Magnetic and Dielectric Studies of Li-Cu Co-doped ZnO Nanoparticles

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Abstract. Room temperature ferromagnetism has been observed in Li-Cu co-doped ZnO nanoparticles prepared by sol-gel route. Our studies indicated that the observed ferromagnetism is a surface phenomenon which depends on oxygen vacancy and the nature of the dopants. Dependence of ferromagnetism on the annealing temperature indicated the role of oxygen vacancy, and the decrease in coercivity as the particle size increases indicates the surface dependence of ferromagnetism. It is found that the addition of dopants also enhanced ferromagnetism. Dielectric studies indicated an increase in dielectric constant as the doping concentration is increased.

Keywords: Sol-gel,ZnO, Magnetism, Oxygen vacancy, Dielectric.
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INTRODUCTION

Defect induced magnetism (DIM)is the source of magnetism in systems without magnetic ions.Studies of Elfimov et al.[1] on CaO with cation vacancies was first to demonstrate that a ferromagnetic ground state is possible for a non-magnetic system. Further studies on oxide systems made the result extended to other oxides with vacancies in octahedral coordination. Since then, DIM has been observed in a variety ofmaterials. Among them, Zinc oxide (ZnO) is a widely investigated material for room temperature ferromagnetism after the prediction that it can act as the host material for the diluted magnetic semiconductors[2]. ZnO is an n-type semiconductor with a wide range of applications. The n-type characteristics are originating from its intrinsic defects like oxygen vacancy, zinc interstitial and zinc vacancy[3].

The effects of Li doping on the magnetic and ferroelctric properties have already been studied. It is found that Li doping significantly enhances the dielectric and ferroelectric properties of ZnO. Li can occupy off centered positions in ZnO lattice, which in turn lead to ferroelectricity. Li doping also results in ferromagnetism, its magnetic moments are arising from zincvacancy[4]. Li ions stabilize the zinc vacancy and supply holes to mediate ferromagnetism. It is also reported that doping with Cu can lead to ferromagnetism in the presence of oxygen vacancy[5]. There is no consensus among researchers about the origin of ferromagnetism in ZnO. Both Zinc vacancy and oxygen vacancy are equally claimed to be the reason for the observed ferromagnetism.

EXPERIMENTAL DETAILS

$Zn_{1-x}Li_{0.5x}Cu_{0.5x}O$, where x = 0.01, 0.02, 0.04 and 0.06 were synthesized by sol-gel method. The starting materials, AR grade zinc nitrate, lithium nitrate and copper nitrate are taken in stoichiometric ratio and dissolved in 0.1 M citric acid. The solution is heated at 80^{o}C to get gel. The gel is heated at 200^{o} C and grounded well for 10 minutes to get fine powder. These powders are then annealed for 4 hours at 235^{o}C, 500^{o}C and 800^{o}C respectively.

The structural studies were carried out by RigakuMiniFlex 600 powder X-ray diffractometer with Cu-Kα radiation (λ=1.5406 Å) in θ/2θ mode. Magnetic measurements of the samples were done withvibrating sample

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