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Evaluation of Mn doped Zinc oxide dilute magnetic semiconductor

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ABSTRACT

Sol–gel method has been used to prepare dilute magnetic semiconductors (DMS) of zinc oxide nanomaterials. Mn was doped in controlled condition tracked by color changes in the powder to yellow. Evaluation of nanoparticle was performed by XRD and SEM. Change in behavior from diamagnetic to paramagnetic was found with increasing concentration of Mn dopant.

Keywords: Mn, ZnO, DMS, Doping, Paramagnetism

I INTRODUCTION

Zinc oxide is well known materials due to their optical, electronic, structural properties and have a band gap of 3.37 eV while working as a semiconductor.[1] The main focus of research lies that how to change the magnetic property of this semiconductor. The simplest way is to incorporate 3d block transition metal ions from periodic table as dopent into ZnO. Semiconductor with small amounts of such ions is also known as dilute magnetic semiconductors (DMS).[2-3]

Transition metal which are important as dopent comes from 8th block of periodic table like Co^{2+} , Mn^{2} Ni^{2+},Cu^{2+}, Fe^{2+}, Al^{3+}, Mg^{2+}, and Cd^{2+}.[4–7] Manganese has also been successfully added to many types of structures besides nanoparticles, including nanorods made.[8-9]

The doped-material had different color from the white ZnO and was yellow with Mn. We observed that the paramagnetism of the materials increased as dopant amounts increased.

II MATERIALS AND METHODS

Zinc acetate, manganese(II) acetate tetrahydrate and ethanol were obtained from commercial sources and used as received.

2.2. Synthesis of ZnO Nanoparticles

Zinc oxide nanoparticles were synthesized in a typical reaction, a round bottom

flask was charged with Zinc acetate (1.097 g,5.00 mmol), in 0.20 mL distilled water and methanol (25 mL). The solution was homogenized by sonication for 8-10 min, and subsequent heating at 70.0 ^{0}C for 24 h. The precipitate was isolated after the solution was sonicated and centrifuged at 4000 rpm for 8 min. The solid was dried overnight and were stored in water free containers to prevent interactions with water vapor in the air.

Synthesis of transition metal doped nanoparticle was performed by methanolic solution of Zn(C2H3O2)2 ·4H2O similar to pure ZnO. A solution of yellow colors was observed when the ions were added.

III RESULTS AND DISCUSSION

The ZnO was synthesized by heating methanolic solutions of zinc acetate and waterat a particular temperature which was critical; below this solids did not form. The transition metal ions affected the color of the ZnO materials. A pale yellow solid was isolated from the brown Mn2+ solution which becomes more intense when higher concentrations of transition metal ions were incorporated.

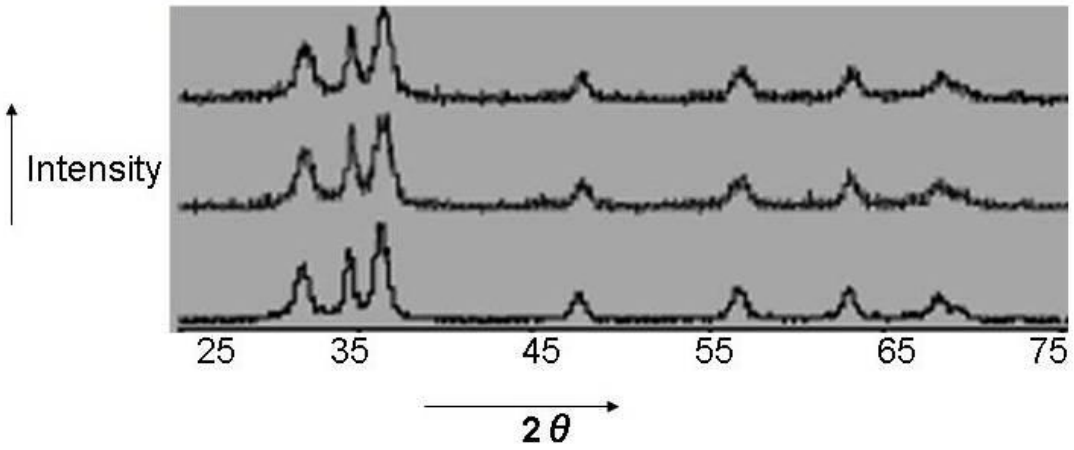

Figure 1: XRD spectra of ZnO with different doped concentration of Mn

Doped and undoped ZnO have a wurtzite structure, as shown by XRD spectra (Fig. 1). There were no peaks for crystalline Ni. The lack of other structures indicates the Mn is incorporated into the ZnO lattice by replacing zinc ions due to their similar charge and size.

The magnetic nature of the transition metal doped materials was investigated to determine if the diamagnetic behavior of ZnO was changed with the addition of transition

Mn ions. The magnetization curve of pure ZnO nanoparticles shows a negative slope which indicates diamagnetic behavior.

IV CONCLUSIONS

ZnO doped with Ni was synthesized from a methanolic solution. Doping with Mn induces paramagnetic different from crystaline ZnO.

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