CHAPTER-V: SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

During the last few decades the studies on ferrites have assumed considerable importance because of their applications in electrical, electronic, computer and microwave regimes. As these materials are technologically important, the same have been studied extensively from the point of view of their magnetic and electrical properties to check their suitability for certain applications. In many electronic applications ferrites with low coersive force and narrow hysteresis loop along with the higher sensitivity are required for minimising eddy currents and hysteresis losses. The other important factor in selecting ferrites for certain amount of magnetic effect in applications is permeability. Without any loss on the performance level, the miniaturation can be done by using ferrites with high permeability. In magnetic switching devices the squareness ratio is of prime importance.

Zinc ferrite is reported to be completely normal spinel and its crystal structure is not affected due to conditions of preparations below 1400°C. Copper and magnesium ferrites are partially inverted ferrites and also show variation in the electrical and magnetic properties when heat treated differently. Copper ferrite exhibits tetragonal structure,[1] changing semi-conducting property[2] and electrical switching.[3] Mixed Cu-Zn[4], Ni-Zn and Mg-Zn[4] systems have been studied by many workers. However, from the point of view of modulation in the electrical and magnetic character of Mg-Zn ferrites on quenching remains to be in oblivion and systematic studies on this system are necessary to have gainful understanding of the role of Mg^{+2} ions on quenching to influence the behaviour of ferrite. It is with this view in mind that we have undertaken studies on structural, electrical and magnetic properties of quenched samples. The results of quenched samples and slow cooled samples are compared. The following studies were proposed to be carried out:

1) A: Preparation of $Zn_xMg_{1-x}Fe_2O_4$ where x = 0, 0.2, 0.4, 0.6, 0.8, 1 by ceramic method.

   B: X-Ray diffraction studies to characterise the ferrite sample.

2) D.C. resistivity studies to understand the mechanism of conduction in ferrite and to determine Curie temperatures of the samples for comparison with the experimental and theoretical values of Curie temperature.

3) Hysteresis studies to determine the saturation magnetisation remnance magnetisation, coersive field and squareness ratio.

Chapter I gives account of crystal structure of ferrites, hystorical and developments of ferrites are followed by Neel's theory. Short account of electrical and magnetic property is also presented. Applications are given at the end.

Chapter II gives method of preparation of ferrites, mechanism of solid state reaction and details of pellet formation.

X-ray diffraction studies have been carried out to confirm the formation of ferrites and characterisation of crystal structure. Both slow cooled and quenched samples exhibit cubic crystal structure and show non-detectable change in lattice parameter on quenching. The lattice parameter variation obeys Vegard's law. The lattice parameter is minimum for Mg ferrite and increases linearly with the addition of zinc and becomes maximum $ZnFe_2O_4$.

The variation is explained on atomic volume differences of Mg and Zn. This chapter is concluded with the report on experimental determination of Curie temperature. The Curie temperatures are determined by improvement on the technique suggested by Loria *et al*. It is observed that Curie temperatures are lowered on addition of zinc and Curie temperatures of slow cooled samples are more than those for quenched samples.

In Chapter III data on electrical resistivity of slow cooled and quenched samples of ferrite have been reported. Resistivity studies have been carried out by two probe method. Graphs of log Vs $\frac{10^3}{T}$ show only one break which is attributed to several sources.[5] The values of ΔE in the ferrimagnetic region were found to be greater than those in the paramagnetic region. For electron hopping the values of ΔE are reported to be 0.2 eV and less.[6,7] Our values of ΔE are greater than 0.2 eV. We suggest that conductivity is due to hopping of polarons. The ΔE values do not exhibit any predictable behaviour on addition of zinc, in both slow cooled and quenched samples. However, the values of ΔE are lowered on quenching. The activation of energy in the paramagnetic region is found to be greater than that for ferrimagnetic region. This suggests that magnetic ordering has role to play in influencing conductivity. It is also seen that the trend of compositional variation of ΔE is somewhat regular than that exhibited by slow cooled samples.

The Curie temperature values show a decrease on addition of zinc and also on quenching. The theoretical T_c values are larger than the values of T_c in slow cooled samples. The theoretical values have been calculated assuming cation distribution like $(Fe_1)^A(Mg_1Fe_1)^BO_4$. Thus, there appears to be migration of Mg^{+2} ions from B site to A site leading to the lowering of T_c. With quenching this behaviour appears to have been aggravated. The compositional variation of resistivity for the slow cooled samples decreases with addition of zinc which has 1:1 correspondence. With the trend exhibited by T_c values quenched samples also show similar behaviour for the content of zinc in excess of 60 per cent. However, the resistivity increases with the addition of zinc upto its 60 per cent concentration. Thus, it is possible that zinc tends to impead the hopping of polarons on its increase till the sample is ferrimagnetic.

The compositional variation of resistivity and magnetisation also show 1:1 correspondence.

In Chapter IV studies on magnetisation have been reported. The values of saturation magnetisation Ms, remnant magnetisation Mr, and squareness ratio $\frac{Mr}{Ms}$ are reported. The values of YK angles have also been found out. The variation of Ms with content of zinc for slow cooled and quenched samples is explained on the Neel two sublattice model. For the samples $MgFe_2O_4$ and $Zn_{.2}Mg_{.8}Fe_2O_4$ the values of YK angles are zero. For the ferrites $Mg_{.6}Zn_{.4}Fe_2O_4$ and $Zn_{.6}Mg_{.4}Fe_2O_4$ Y-K angles are nonzero and magnetisation behaviour is explained on the triangular spin arrangement. Conditions to YK angles to occur in Ni-Zn ferrite system and CuZn Ferrite system have been investigated by Satyamurthy *et al.*[4] using a non-linear sublattice model. The values of n_β for the quenched samples are found to be more. This increase is explained on the cation migration and the high temperature freezing of the cation distribution.

Compositional variation of squareness ration shows decrease for the slow cooled samples. However, in case of quenched samples the ration $\frac{Mr}{Ms}$ shows an increase on addition of zinc. In case of slow cooled samples hindrances to domain wall motion appear to increase with zinc substitution while these hindrances are anealed out to their equilibrium concentration on quenching. The samples from higher temperatures leading to higher values of $\frac{Mr}{Ms}$. The samples of $Zn_{.6}Mg_{.4}Fe_2O_4$ shows lower values of $\frac{Mr}{Ms}$ even when quenched. This is attributed to magnetic ordering change.

NOTES AND REFERENCES

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