CHAPTER V

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SUMMARY AND CONCLUSION

A variety of magnetic oxides, specially ferrite materials have been developed for Electrical, electronic, microwave and computer applications. Extensive work has been done by various workers to upgrade the properties of ferrites by substituting impurities. It has been proved that by doping small amount of tetravalent ions, the electrical and microstructural properties of the basic ferrite can be significantly influenced.

Zinc substituted spinel ferrites show good magnetic properties for technical application. Different ferrite systems like Cu-Cd, Ni-Cd have also been investigated [1]. Co-Zn ferrite has been studied by Josyulu and Sobhanadri [2], Ahmed M.A. [3] and Sagar D.R. et al. [4]. However silicon doped Co-Zn ferrites is scanty. Therefore with a view to look into the possible effects, on D.C. electrical resistivity, magnetization, A.C. susceptibility of Co-Zn ferrites by silicon doping following studies were undertaken.

1) Silicon doped Co-Zn ferrite system have been prepared by standard ceramic method. They are -

i) $Co_{x-2y}Zn_{1-x}Si_yFe_2O_4$

with y = 0.05 and x = 0.3, 0.5, 0.7, 0.9, 1.0

ii) $Co_{x-2y}Zn_{1-x}Si_yFe_2O_4$

with y = 0.1 and x = 0.3, 0.5, 0.7, 0.9, 1.0

2) XRD and IR studies were calculated to ascertain the formation of solid solution and also to determine lattice parameters, bond lengths and impurity.

3) D.C. Electrical resistivity measurements were carried out to understand the conduction phenomenon in doped ferrites.

4) Magnetic studies were conducted to observe the variation in magnetic moment and magnetization with composition. A.C. susceptibility studies were conducted to observe the domain structure and to determine Curie temperature. Curie temperature is also determined by modified Loroia-Sinha technique.

Above mentioned work has been presented in this dissertation that consists of five chapters. First chapter deals with introductory review of history of work done on mixed ferrites. Also deals with crystal structure of ferrites, Electrical and magnetic properties, Neel's and Yafet-Kittel theory of ferrimagnetism.

Chapter II is split into three parts A, B and C. In part A, the experimental details regarding the method of preparation of doped ferrite samples is

described. We have prepared these samples by standard ceramic technique. In part B, data on crystal structure is presented i.e. observed and calculated 'd' values hkl planes for the samples are given. Part C deals with IR absorption spectra and observance of vibration bands ν_1 and ν_2 and force constants are reported in this part.

X-ray diffractograms reveals the completion of solid state reaction and formation of spinel structure. The lattice constant decrease with increase of Co content and percentage doping of Si. This is attributed to smaller size of Co^{2+} and Si^{4+} ions in comparison with Zn^{2+} ions. According to Levine's theory decrease in bond length corresponds to an increase in the covalent character of the spinel. The calculated bond lengths for present system indicate that Si^{4+} doping does not affect bond lengths to noticeable extent. As Co content increases covalent nature of spinel increases hence bond length decreases.

IR spectra reveals two main absorption bands accordance with Waldron [5] observations in ferrites. The bond near 600 cm^{-1} (ν_1) is attributed to tetrahedral complexes and that near 400 cm^{-1} (ν_2) to the octahedral complexes. For silicon doped Co-Zn system the observed frequencies are in expected range. The force constants K_1 and K_2 decrease with increase in

Co content. This may be due to charge imbalance between Fe and O. It is also observed that the octahecral band $_2$ shows splitting and the fine structure is clear. This may be due to presence of more cations on B-site, i.e. octahedral site and Co-O complexes.

Ferrites behave like semiconductors and their D.C. electrical resistivity obey the relations

$$\rho = \rho_o \, e^{\Delta E/kT}$$

The plots of log ρ verses 1/T are used to calculate the activation energies. The transition temperature at which slope changes, for last two samples in each series, is nearly to the Curie temperature of the samples. The electrical conduction in our samples is due to following mechanism

$$Co^{2+} + Fe^{3+} \rightleftharpoons Co^{3+} + Fe^{2+}$$

It is seen that the conductivity increases with the increase of Co content, this is because greater presence of Co^{2+} changes $Fe^{3+} \longleftrightarrow Fe^{2+}$.

The compositional variation of saturation magnetization Ms shows that Ms increases with increase in Co content. This can be explained on the basis of Neel's two sublattice model. The comparison of magnetic moment and saturation magnetization in the two systems show that magnetic moment and saturation magnetization have higher values for higher Si- content. As Si^{4+} has

A-site preference it increases the magnetic moment and saturation magnetization.

According to Neel's model the Curie temperature of the ferrite is proportional to the Fe^{3+} content on the two sites and their distance i.e. (Fe_A - O - Fe_B) and bond angles. From the Curie temperatures of our samples it is observed that there is no noticeable effect of Si^{4+} doping on Curie temperatures.

The nature of the χ_{ac} vs T curves show that six samples are paramagnetic (three in each series with higher Zn content), their χ_{ac} decreases as temperature increases. For the other four samples speaking nature at Curie temperature is observed which indicates that SD single domain state in ferrites.

References

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