

Impingement of Co Substitution on Structural, Dielectric and Magnetic Behavior of NiZn Mixed Nano Ferrites

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Abstract — A series of polycrystalline nickel zinc nano ferrites with generic formula $\text{Ni}_{0.5-x}\text{Zn}_{0.5}\text{Co}_x\text{Fe}_2\text{O}_4$ ($x = 0, 0.1, 0.2, 0.3$) have been synthesized by novel microwave assisted sol gel process using urea as fuel. Structural characterizations of the prepared samples have been performed using X-ray powder diffraction pattern, which shows formation of single spinel cubic phase. The lattice parameter, X-ray density (D_x), experimental density (D), porosity (P) and induced strain of the samples are measured from XRD data. We observed that the lattice parameter “a” increases with content of cobalt. The crystallite size is in the range 31- 98 nm, shows nanosize of prepared samples. The microstructure is studied by scanning electron microscopy (SEM). The ac electrical conductivity and dielectric parameters are measured in the range 100Hz to 0.2MHz. The dielectric constant (ϵ') and dielectric loss ($\tan \delta$) decreases, while ac conductivity enhances with the increase of frequency. The ac conductivity and dielectric properties are based on the space charge polarization according to the Maxwell- Wagner two layer model and the Koop's phenomenological theory. Magnetic parameters show variation with content of zinc.

Keywords - Nano ferrites, XRD, SEM, AC electrical conductivity, Dielectric constant, saturation magnetization, coercivity.

I. INTRODUCTION

Spinel ferrites are good dielectric materials because of their high resistivity and low loss behaviour and hence vast applications over a wide range of frequencies. Nano crystalline ferrites are technologically important materials because of their unique electric, dielectric, magnetic and optical properties, which makes them useful for many applications like radio frequency circuits, microwave devices, transformer core, rod antennas, storage devices etc. [1]. Hence it is important to study their dielectric behavior at different frequencies.

The study of DC electrical conductivity, ac electrical conductivity, dielectric constant, charge carriers concentration and charge carriers mobility give much information on the behaviour of the free and localized charge carriers. This leads to good explanation and understanding of the mechanism of electric conduction in the studied samples.

Nanoferrites are usually synthesized using various physical and chemical methods. The dielectric properties of nanometer size nickel ferrites can be changed by addition of small traces of cobalt, manganese and copper, and also by deviation from stoichiometry. Cobalt ferrite based nanomaterials are known to be the good candidates for magneto optical recording and high density storage [2], [3]. Therefore the authors aimed to study the structural and frequency dependence dielectric behaviour of Co substituted $\text{Ni}_{0.5-x}\text{Zn}_{0.5}\text{Co}_x\text{Fe}_2\text{O}_4$ ($x = 0, 0.1, 0.2, 0.3$) nano ferrites.