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ORIGINAL ARTICLE

THERMAL VARIATIONS OF MAGNETIC PROPERTIES IN NICKEL SUBSTITUTED Cu-Zn FERRITE PREPARED BY OXALATE PRECURSOR ROUTE

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Abstract:

Ni substituted Cu-Zn ferrites with chemical reaction having formula $Ni_xCu_{0.55-x}Zn_{0.45}Fe_2O_4$ (x = 0.0, 0.05, 0.10, 0.15, 0.20, 0.30, 0.40, 0.50) have been prepared by oxalate precursor route. The crystal phase of $Ni_xCu_{0.55-x}Zn_{0.45}Fe_2O_4$ was characterized by X-ray powder diffraction analysis (XRD). Thermal variation of normalized susceptibility with temperature was studied by using AC susceptibility technique. The initial permeability as a function of temperature from room temperature to 450 ^{0}C was measured at 1 KHz frequency

KEYWORDS:

Oxalate precursor synthesis, Thermal variation, Initial permeability

1.0 INTRODUCTION

Spinels of the type MFe_2O_4 attract several researchers because of their twin property of magnetic conductor and electric insulator. These materials are widely used in the electronic and electrical industries for the fabrication of devices and components such as high density magnetic core of read/ write for the high speed tapes etc. [1, 2]. In recent years there has been considerable interest in the study of the properties of nanosized ferrite particles/ ultra fine particles because of their importance in the fundamental understanding of the physical properties as well as to their proposed applications for many technological purposes [3, 4].

The magnetic properties of several mix ferrites with the spinel type crystal structure have been the subject of many investigations. The magnetic properties of spinel ferrite strongly depend on the distribution of cation over the tetrahedral and octahedral sites. Cations in spinel ferrite can occupy either an interstitial site of tetrahedral symmetry or octahedral symmetry with a closed packed oxygen lattice.

Ferrites have many applications in high frequency devices and they play a useful role in technological and magnetic applications due to their high electrical resistivity, low eddy current and dielectric losses over a wide range of frequencies. They are widely used in transformer core, inductor data storage and microwave devices. The basic electrical and magnetic properties can be tailor made by careful

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control of composition and microstructure, by method of preparation [5, 6].

This paper reports on an oxalate precursor synthesis of spinel Ni-Cu-Zn ferrite with significantly improved magnetic properties. The thermal variation of magnetic susceptibility and initial permeability with composition was investigated.

EXPERIMENTAL PROCEDURE:

Ferrite powders of $Ni_xCu_{0.55-x}Zn_{0.45}Fe_2O_4$ spinels were synthesized by oxalate precursor technique. All of the chemicals were analytical grade with purity ≥99% and were used without any further purification [7, 8]. The prepared materials were characterized by X-ray diffraction technique at room temperature by using Cu-K radiations in the 2 range from 20-80. The magnetic measurements were carried out by AC susceptibility technique. The initial permeability measurements were carried on toroid-shaped disc.

RESULTS AND DISCUSSION:

Figure 1 shows the X-ray diffraction pattern for typical sample $Cu_{0.55}Zn_{0.45}Fe_2O_4$ synthesized by oxalate precursor method. It can be seen from the figures that samples possess mono-phase in nature. No impurity peak was observed.

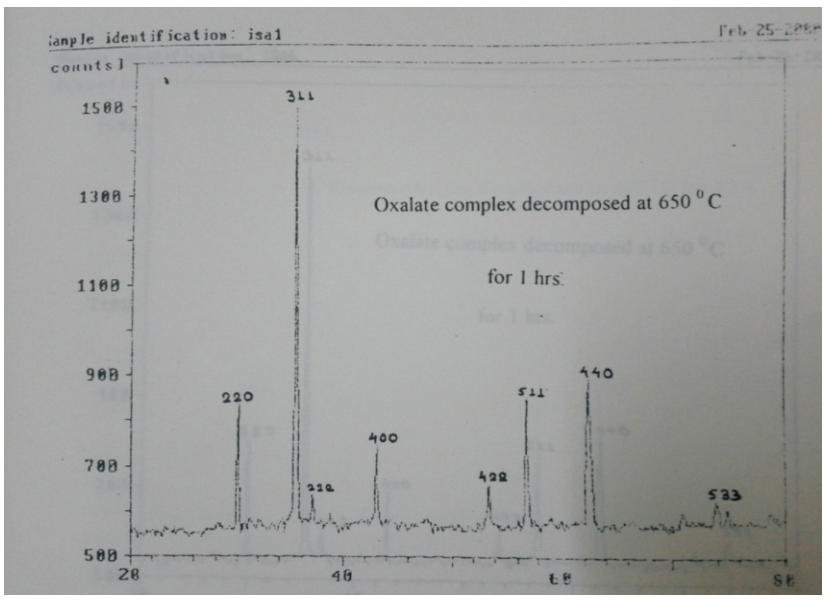

Figure 1: X-ray diffraction pattern for typical sample $Cu_{0.55}Zn_{0.45}Fe_2O_4$

Thermal variation of normalized susceptibility for the compositions of $NixCu_{0.55-x}Zn_{0.45}Fe_2O_4$ (with x = 0.0, 0.05, 0.10, 0.15, 0.20, 0.30, 0.40, 0.50) is shown in Fig. 2. From Fig. 2 it is observed that ac-T variation is independent of temperature. According to theory of ac it can be concluded that all the compositions contains multi-domain (MD) grains in predominance. The initial susceptibility (ac) does not very with the rise of temperature earlier to Curie temperature Tc near the Curie temperature the susceptibility drops to zero sharply without exhibilting double Tc behavior for any of the compositions. This suggests that all the compositions are single phase as evidenced by the XRD analysis.

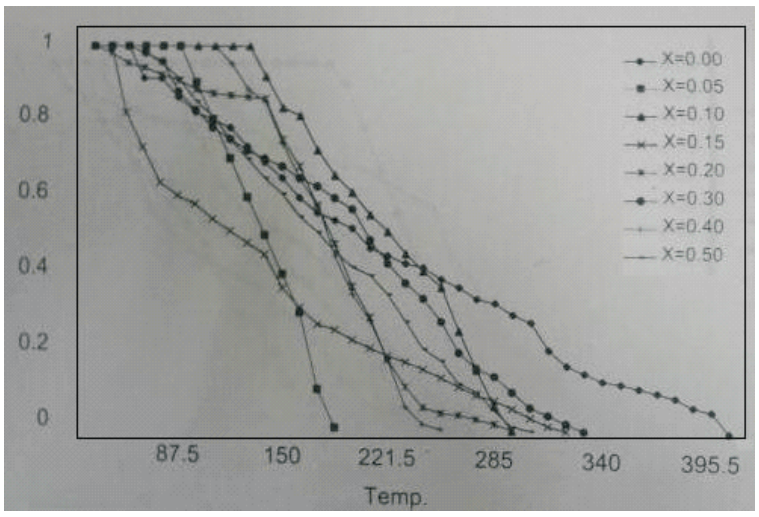

Figure 2: Thermal variation of normalized susceptibility (T/ RT) with temperature for $Ni_xCu_{0.55-x}Zn_{0.45}Fe_2O_4$ (with x = 0.0, 0.05, 0.10, 0.15, 0.20, 0.30, 0.40 and 0.50)

The initial permeability as a function of temperature from room temperature to 450 C was measured at 1 KHz frequency. In Fig. 3 variation of initial permeability with the content of Ni^{2+} in the ferrite system is presented. It is observed from Fig. 3 that i increase with increase of Ni^{2+} concentration. It is found that the curves are typical of multi domain grains showing a sudden drop in i at the Curie temperature (Tc). It was reported that the sharp decrease of i with temperature at Tc reflects the homogeneity of the sample [9, 10].

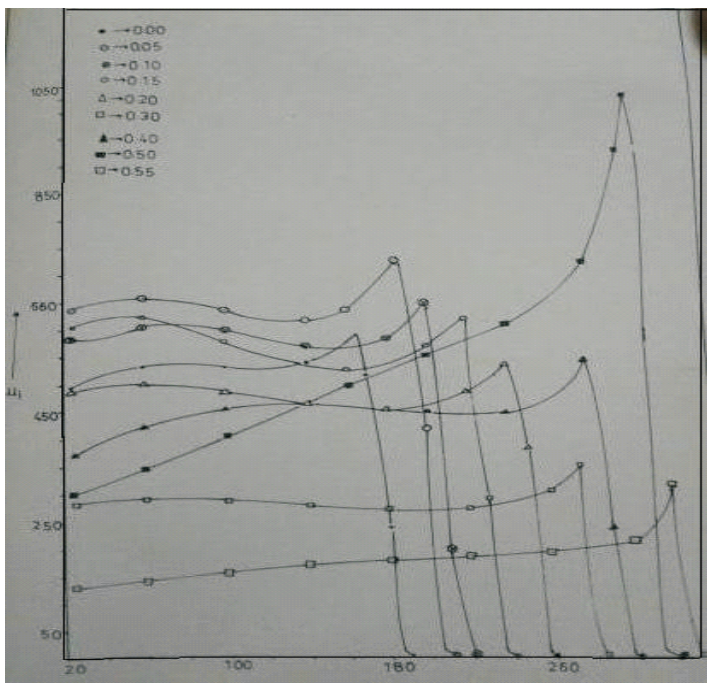

Figure 3: Variation of initial permeability ($_i$) with temperature for $Ni_xCu_{0.55-x}Zn_{0.45}Fe_2O_4$ (with x = 0.0, 0.05, 0.10, 0.15, 0.20, 0.30, 0.40 and 0.50)

CONCLUSION:

Ferrite powders of $Ni_xCu_{0.55-x}Zn_{0.45}Fe_2O_4$ (with x = 0.0, 0.05, 0.10, 0.15, 0.20, 0.30, 0.40 and 0.50) were synthesized through oxalate precursor technique. The formation of single phase cubic spinel structure for $Cu_{0.55}Zn_{0.45}Fe_2O_4$ was confirmed by X-ray diffraction technique. The thermal variation of ac susceptibility and permeability shows composition dependence and shows increasing trends with increase in Ni^{2+} content.

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