CHAPTER - V

SUMMARY AND CONCLUSION

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The ferrimagnetic oxides generally known as ferrites owing to their important electrical and magnetic properties happen to be industrially important materials. They have applications in electrical and electronic industries and therefore have aroused considerable interest particularly during last two decades. The ferrites have general formula M Fe_2O_4, where M is divalent metal ion. It was observed when the diavalent metal ion which is magnetic in nature if replaced by a non-magnetic ~~in nature if replaced by a non-magnetic~~ ion like Zn the net magnetic moment of the sample is enhanced. This was later explained on the two-sub-lattice model by N'eel.* It was, therefore, proposed to study the mixed ferrite system, where a partial substitution of the divalent magnetic ion by a di-magnetic ion. That is to prepare the mixed ferrite system $Cu_xNi_{1-x}Fe_2O_4$ by substitution of Ni^{2+} by Cu^{2+} partially (Cu = x = 0.0, 0.2, 0.4, 0.6, 0.8 and 1.0) maintaining the stoichiometry of the ferrites.

In Chapter I a short survey of magnetic materials - the ferrites, is given; where the classification of magnetic materials, their crystal structure, normal and inverse, substitution, magnetic properties are discussed. The application of ferrites are also made mention of and the orientation of the present work is also mentioned.

The standard ceramic method is employed to prepare the ferrite samples. A flow chart involving all the steps in preparation of these materials is given in Chapter-II. The actual steps followed in preparing these samples, giving a specimen calculation, is also presented. In the same Chapter is given work on X-ray crystal structure characterization carried out on these samples, to confirm the single phase formation. The details of 'd' values, the Miller indices (hkl) of the reflecting planes and the lattice parameters 'a' are also given along with the X-ray diffractograms of the series. It is found that all the compositions of mixed ferrite exhibit cubic lattice except for pure $CuFe_2O_4$ which is tetragonal with c/a value 1.0415. The compositional dependence of lattice parameter being linear is found to obey Vegard's law. The physical densities and also X-ray densities are presented. The physical densities are found to be smaller than the corresponding X-ray densities which suggests that some porosity does exist in the samples which are in the pellet form prepared by hydraulic pressing by applying about 15 tons per square inch pressure.

After getting thus prepared the series $Cu_xNi_{1-x}Fe_2O_4$, the ferrite samples in the pellet form are subjected to a systematic study in the following way. In Chapter-III the details of measurement of Curie temperature of all the compositions is presented. The details of experimental set-up used and the Curie temperatures measured which give a magnetic transformation from ferri to para magnetic state are discussed.

The compositional dependance of Curie temperatures (Tc) is found to be almost linear. Secondly, the saturation magnetization (Ms) values have been obtained by studying the hysteresis loss in the samples. This work was carried out at IIT, Pawai on a standardised instrument set-up known as HIGH FIELD LOOP TRACER HS 869 supplied by Electronic Corporation of India, Hyderabad. The interest in the saturation magnetization was because if the study is carried out at cryogenic temperatures and if the graph of saturation magnetization (Ms) is extrapolated to 0°K it helps to quantitatively estimate the cation distribution in the ferrites, which decides their final properties. All the details of experimental set up, method of calibration and together with a specimen calculation are presented along with the discussion on the results obtained in the same chapter.

In Chapter-IV, our work on electrical d.c. resistivity measurements on all the compositions in the pellet form are presented. A simple cell for making these measurements is fabricated, the details of which are also given. The graphs of log (ρ) Vs $\frac{10^3}{T}$ are plotted and it is found for all the samples there is a little deviation from linearity in ferrimagnetic region. This is attributed to the method of preparation particularly to porosity in the samples so also it is suggested that either the deficiency or excess of oxygen that may be incorporated at elevated temperatures depending on the system as the experiment is carried out in air. The activation energies (ΔE) have been calculated in both ferri and para magnetic regions and it is found that these goes on decreasing with increasing copper content in the system. The graph of resistivity (ρ) with composition shows a change over at about $x = 0.6$. This is correlated with the magnetization data obtained in Chapter-III.

Reference :

* Nee'l L., "Magnetic Properties of Ferrite, ferrimagnetism and antiferromagnetism", Ann.Physique, 3, 137 (1948).