Chapter - V

Summary and Conclusions

SUMMARY AND CONCLUSION :

After 1950 ferrites aroused a considerable interest because of their electronic, microwave and computer applications. Being technologically important materials they have been extensively studied from the point of view of determination of their electric and magnetic properties to check the suitability of certain applications. They were also subjected to rigorous investigations using techniques like X-ray diffraction, Mossbauer techniques etc., in order to understand the Physico-chemical state and structure property relationship. Results obtained are most contraversial in quite few cases.

The contraversies may be due to structural aspects on preparation condition, composition and partly due to lack of understanding copper ferrite appeared to be interesting from the above point of view because it shows lattice distortion, structural changes with composition and temperature of preparation including quenching. It also shows electrical switching and crystal distortion.[1] Recently most of the studies on Cu mixed ferrites have under taken by many workers[2,3,4,5] and tried to establish conduction mecnanism and cation distribution with composition.

In order to unravel the role of composition in affecting the crystal structure,cation distribution and conduction mechanism. It is also importion to study the behavio r of quenching temperature an magnetisation and conductivity of the ferrites.

We have undertaken the following studies on Cu_x Co_{1-x} Fe_2O_4 system.

1) Preparation of $Cu_xCo_{1-x}Fe_2O_4$

where $x = 0, 0.2, 0.4, 0.6, 0.8, 1.0$

by ceramic method at an appropriate temperature due care being taken for non reduction of copper ions.

X-ray diffraction studies of ferrite samples for finding the Bravies lattice and lattice parameter with view to find out variation of C/a ratio with composition.

2) Electrical resistivity and curie temperature measurement studies for finding out the conduction mechanism involved in ferrites and behavior resistivity with composition of Co.

3) Magentisation studies on these ferrites for finding out the cation distribution and magnetic moment behavior with the composition with view to find out the role of Co ion in changing the magnetisation with composition and quenching temperature.

In chapter I the brief review of historical development of ferrites and the properties of ferrites like crystal structure, magnetisation, conductivity are given. The general spinel structure is explained in detail while inverse and normal spinels are also incorporated. The Neel's theory of Ferromagnetism for the ferrites is given at the end.

Chapter II split up into two parts A and B.

Part A is devoted to method of preparation and part B deals with X-ray diffraction studies of the present system. Methods of preparation of ferrites are reviewed. The role of heat treatment and inert atmosphere during preparation discussed. The procedural details of ceramic method followed for the preparation of ferite is given.

Part B is devoted to the working principles x-ray diffractometer and method for characterising the structure of the spinel x-ray diffractometer at slow speed giving leave to 1° of 2θ and the radiation CoK_{α} is used. The data on crystal structure, 'd' values, lattice constant, C/a ratio is also tabulated.

The observed and calculated 'd' values indicate the spinel structure is fully formed in our samples. In $Cu_x Co_{1-x} Fe_2O_4$ Where X =1, 0.8, 0.6, 0.4 of Cu show tetragonal structure and remaining compositions show the cubic structure.

It is observed that tetragonality decreases with content of co increases. This has been interpreted in terms of replacement of more and more cobalt ions on B site than copper ions. The phase relationships of Cu-Fe-O and Co-Fe-O are also discussed and tried to explain with the observed results qualitatively. The possibility of different phases like S+S and $CuFe_2 O - Fe_3 O_4$ may be occured in present system.[6]

Electrical resistivities and curie temperatures are reported in chapter III. The different conduction mechanisms, of ferrites are reviewed. The details of experimental procedure is also given. The log ϱ vs 1/T shows two breaks giving rise to three regions. The low temperature is interpreted as the basic change in crystal structure i.e. tetrognal cubic.

This is consistant with the observed data for Cu Ni ferrites.[7] The break at higher temperature occures nearly at curie temperature. The observed curie temperature and measured curie temperature shows the same trend. As the Co content increases the curie temp increases which is attributed to replacement of Cu ions on B site by co ions and A-B interaction becomes stronger. It is observed that activation energy is higher in para magnetic region than in ferrimagnetic region. The conductivity in ferrites is via hopping of thermally activated Polarons. These Polaron have low activation energy in the magnetic region while more activation energy in the non magnetic region.[8]

For slow cooled and quenched samples it is observed that curie temperature increases with increase quenching temperature. This is ascribed due to the migration of Cu ions to A and Fe ions on B site and the contribution to conductivity $Fe^{+} \rightleftharpoons F^{+3}$ or $Fe^{+2} \rightleftharpoons Co^{+3}$ Or $Co^{+3} \rightleftharpoons Co^{+2}$ which clearly indicates decrease of activation energy in the system.

The sudden increase of ΔE from $Cu_{0.4}$ to $Cu_{0.2}$ is due to change in the crystal structure from tetragonal to cubic. This may be due to formation of different phases.

In chapter IV the magnetisation studies are reported. The relevent theory of magnetisation and different type of losses are explained briefly. The experimental details and method for calculation magnetisation, Gilleo's formula to calculate the cation distribution ~~is~~ are also given. The obtained results are explained on the basis of Neel's two sub lattice model because they show Zero Yafet - Kittle angle.

The increase in n_B is observed with increase of Co ~~contact~~ content. This may be due to increase of co magnetic ion at B site and A-B interaction becomes stronger. Quenched samples shows the higher nB than the slow cooled one.

This is explained on the basis of migration of cu ions from B→A site where iron ions from A to B site. The composition variation of squarness ratio Mr/Ms shows that $\frac{Mr}{Ms}$ increase as X = 0.2 to 0.5 and decreases as X = 0.6 to X x = 0.8.

These variation mainly depend on the domain structure, impurities Polarisable constituents and other phases involved in the samples.

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