CHAPTER-V

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Despite a lot of published work, copper ferrite continues to be an interesting ferrite because it exhibits phase transitions, changes semiconductive properties and shows electrical switching and tetragonality variation when treated under different conditions. Abnormal behaviour in magnetic, dielectric and thermal properties of Cu containing ferrites has been studied by many workers (1,2). The present work deals with the effect of Cr ion substitution on physical properties in CuCo ferrites.

The work presented in this dissertation is distributed in to five chapters . First Chapter presents an introductory review of the properties of the ferrites. In the Second Chapter the ceramic method is discussed briefly. The laboratory preparation of the sample is also given. The samples belong to the general chemical formula $Cu_{0.5}Co_{0.5}Cr_xFe_{2-x}O_4$ (where x=0.0 to 1.0). In the same chapter the section B is devoted to the characterisation of the samples by X-ray diffraction study. X-ray diffraction patterns reveal single phase spinel structure. The lattice constant decreases upto $x = 0.6$ and then increases for $x > 0.6$. This is explained on the basis of covalent bond formation of Cu and Cr ions at A site.

Chapter Three deals with magnetisation, Curie Temperature and a.c. susceptibility The magnetic properties of ferrites are briefly reviewed. Experimental details with necessary formulae are given. The magnetisation and

Curie temperature decreases with increase of Cr content. This is explained on the basis of Neel's two sub-lattice model(3). The decrease in magnetic moment is attributed to decrease of A-B interaction energy. Shapes of χ_{ac}-T curves indicate the presence domain states in ferrites, Such as multidomain (MD), Single Domain (SD), and superparamagnetic particles (SP) The interesting features of present study is that the samples with x=0 and x=0.2 shows a peak in susceptibility. The susceptibility drops to zero near Curie temperature. For remaining samples the peak height decreases and the peak becomes broader and broader with increase in Cr. These latter curves shows a tailing effect near Curie temperature. Curie temperature (noted from these plots) decrease with increase in x. This is attributed to Fe^{3+} -O-Fe^{3+} linkages and angle between them (4). From the shapes of the curves it is concluded that the composition with x =0 and 0.2 shows MD plus S.D. type particles, where as remaining samples contain SD particles. To check the validity of Neel's model, to explain the magnetisation behaviour for the present system we have used Gilleo's model (5) to calculate the Curie temperatures. It is interesting to note that Curie temperatures nearly agreed for lower content i..e. $x \leq 0.2$ Cr. Where as the difference is large for higher contents of Cr. This may be due to canted spin arrangement in the latter case . This conclusion is also supported by observing the tailing effect in χ_{ac}-T curves.

From cation distribution study, it is noted that, the copper ion at A site increases with increase in concentration of Cr upto x =0.6 and then decreases with further increase of Cr. This conclusion will also support the lattice constant variation. The covalent bond formation due to Cu is more favoured in the volume expansion of the lattice. Hence there is a decrease in lattice constant upto x = 0.6, an increase for higher values of x.

Chapter Four presents the resistivity and thermoemf results which are discussed in the light of existing theories. All the samples shows semiconducting behaviour. However, the samples with x < 0.6 show anomalous behaviour at lower temperatures (i.e. less than 450 K). From thermoemf data it is found that all the samples are n-type. The conduction mechanism in these ferrites is explained on the basis of hopping model. The mobilities were calculated by using the results of α and ρ . The activation energies from mobility and conductivity agreed with each other. This confirms that the conduction phenomenon in these ferrites is due to polaron hopping.

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