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Study of Transition Metal Ddoped ZnO Nanostructures

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Abstract:- The grain size value of Ni doped ZnO thin films increases with the Ni concentration and it deteriorates the ZnO crystalline quality. The bandgap values of Ni doped ZnO thin films were found to decreases with increase in Ni concentration. The low reflectance and high value of index possessed by ZnO and Ni doped ZnO films are suitable for antireflection coatings. The Optical bandgap values obtained by single oscillator model for ZnO film exactly matches with the Tauc's plot values. The resistivity values of Ni doped ZnO films decreses with increase in Ni doping concentration.

Keywords:- *ZnO Nano Structures; Doping; XRD; Refractive Index; Resistivity.*

I. INTRODUCTION

Nanocrystalline ZnO is of distinct interest, because of the options for the alteration of various ZnO based nanostructures[1]. In recent years doped ZnO thin films have been the subject of much attention because of their potential for important applications such as a hetero junction device[2], luminescent material[3], gas sensor[4], transparent conductor[5] and dilute magnetic semiconductor[6]. By doping with different metal ions using different techniques can improve the properties of ZnO, particularly the electrical behavior. The isovalent nature of both ZnO and transition metal ions(TM) have made it possible to dope ZnO with Al [7], Ga, Co, Cd[8,9,10], Mg [11] and Ni. Only very few studies has been carried out on ZnO:Ni system due to the phase segregation of ZnO and NiO. This happens due to the large driving force of Ni-O bond as compared to Zn-O bond [12].

Various methods have been used to prepare transition metal doped ZnO such as chemical vapour deposition(CVD), pulsed laser deposition(PLD) and sol gel process, The sol–gel process presents some noticeable advantages, such as; a wide possibility of varying the material properties by changing the composition of the starting solution [1,14], easy to obtain nanoscale materials in volume of gram and its low cost. In the present work, sol- gel spin coating process was used to deposit Ni-doped ZnO films on glass substrate. The variation in structural, optical and electrical properties of Ni doped ZnO film with change in Ni doping concentration has been investigated.

II. EXPERIMENTAL METHOD

Ni^{2+} doping (1,2 and 3 wt%) with ZnO was achieved by dissolving nickel acetatete tetrahydrate ($Ni(CH_3COO)_2.4H_2O$) (in wt%) in a mixture of zinc acetate dihydrate ($Zn(CH_3COO)_2.2H_2O$) and 2-methoxyethanol. The monoethanolamine(MEA) was added as a stabilizer and the solution was mixed together in a round-bottom flask by stirring at room temperature for 15 minute. The obtained clear solution was heated at 60˚C upon magnetic stirring for 60 minute and left undisturbed for 12 hours. The clear and homogenous solution obtained was used as the coating solution for film preparation. The Ni doped ZnO thin film was coated by sol-gel spin coating method at 4000rpm spin rate for 30 seconds by using a spin coater on glass substrate. The film was prepared with 7 coatings with drying at 300˚C for 15 minute after each coating. Finally the film on the glass substrate was annealed at 500˚C for 60 minute in order to obtain the Ni doped ZnO thin films. In this method three ZnO:Ni samples were prepared by varying nickel acetate tetrahydrate concentration as 1 wt%,2 wt% and 3 wt%.

III. RESULTS AND DISCUSSION

A. X-ray Diffraction Study

Figure 1 shows the XRD patterns of undoped ZnO and Ni doped ZnO thin films. From Figure 1 it can be seen that all the films are polycrystalline in nature and have a preferential c-axis orientation along the (002) direction.The intensity of the (002) peak of the 1 wt% Ni doped ZnO film is very low compared to the undoped sample and the (002) peak intensity increases with increase in Ni doping concentration as 2wt% and 3wt%.

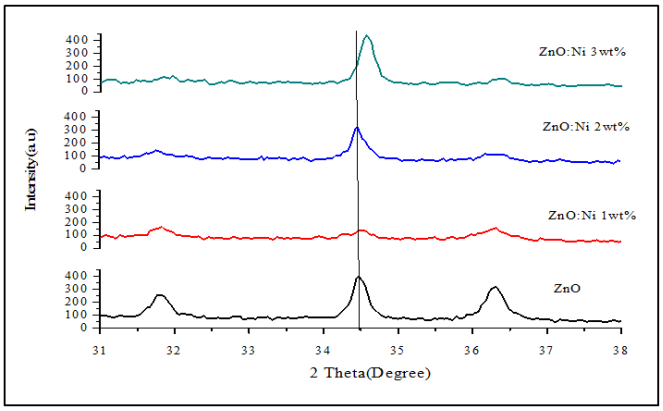

Fig 1:- XRD pattern of ZnO and Ni doped ZnO thin films