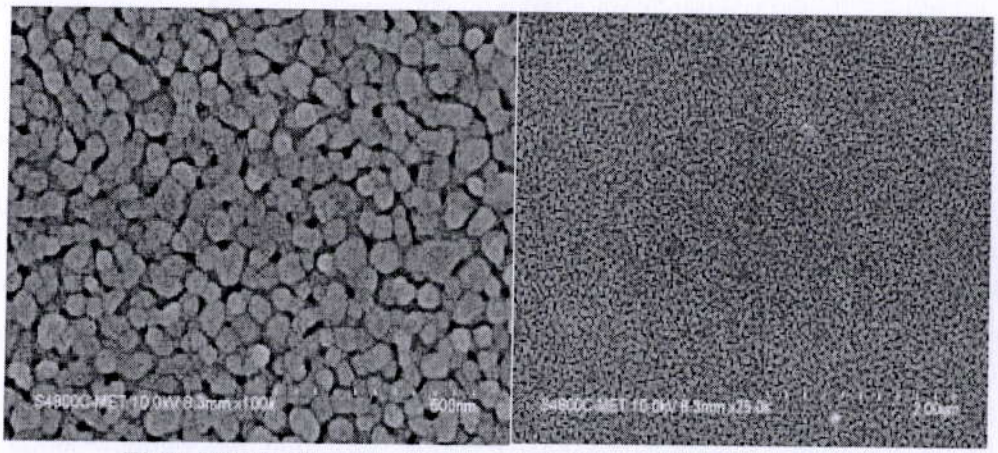

Fig2: FESEM images of Li doped ZnO nano film

Fig 2 shows the FESEM micrograph of Li doped ZnO thin films at different spot and magnification. Field emission scanning electron microscopy exhibits uniform granular structure of the deposited samples. The image was revealed that the product has high density with under 100nm.

Optical transmission spectra of prepared samples were obtained by UV visible spectroscopy. Fig. 3 shows the transmission spectrum of the lithium doped ZnO thin films annealed at 250 €,300 €,350 € and 400 € the transmission spectra exhibits more than 87% average transparency in the 350 to 750 nm range. Increased in the post annealing temperature shows increase in the max average transmission max average transmission at was to and at 400 €.

IV characteristic: Electrical characterization of prepared samples were shown in the fig. 4 As ZnO thin films are conducting material, IV characteristic was obtained linear. It exhibits the increase in conduction properties with increase in post annealing temperature. Sample post annealed at 400 ° c shows high current carrying capacity.

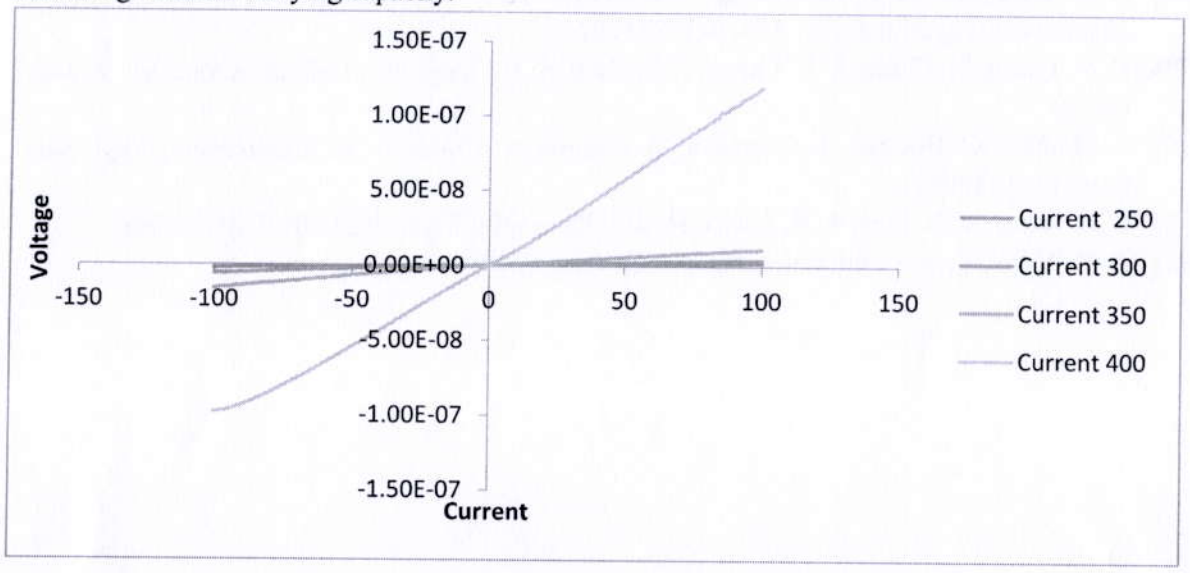

Fig. 5: IV of Li doped thin films

CONCLUSION

In the present study, Li doped ZnO nano films were successfully deposited on the glass substrates. Effect of an annealing temperature on optical and electrical properties was investigated for 10 at% of lithium. XRD spectrum reveals that the synthesized films were grown along C-axis with hexagonal wurtzite structure. The doping of lithium in ZnO did not cause any effect on the crystalline structure of ZnO. FESEM images showed the uniform granular nanostructure. Average transmittances of all deposited films were found to be more than 87% in visible range (350 -700nm). A Photoluminescence (PL) spectrum shows one emission peak at 397 nm. Thus the optical and electrical properties are studied for different post annealed Li doped ZnO nano films.

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