CHAPTER V

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SUMMARY AND CONCLUSION

Ferrites are important magnetic materials which find application in the field of electronics and communication instruments. Extensive work has been done on ferrites by many research workers to upgrade the properties. Ferrites are semiconductor by nature and they possess high electrical resistivity, low power looses due to eddy current, high permeability and small coercive force

The electrical and magnetic properties of ferrites are structure sensitive and are highly influenced by impurity doping and heat treatment. The mixed Mg-Cd ferrite system has been studied by many workers [1 to 5] from the point of view of crystal structure, d.c. electrical and magnetic properties. However the data on Si doped Mg-Cd ferrite is scarce in literature. Hence for the present work Mg-Cd ferrite doped with silicon is undertaken and its characterization and properties are studied. The $CdFe_2O_4$ is normal spinel where as the $MgFe_2O_4$ is an inverse spinel. Both possess high electrical resistivity. Thus in Mg-Cd ferrite both electrical and magnetic properties are expected to change. Further silicon is tetravalent and to dope it in the Mg-Cd ferrite system care is to be taken to

satisfy the valency of the resulting compound. Therefore in order to understand the role of doping of silicon in Mg-Cd ferrite system the following studies have been carried out.

(1) Preparation of ferrite system $Mg_{x-2y}Cd_{1-x}Si_yFe_2O_4$ by standard ceramic method with x = 0.3, 0.5, 0.7, 0.9 and 1.0 and y = 0.05 and 0..1 for each value of x.

(2) XRD studies to confirm the solid state reaction, determination of crystal structure and calculation of lattice parameter.

(3) IR studies to detect the internal vibration due to tetrahedral and octahedral metal ion complexes and to evaluate force constant.

(4) Measurement of d.c. electrical conductivity to compute activation energy and to propose conduction mechanism.

(5) Hysteresis study at room temperature to observe the variation of saturation magnetization and magnetic moment with composition.

(6) A.C. susceptibility measurements to decide the nature of magnetic particles.

(7) Curie temperature measurement by modified Loroia-Sinha technique.

The reports of these studies have been presented in this dissertation.

The first chapter deals with the introduction of ferrites in which historical development, crystal structure of spinel ferrites along with classification are discussed. The theories of ferrimagnetism, electrical and magnetic properties have been discussed briefly. Application of ferrites are mentioned and the orientation of work is given at the end of the chapter.

The second chapter is divided into three parts viz. preparation, XRD studies and IR studies. In the preparation part various methods of preparation of ferrites are given along with the stages of preparation are reviewed. A brief discussion of sintering and pressing is given along with a short introduction of hot pressing technique. A detailed procedure used for the sample preparation and flowchart of the preparation is presented.

The XRD studies deals with the idea of X-ray diffraction and Bragg's law. The methods of X-ray diffraction are discussed briefly. The XRD pattern of all the ferrite samples are obtained to confirm the single phase formation of ferrites. The lattice parameter 'a' and the interplaner distance 'd' are calculated. The observed 'd' value is found to match with the calculated d-values. The variation of lattice parameter with Cd content is presented. The XRD pattern

of all the ten samples are also presented. The bond length R_A, R_B and site radii r_A, r_B are calculated and are tabulated for all the samples. It has been found that the R_A, R_B, r_A and r_B increases with increasing Cd content. Also porosity decreases with increasing Cd content.

The IR studies are carried out at room temperature in the frequency range of 200 cm^{-1} to 800 cm^{-1}. The high frequency band ν_1 is observed at 570 cm^{-1} to 610 cm^{-1} and low frequency band ν_2 is observed at 400 cm^{-1} to 450 cm^{-1}. From the band frequencies ν_1 and ν_2 and the force constants K_1 and K_2 are determined. It has been observed that the force constant increases with increasing Cd content. This is due to the increase in covalency with increase in Cd content. That is CdO band is more covalent than MgO. Further the doping of silicon does not change force constant appreciably.

The third chapter deals with the electrical properties such as d.c. conductivity. The conduction mechanism is discussed briefly with hopping mechanism. The experimental technique used for d.c. electrical resistivity is given. The d.c. conductivity study shows that the variation of resistivity with temperature obeys the equation

$$\rho = \rho_o \exp(\Delta E/kT)$$

Three distinct regions of conductivity were observed in the conductivity plots. The activation energy in the paramagnetic and ferrimagnetic region is calculated and it has been found that the activation energy in para-region is more than in ferri-region. Also it was observed that Curie temperature increases with decreasing cadmium content. Further it is observed that the resistivity slightly increases with increase in silicon content and Curie temperature marginally decreases with increase in silicon content.

The fourth chapter is divided into three sections such as magnetization studies, a.c. susceptibility and Curie temperature measurements. In the magnetization studies domain theory, hysteresis and coercivity is discussed briefly. The experimental technique and formulae for magnetization calculation is given. It is observed that magnetic moment and saturation magnetization increases with cd content and then decreases with further increase of Cd content. The values of n_B, M_s are presented.

The a.c. susceptibility studies includes the theory of a.c. susceptibility and experimental technique. The variation of normalized susceptibility with temperature indicates that for lower concentration of Cd content MD particle behaviour is observed. For

higher concentration of Cd content SD+MD behaviour is observed but for still higher concentration of Cd content SD to MD transformation favours.

The Curie temperature measurements were carried out by Loroia-Sinha technique. The values of Curie temperatures obtained from this method are found in good agreement with those obtained by d.c. conductivity and a.c. susceptibility methods. It is observed that Curie temperature increases with decrease in cadmium content and also the Curie temperature marginally decrease with increase in silicon content.

REFERENCES

1. Upadhyay R.V., Rao S.N. and Kulkarni R.G.
J. Mater. Sci. Lett. 3 (1985) 78

2. Eissa N.A., Salam H.A., Salah S.H., Meera A.F. and Hasib A.
Hyperfine Int.(Switzerland) 28 (1986) 843

3. Upadhyay R.V.
Solid Stat. Commun. (USA) 48 (1983) 691

4. Gawade R.J.
Ph.D. Thesis, Shivaji UNiv., Kolhapur (1993)

5. Bhosale J.L., Kulkarni S.N., Sasmile R.B. and Chougule B.K.
Ind. J. Pure Appl. Phys. 33 (1995) 412