CHAPTER IV

SUMMARY AND CONCLUSIONS

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The effects of Cu substitution on the properties of Ni-Zn ferrites sintered at low temperature with various compositions are investigated. There has been a growing interest in Ni-Cu-Zn ferrites for the application in producing multilayer-type chips mainly because these oxides can be sintered at a relatively low temperature with a wide range of composition. The purpose of this study is to investigate the effect of copper substitution on the magnetic properties of Ni-Zn ferrites sintered at low temperature with various compositions.

As much of the work has been carried out with various substituents on Ni-Zn ferrites using standard ceramic method. However, the formation of ferrites by this method has disadvantages like, non-homogenity, poor sinterability, low surface area, large particle size, and requires high temperature. Chemical routes enable the synthesis of ferrites in state of high homogeneity and punity than the cermic method. There are various chemical routes available like coprecipitation, sol precipitation, spray pyrolysis, decomposition of organometallic precursors, and sol-gel. We have synthesized Ni-Cu-Zn ferrites by oxalate percursor. This technique gives good homogeneity, greater reactivity, fine particle size, high purity.

Ni-Cu-Zn ferrites, $Zn_{0.6}$ $Ni_{0.4-x}$ Cu_x Fe_2O_4 where x=0.00, 0.025, 0.05 0.075, 0.10, 0.125, 0.150, 0.175, 0.20, 0.225, 0.25, and 0.30. were prepared by coprecipitation technique using oxalate precursors. The solid, solutions of oxalate complexes, thus obtained were decomposed. The decomposed products were then pressed to pellets and torroids in desired dimensions. The pressure of 10ton/inch^2 for 5 minutes were applied to form the pellets and torroids.

The dissertation comprises of four chapters. The first chapter gives historical development of ferrites and brief theory on various parameters which characterize the ferrites. The data of various properties of Nickel, Copper and Zinc ferrite is given. A brief survey of research work carried out on Ni-Cu-Zn ferrites. The orientation of work has been given at the end of the first chapter.

The second chapter consists of four sections. The part A deals with the synthesis of ferrites. A brief analysis on synthesis of ferrites by chemical routes and precursor methods are presented. The solid solution of oxalate complexes were obtained by coprecipitation of Cu^{2+}, Ni^{2+}, Zn^{2+}, Fe^{3+} acetate solutions with oxalic acid.

The B section deals with the XRD studies of the ferrites prepared. XRD studies were carried out using philis X-ray diffractometer. The lattice parameter values decreses with increase in copper concentration, which is attributed to smaller ionic radii of copper.

The part C section deals with the determination of densities of various ferrites compositions. The densities were determined using Xylen medium and compared with X-ray density.

The part D section deals on the scanning Electron microscope SEM studies. The SEM studies revealed that with the addition of Cu^{2+} grain size increases , upto $x = 0.175$ and excssive addition of Cu^{2+} $x > 0.175$ tends to decrease grain size.

The third chapter is divided into three sections section I deals with a.c. susceptibility studies using the double coil set up . The thermal variation of normalised a.c. susceptibility curves shows that all the compositions exhibit temperature dependent. A small peak is observed near to the temperature which is characteristic S.D. grains . It has been concluded that it has dominance S.D. + M.D. type grains. The peaking behaviour of high temperature indicates the presence of S.D. grains. The curie temperature is found to decrease with addition of copper concentration which is explained on the basis of exchange interaction.

Section- B deals with hysteresis the decrease in n_B with addition of copper is attributed to smaller magnetic moment of copper as compared to nickel which is responsible to lower Ms value. The change in magnetisation on copper substitution which occur due to presence of Y-K type spin at B- site . Magnetocrystalline anisotropy , Magnetocrystalline anisotropy (K_1) and Remanance ratio is invanient and (H^A_K)is increasing .

Section- C deals with initial permeability measurments of μ_i as a function of temperature and frequency were carried out on HP-LCRQ meter . It is observed that permeability obeys Globus model . The mean contribution of initial permeability μ_i is due to wall permeability , which is greater than rotational permeability i.e. μ_{rk}. With the addition of copper the wall permeability increases which is attributed that these ion cause impendence to the domain wall motion and that more the concentration os these ions less the effect of wall motion. There is increase in μ_i with the substitution of copper which is explained using Globus and Duplex wall permeability .

The μ_i -T curves with its real part (μ') and imagnary part (μ'') for various compositions shows that it increases slightly with temperature upto curie temperature. Near curie temperature there is sharp drop to zero. These curve resemble with $\chi_{a.c.}$ - T curves , indicating presence of S.D. + M.D.The peaking beghaviour at high temperature indicates presence of S.D. The frequency variation of μ' and μ'' clearly indicated low frequency dispersion . This is attributed to the domain wall moments , which supports these observations.

The dispersion of loss factor (L.F.) studies indicates losses are minium in the high frequeney region . The thermal variation of loss factor indicates that L.F. are constant with increase in temperature from range (25 ^{0}C to 85 ^{0}C) and (for temperature range 85 ^{0}C to 165 ^{0} C) the loss factor increases.