



## CURIE TEMPERATURE OF Cd-Ti SUBSTITUTED Li-Mn FERRITES

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### ABSTRACT:

A financially savvy strategy for transformation of a vertical tube thermo gravimetric investigation framework into an attractive equalization fit for estimating Curie Temperatures is introduced. Reference and fundamental exploratory information produced utilizing this framework is broke down by means of a broadly useful wavelet based Curie point edge recognition method taking into consideration improved speed, simplicity and repeatability of attractive parity information examination. The Curie temperatures for various Heusler mixes are reported. Curie point, likewise called Curie Temperature, temperature at which certain attractive materials experience a sharp change in their attractive properties. This temperature is named for the French physicist Pierre Curie, who in 1895 found the laws that relate some attractive properties to change in temperature. At low temperatures, attractive dipoles are adjusted. Over the curie point, irregular warm movements bump dipoles crooked.

**KEYWORDS:** vertical tube thermo , curie point, irregular warm.

### INTRODUCTION:

The high curie temp & rectangular B-H loop characteristics have made these materials useful for latching devices (such as phate sniffers). The temperature at which spontaneous magnetization ' $M_s$ ' of a ferromagnetic / ferrimagnetic substance becomes zero is called as Curie temperature<sup>(1)</sup>. This temperature is the same as temperature at which susceptibility  $\chi$  becomes infinite i. e.  $1/\chi$  becomes zero<sup>(2)</sup>. The spontaneous magnetization  $M_s$  decreases with increasing temperature and at some critical temperature known as Curie temperature ( $T_c$ ), the thermal energy exceeds exchange energies. Above  $T_c$ , a ferromagnetic / ferrimagnetic material behaves as a paramagnet and obeys Curie-Weiss law<sup>(3)</sup>.

In the spinel structure each octahedral ion favorably interacts with six tetrahedral ions and each tetrahedral ion with twelve octahedral ions. The maximum number of such  $Fe^{3+}_{(A)}-O^{2-}-Fe^{3+}_{(B)}$  interaction linkages in a hypothetical spinel with all the three cations in the formula unit as the  $Fe^{3+}$  ions is, therefore, twenty four while this number is eighteen for Li-ferrite. The overall strength of these A-B interactions determines the Curie temperature of the compound<sup>(4)</sup>. In this view an attempt has been made in the present paper to study the curie temperature measurements in Cd, Mn and Ti substituted Li ferrite.

### EXPERIMENTAL

The series  $Li_{0.5}Cd_xTi_xMn_{0.1}Fe_{2.4-2x}O_4$  with  $x = 0.0, 0.1, 0.2, 0.3, 0.4$  &  $0.5$  prepared by standard ceramic technique by using pure metal oxides. The Curie temperature values ( $T_c$ ) were determined from  $\chi_{ac} \rightarrow T$  and  $\mu_i \rightarrow T$  measurements. For  $\mu_i \rightarrow T$  measurement, HP-4284A precision LCR-Q meter was employed. For  $\chi_{ac} \rightarrow T$  measurement double coil set up was used. The Curie temperature of a ferromagnetic material can be measured in two different ways.

The susceptibility can be measured as a function of temperature above the Curie temperature. From the equation  $\chi = C / (T - \theta)$ , a graph of  $\chi^{-1} \rightarrow T$  should give a straight line, reaching zero at  $T = \theta$  fig. 1.1 In practice the line becomes curved near  $T = \theta$  and has to be found by extrapolation from higher temperatures. The values measured in this way are a paramagnetic Curie temperature.

The magnetization can be measured as a function of temperature below the Curie temperature. The temperature at which spontaneous magnetization  $M_s$  becomes zero is ferromagnetic Curie temperature. However in order to measure the spontaneous magnetization, a magnetic field  $H$ , must be applied in order to produce uniform magnetization in the sample (i.e. drive out domain walls). This field affects  $M_s$ . At low temperature the increase of  $M_s$  with  $H$  is small, but as Curie temperature is approached,  $M_s$  varies more and more strongly with  $H$ . The result is that the measured magnetization is greater than  $M_s$ , the difference between two increases as temperature increases. At Curie temperature where  $M_s = 0$ , the measured magnetization will not be zero. To measure Curie temperature, the magnetization should be measured for a number of different values of  $H$  as a function of temperature. Now,  $M_s \propto (\theta_c - T)^{1/2}$  near Curie temperature. A plot of  $M_s \rightarrow T$ , is parabolic when  $T = \theta_c$  fig. 1.2 (I)

Fig 1.2(I) shows variation of  $M_s$  and measured magnetization with each other as Temperature decreases. If we plot  $M^2 \rightarrow T$ , Curie approximates a straight line fig. 1.2 (II), so that  $\theta_c$  can be found more accurately by extrapolation.

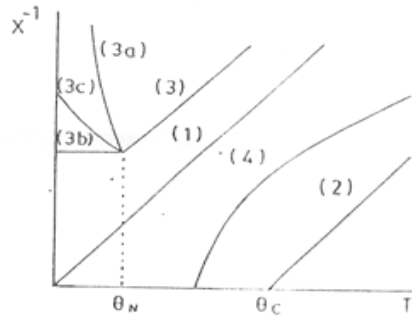


Fig.1.1 : VARIATION OF  $\chi^{-1}$  WITH T FOR (1) PARAMAGNETIC, (2) FERROMAGNETIC, (3) ANTIFERROMAGNETIC AND (4) FERRIMAGNETIC MATERIALS.

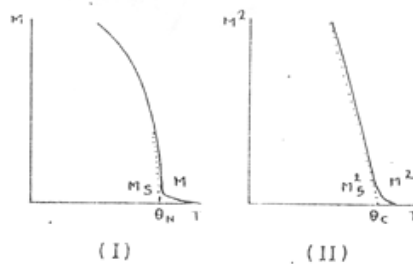


Fig.1.2 : METHODS OF PLOTTING MEASURED MAGNETIZATION M AGAINST TEMPERATURE T TO DETERMINE THE CURIE TEMPERATURE.

## RESULTS AND DISCUSSION

The Curie temperature is temperature at which spontaneous magnetization of ferromagnetic or ferrimagnetic material becomes zero. It is also defined as temperature at which relative permeability  $\mu_r = 1$ .

The rapid falling of  $\mu_i$  from Hopkinson temperature is generally confined to small arc of curve and approaches the value  $\mu= 1$  at somewhat higher temperature. This implies that there is no unique Curie temperature, but temperature over which Weiss domain disappears<sup>(5)</sup>.

**Table 1. Data on Curie temperature by d.c. resistivity, susceptibility and permeability measurements and kTc values**

x	Curie temperature Tc (°C)			
	Resistivity d.c	Susceptibility	Permeability	KTc (e v)
0.0	---	----	650	0.0560
0.1	530	525	525	0.0452
0.2	400	406	400	0.0345
0.3	310	305	300	0.0258
0.4	200	210	200	0.0172
0.5	150	150	150	0.0129

Table 1 gives data on Curie temperature determined by various techniques i.e.  $\log \rho \rightarrow (10^3/T)$ ,  $\chi_{ac} \rightarrow T$  and  $\mu_i \rightarrow T$  variation. It is clear from table 1 that with increase in  $Cd^{2+}Ti^{4+}$  content in the ferrite system the curie temperature goes on decreasing.

The decrease in Curie temperature with increasing x. This change with Cd Ti is dependent upon the cationic distribution and spacing in the crystal structure witch determines the number and strength of the  $Fe_A - Fe_B$  bonds. The increase in  $Cd^{2+}Ti^{4+}$  concentration by x has an effect of reducing the  $Fe^{3+}$  ion concentration to  $(2.4-2x)$ , while the concentration of  $Li^{1+}$  ion in the system is fixed.  $Li^{1+}$ ,  $Cd^{2+}Ti^{4+}$  ions are nonmagnetic. In our system the contribution to the A-B interaction is only from  $Fe_A^{3+}-O-Fe_B^{3+}$  linkages. Thus the total number of  $Fe^{3+}$  ions at A and B sites governs the behavior of Tc.

**CONCLUSION**

With the increase of x, the total number of  $Fe^{3+}$  ions is reduced. The thermal energy required to offset the spin alignment decrease, which decreases the Curie temperatures. The experimental Tc values match perfectly well with the values determined from  $\log \rho$  Vs  $1/T$ ,  $\chi/\chi_{RT}$  Vs T, and  $\mu_i$  Vs T. This is in agreement with the observations made by Argentina and Baba<sup>(6)</sup> for Li -ferrite.

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