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# Conductivity Enhancement from $Li_{0.05}Zn_{0.95}O$ Nanostructures

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## ABSTRACT

Conductivity enhancement has been observed from ternary alloy compound of Li0.05Zn0.95O nanostructures. The influence of Lithium doping on electrical properties of sol-gel derived zinc oxide nanostructures was studied. Li0.05Zn0.95O Nanostructures were characterized. The XRD measurement exhibits single phase wurtzite structure along the (002) plane. The average particle size of pure ZnO and Li0.05Zn0.95O was found to be 36 nm and 30 nm respectively. Incorporation of Lithium, influenced the particle size. FESEM reveals the uniform rope type structure. The current-voltage characteristics obtained from semiconductor characterization system reveals that resistance of the nanostructures was found to be decreased with doping of Lithium. These results explore the applicability of Li0.05Zn0.95O nanostructures as a conducting oxide in electronic devices.

**Keywords:** Nanostructures; Li0.05Zn0.95O; sol-gel; XRD measurement.

## I. INTRODUCTION

ZnO nanostructures have attracted much interest of researchers due to its useful structural and electrical properties. ZnO as a wide band gap material found to be promising candidate in many electronics applications such as thin film transistors [1], photo detectors [2] and light emitting devices [3]. These ZnO nanostructures can be fabricated by various kinds of fabrication methods, such as chemical bath deposition [4], spray pyrolysis [5], pulsed laser deposition [6], sol-gel process [7]etc. While the sol-gels based deposition of nanostructures offers reduction in the cost of fabrication and excellent compositional control [8].

In the present study, sol-gel deposition process is used for fabrication of nanostructures According to recent literature, by using sol-gel spin coating method Li doped ZnO nano structures were deposited on different types of substrate such as glass[9] and silicon[10]. The change in property of ZnO had been observed with doping. Present study reveals that the doping of Li changes grain size and conductivity.

## II. EXPERIMENTAL

ZnO and $Li_{0.05}Zn_{0.95}O$ nano structures were deposited using sol-gel spin coating method. Zinc acetate dihydrate, methoxy ethanol, Lithium acetate, were used as a starting precursor. Solution was prepared for

0.4 moles of 5 at% Lithium. The solution was stirred on hot magnetic plate 50 minutes. After cooling of solution, it was used for spin coating deposition. With constant speed of rotation films were coated. The films were coated repeatedly get desired thickness. Pre and post heating treatment are given to samples after each coating and cooled down at room temperature. Samples were characterized for structural and electrical properties.

## III. RESULTS AND DISCUSSION:

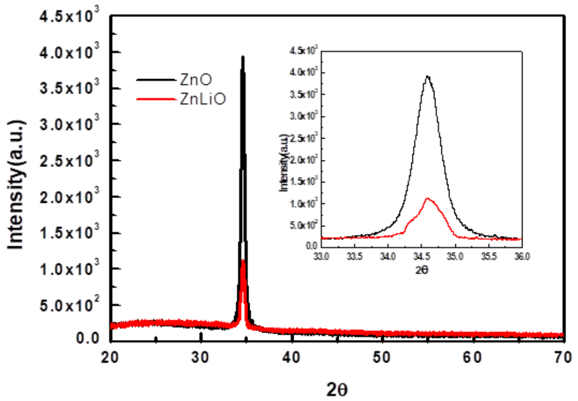


**Fig. 1 XRD pattern of ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures. (Inset: Intensity of peak)**

To investigate the crystal structure of deposited ZnO and $Li_{0.05}Zn_{0.95}O$ nano structures were characterized using X-ray diffractometer. Fig. 1 shows the XRD plot of ZnO and$Li_{0.05}Zn_{0.95}O$ nanostructures. Analysis clearly indicates single dominant peak corresponding to (002) plane at the 2Θ value of 34.58°. The doping of Lithium does not deteriorate the crystal structure. The average crystalline size of ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures has been estimated from Debye Scherrer equation[11].

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

Where, D is the average crystalline size of the film. λ is the wave length of X-ray source(1.54059 Å), θ is the Bragg diffraction angle and β is the full width at half maximum intensity (FWHM)in radians. Average crystalline size estimated from XRD pattern and found to be 36.30 nm and 30.26 nm for ZnO and $Li_{0.05}Zn_{0.95}O$ nano structures respectively. Crystalline size decreased by Li doping. The diffraction angle of peak (002) is 34.58° and 34.59° for ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures respectively. Inset of fig. 1 shows the decrease in intensity with Li doping. The structural parameters of ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures were summarized in the table 1.

| | Compound | 2 θ () | FWHM (°) | Max. Intensity | Grain size D(nm) |
|---|---|---|---|---|---|
| Deposited samples | ZnO | 34.58 | 0.23 | 3946.31 | 36.30 |
| | Li0.05Zn 0.95O | 34.59 | 0.275 | 1150.46 | 30.26 |

**Table 1: Structural parameters of ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures**

Fig. 2 presents the FESEM images of ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures. Images of the films were taken at the scale of 10μm with magnification of 5,000 for ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures. Uniform rope type structure is retained for both the films with change in crystal size. The $Li_{0.05}Zn_{0.95}O$ nanostructures show denser morphology without visible voids and defects overall the surface.

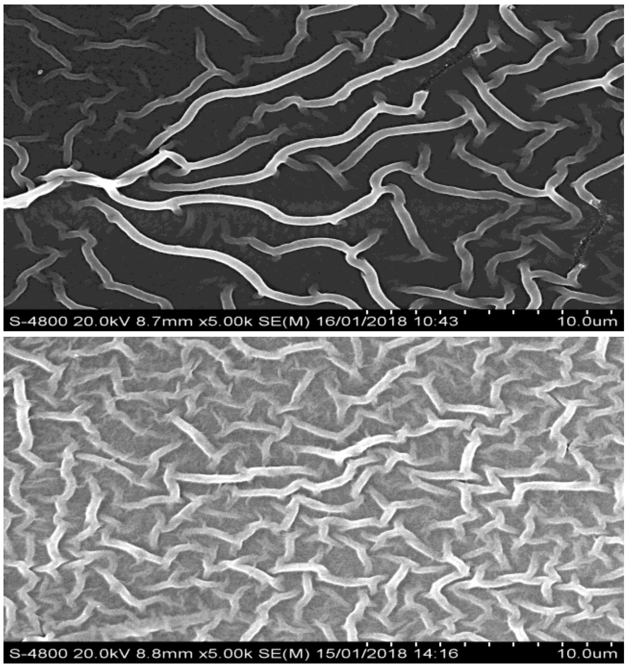


**Fig.2 FESEM images of ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures.**

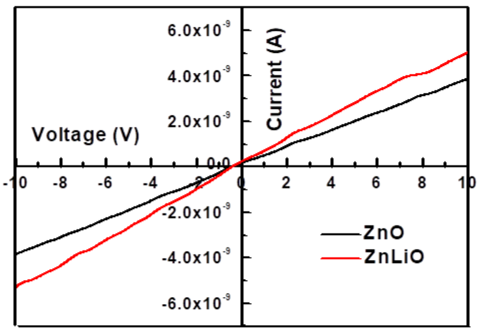


**Fig. 4 I-V characteristics of ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures.**

The electrical behavior of ZnO and $Li_{0.05}Zn_{0.95}O$ nanostructures was investigated by (I-V) Keithley instrument, which is realized in fig. 4. The characteristics were investigated for voltage between -10 V and 10 V. It was found to exhibit ohmic nature. The linear, ohmic nature showed the good quality of deposited $Li_{0.05}Zn_{0.95}O$ nanostructures. The doping of Lithium was an important factor to influence the current density with respect to bias voltage. The decrease in average resistance is observed with $Li_{0.05}Zn_{0.95}O$ nanostructures. The results revealed that conductivity of $Li_{0.05}Zn_{0.95}O$ nanostructures is higher than ZnO nanostructures due to decreasing grain size and increasing number of grain boundaries.

## IV. CONCLUSION

In summary, the ZnO and Li0.05Zn0.95O nanostructures were synthesized by simple and inexpensive sol-gel spin coating technique on glass substrate. The XRD spectra reveals the crystalline quality ofLi0.05Zn0.95O nanostructures without any degradation of the wurtzite structure of the zinc oxide. The size of grains was found to decrease with Li incorporation in the ZnO nanostructures. The incorporation of Li in ZnO and decrease in size was confirmed through FESEM, which reflects uniform rope type structure. I-V characteristics analysis reveals increase in currant with doping of Lithium in ZnO nanostructures. The analysis and investigation lead successful incorporation of Li dopant in ZnO for conducting oxide in electronic devices.

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