CHAPTER - IV

SUMMARY AND CONCLUSIONS

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Nickel ferrite and Mn ferrites are the most widely used ferrites as tailor making, of these ferrites to suit a particular application with different substitution is possible. Many workers in the past have concentrated their work mainly on Ni-Zn and Mn-Zn ferrite compositions and very small amount of work is carried out on Cadmium substituted Nickel ferrite or Mn ferrite. It was with this perspective we proposed to take up Ni-Cd series for investigating the magnetic studies. Recently R.K. Puri et al have carried out electrical and magnetic properties of Sn^{4+} substituted Ni-Cd ferrites. These studies indicate that magnetic properties of Ni-Cd ferrites are comparable to those of Ni-Zn ferrites. However Ni-Cd ferrites have low resistivity giving rise to higher losses. It is known that a tetravalent ion when substituted in a ferrite tends to localise Fe^{2+} ions at the B-site according to the equation.

$$2Fe^{3+} \longrightarrow Fe^{2+} + Ti^{4+}$$

The localisation of Fe^{2+} does not leave it free to participate in verwey conduction mechanism which normally occurs in ferrites.

Thus to improve the electrical properties, we decided to substitute Ti^{4+} in Ni-Cd ferrite by 5% weight of Ni-Cd compositions. Additional point in selecting Ti^{4+} was that it has good solubility limit.

It was therefore proposed to carry out following studies to characterise these ferrites and to explore their magnetic character.

1) XRD and to confirm single phase, lattice parameter variation.
2) Microstructure study to understand the variation of grain size and its relation with the magnetic properties.
3) Magnetic properties like
   i) Hysteresis studies.
   ii) Thermal variation of A.C. susceptibility.
   iii) Thermal variation of Initial permeability.

In chapter I we have summarised theories relating to magnetic properties of the ferrites in general while giving the summary of work done on Ni ferrite and Cd ferrite. The structure of ferrite is also discussed. At the end of every chapter references are given.

Chapter II begins with the method of preparation. Different methods of ferrite preparation have been described in brief. The mechanism of solid state reaction and aspects of grain growth have been also discussed. We have prepared the ferrites by standard ceramic technique.

NiO, CdO, TiO_2 and Fe_2O_3 A.R. grade oxides were weighed in required proportions and mixed homogenously. The mixture was presintered at 600 °C for 10 hrs. followed by final sintering at 1200°C for 24 hrs. Pellets of 1 cm. dimeter and torroids of I.D. = 1 cm and O.D. = 2 cm were pressed to a pressure of 10 tonnes for ten minutes. These were finally sintered at 1200 °C for 24 hrs.

XRD studies were carried out on PW 1820 at RSIC, Nagpur using CuK_α radiation (1.542°A). All the compositions showed single phase cubic structure. The lattice parameter variation obeys vegards law, which is explained on the basis of ionic radii of cations involved. It is observed that Ti^{4+} goes into the solid solution completely it is observed that substitution of Cd^{2+} tends to increase the density. Bond lengths R_A and R_B increase with the substitution of Cd^{2+} suggesting that Iono-covalent character decreases from $NiFe_2O_4$ to $CdFe_2O_4$.

Micro-structure studies reveal the following information.

i) The grain size increase with the increase of Cd^{2+}.

ii) The grain growth is continuous and there is no exaggerate grain growth.

iii) Secondary electron images are absent.

iv) The number of neighbours of the planer grain crosssection is equal to the number of sides.

v) The tendency to show the maximum coordinate number is with n = 5 and 6.

In the third chapter studies on Magnetic hysteresis, a.c. susceptibility and Initial permeability are reported.

For the series $Ni_xCd_{1-x}Fe_2O_4$ (x = 0.3, ... 1) when Cd^{2+} is added canting of the spin occurs at B-site for $x > 0.8$ while there is no canting for remainging samples. The magnetisation behaviour for $x \geqslant 0.8$ is explained on the basis of Neel's two sublattice model while for $x < 0.8$ the magnetisation behaviour is in conformity with YK theory. We have calculated the YK angles, n_B values and Mr/Ms. The squareness ratio decreases with substitution of Cd^{2+} which is attributed to decrease of K_1. With the substitution of Ti^{4+} the magnetisation was found to decrease which is explained on cation transfer.

The a.c. susceptibility studies were carried out at different temperatures and following conclusions are drawn.

From x = 1 to 0.7 the samples contain (S.D.) with (UA) while the remaining samples contain predominantly MD type of grains. Near curie temperature the susceptibility drops sharply corroborating our finding from the X-ray studies that all the compositions are single phase. The curie temperatures decrease with the increase of Cd^{2+}.

The substitution of Ti^{4+} leads to the formation of MD type of grains in the ferrites. The Initial permeability studies carried out on torroidal samples indicate that the compositional variation of permeability obeys Globus model.

$$\mu_i = M_S 2 \ dm / K_1$$

For some compositions the permeability increases with temperature reaches some peak value and drops sharply to zero near the curie temperature. The increase of permeability is explained on variation of K_1 (anisotropy constant) with temperature. The composition variation of permeability follows the trend of compositional variation of magnetisation.

Substitution of Ti^{4+} leads to decrease of μ_i which is attributed to decrease of M_S.