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# Synthesis and characterization of Mn doped ZnO nanobelts

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Mn doped zinc oxide nanobelts have been synthesized by chemical precipitation technique using zinc acetate, manganese acetate and absolute ethanol as starting materials. Morphological characterizations have been done using scanning electron microscope and X-ray diffraction analysis. Scanning electron microscopic observations indicate that the lengths of nanobelts are ranging from a few hundreds of micrometers to a few millimeters. X-Ray Diffraction pattern confirms the wurtzite crystal structure of the synthesized Mn doped ZnO nanobelts.

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*Keywords*: Nanobelts, Mn doped ZnO, X-ray diffraction

## 1. Introduction

Various chemical synthesis methods have been employed to synthesize the nanostructures such as solvothermal, hydrothermal, self assembly and template assisted sol-gel [1-6]. However in this paper very simple and low temperature fabrication methods for long nanobelts of ZnO are mentioned. Doping of Mn in ZnO has so many advantages and utilities. Mn doped ZnO have ferromagnetism even above room temperature [7] and at nano level, coercivity of Mn doped ZnO increases. Due to this Diluted Magnetic Semiconductors (DMS) are considered as ideal systems for spintronics. DMS are semiconductors in which magnetic ion replace cations of the host semiconductor. The replaced magnetic ion couple with extended electrons in the semiconductor band and this coupling results in various interesting properties like magneto-optical and magneto-electrical effects [8,9]. DMS are very interesting materials subjected to their promising applications to spintronics (spin + electronics). There has been much interest in magnetic semiconductors which exploit both spin and charge carrier because of combination of two degree freedom promise new functionality of memories detectors and light emitting source [9-10]. However, the luminescence intensity of the Mn doping in ZnO nanobelts quenches by several orders of magnitude [11] and hence is not employed as an efficient phosphor for light emitting applications. This paper is contributed for synthesis and characterization of long length nanobelts of Mn doped ZnO.

## 2. Experimental

### 2.1 Sample preparation

Synthesis of long length Mn doped ZnO nanobelts were carried out using chemicals zinc acetate, manganese acetate and absolute ethanol. The synthesis method was initially based on the experimental procedure as adopted by Spanhel and Anderson [12]. Alcohols are commonly used because the solvent also act as a reagent. However, the solvent does not participate in the reaction forming ZnO from zinc acetate [13]. 0.1M $Zn^{2+}$ prepared from zinc acetate in absolute ethanol was refluxed for 3 hours under magnetic stirring at 80 $^{o}$C. Next, two routs have been opted for obtaining nanobelts from precursor which are as follows:

In the first method, the precursor obtained was mixed with 0.1M LiOH prepared in 100 ml tripply deionized water. Precipitates were formed immediately and separated out using centrifugal machine at room temperature. Finally, precipitates were dried in oven at 100 $^{o}$C.

In the second method, the precursor was mixed with 0.14M LiOH prepared in 100ml tripply deionized water. Immediately precipitation starts forming, which were kept at 4 $^{o}$C for few hours and then the precipitates, were separated out using centrifugal machine at -10 $^{o}$C. Precipitates were then dried in the oven at 100 $^{o}$C.

### 2.2 Morphological characterizations

X-ray Diffraction (XRD) data for structural characterization of the various prepared samples of ZnO were collected on an X-ray diffractometer (PW1710) using Cu-Kα radiation (1.541 Å). Scanning electron microscope (SEM) images of the samples were obtained from JSM-6100 type microscope.

## 3. Results and discussion

Nanobelts of Mn (at. wt. 10%) doped ZnO nanobelts have been characterized using Scanning electron Microscope (SEM) and X-ray Diffraction (XRD) analysis. SEM images obtained from JSM microscope and XRD patterns obtained from PW1710 type diffractometer are shown in Figs. 1, 2 and 3. SEM images (Fig. 1 and 2) reveal long length nanobelts ranging to a few micrometers in length and XRD patterns (Fig. 3) reveal their high crystallinity. Wurtzite geometry of ZnO was confirmed as

lattice constants a = b = 0.32 nm, c = 0.52 nm and diffraction peaks corresponding to the planes <100>, <002> and <101> were obtained. Refluxing of precursor containing zinc acetate and ethanol for long time results in long nanobelts of ZnO. Addition of a catalyst stops isotropic agglomeration of particles instead anisotropic agglomeration occurs resulting in nanowires or nanobelts [14]. 0.1M LiOH give positively charged nanobelts (pH = 6.5) whereas 0.14M LiOH gives nearly neutral nanobelts (pH = 8.0)[12]. It is very much clear from the SEM images obtained from two methods that positively charged clusters results in deformation of nanobelts and nearly neutral charged clusters results in long length nano belts.

## 4. Conclusions

High purity nanobelts of ZnO having lengths in the range of several hundreds of micrometers to a few millimeters have been synthesized in the laboratory. SEM gives beautiful results of the synthesized doped nanobelts. Length of the nanobelts varies from a few micrometers to a few millimeters. XRD patterns confirm the wurtzite crystal structure and high crystallanity. Mn doped ZnO nanobelts have several applications and can be employed as best suited materials for spintronics, gas sensors, better insulation materials, high energy density batteries etc.

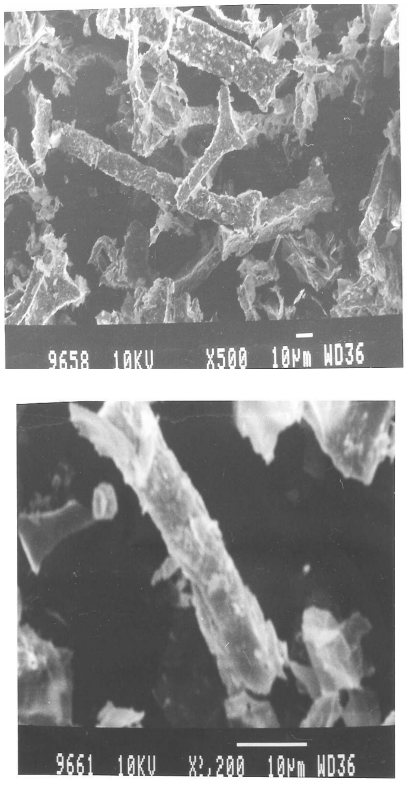


*Fig. 1. Scanning Electron Micrographs of Mn doped ZnO nanobelts synthesized by method 2.1.1.*

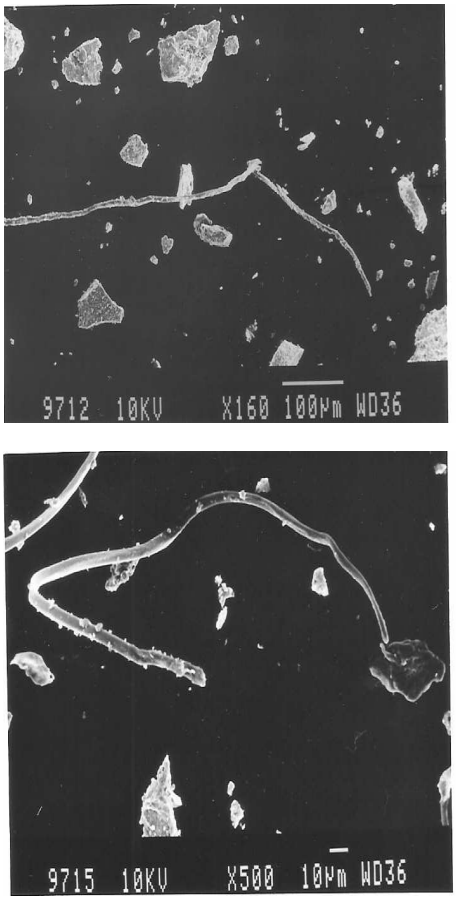


*Fig. 2. Scanning Electron Micrographs of Mn doped ZnO nanobelts synthesized by method 2.1.2.*

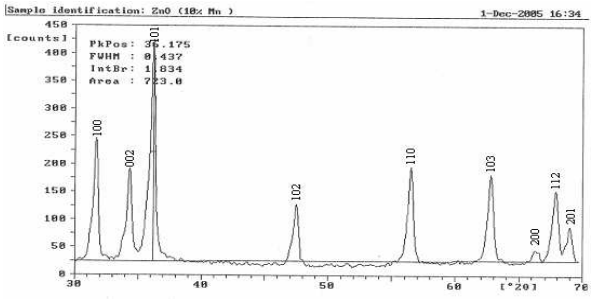


*Fig. 3. X-ray Diffraction Pattern (XRD) pattern of ZnO nanobelts.*

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