A Study of Composite Material-" Lithium-Cadmium-Copper Ferrite"- Curie Temperature

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Abstract- Ceramic magnets became commercially available in the 1950's (Alnico magnets were the first true magnets to be introduced n the 1930's).There are currently 27 grades of Ferrite Permanent Magnet available. Ferromagnetic, Paramagnetic, and Antiferromagnetic materials are all made up of intrinsic magnetic moments. Magnetic moments depend on temperature as thermal disorder destroys alignment between dipoles. It is at this temperature point, the Curie temperature where the materials change from Ferromagnetic order to Paramagnetic order or vice versa. Ferrite is ceramic material with magnetic properties, is useful in many types of electronic devices and building materials.. It is the component which gives steel and cast iron their magnetic properties, and is the classic example of a ferromagnetic material. Our observations is that the Curie temperature decreases with addition of Cu^{2+},Cd^{2+} ions tends to decrease the number of A-B interactions. This may be due to A-O-B distance. Due to thermal vibrations, the magnetic A-B interactions in ceramic material are broken at Curie temperature.

Index Terms- Ceramic material, , Ferromagnetic material, Curie temperature, A-B interactions.

I. Introduction

In physics and materials science, the Curie temperature (Tc), or Curie **point**, is the critical point of a second order phase transition where magnetic moments change their orientations. Ferromagnetic, Paramagnetic, Ferromagnetic and A ntiferromagntic materia have different structures of intrinsic magnetic moments that depend on temperature. It is at a material specific Curie temperature where they change properties.

Ferrite, a ceramic-like material with magnetic properties, is useful in many types of electronic devices and building materials. They are composed of iron oxide and one or more other metals in chemical combination. Ferrites are hard, brittle, generally gray or black, and typically have a crystal structure which has more than one type of site for the cations. Usually the magnetic moments of the metal ions on sites of one type are parallel to each other and anti-parallel to the moments on at least one site of another type. It is the component which gives steel and cast iron their magnetic properties, and is the classic example of a ferromagnetic material.

A large number of applications of ceramic materials depend on their electrical properties. Composite materials are formed from combination of two or more single phase compounds. Physical properties of composites are determined by the properties of their constituent phases and the interaction between them. Composite have some properties which give rise to sum of their constituents. The electrical properties of composite are quantitatively considered as sum properties of their individual electrical and ionic behavior. In industrial electronics Ferrites are play an important role as material.

II. EXPERIMENTAL SET UP

For Curie temperature measurement we require proper arrangement .which is shown in Fig.1.

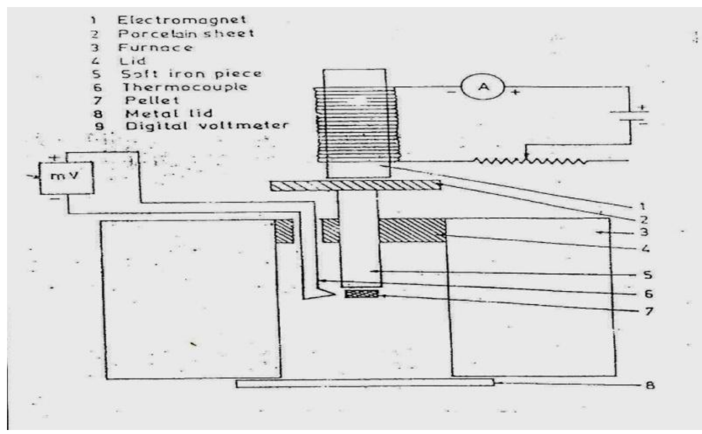


Fig.1 Experimental set up

Set up consist of

- Tabular furnace- For heating purpose.
- Soft iron rod-For holding sample in pellet formation.
- Dimmerstat –For changing voltage required for heating purpose.
- D.C.Supply-For maintaining supply given to pellet.
- Pellet sample

III. EXPERIMENTATION

3.1 Experimental methods

A transition temperature marking a change in the magnetic or ferroelectric properties of a substance, especially the change from ferromagnetism to paramagnetic. Also called Curie temperature.

Curie temperature is one of the important properties of microwave ferrite. There are few experimental methods to determine curie temperature T_C.

There are few methods for Curie temperature measurements as given below-

1. Loria method
2. Permeability method.

In this paper for measurement of Curie temperature we use famous method i.e .Loria method.

3.2 Preparation of Li-Cd – Cu Ferrite-

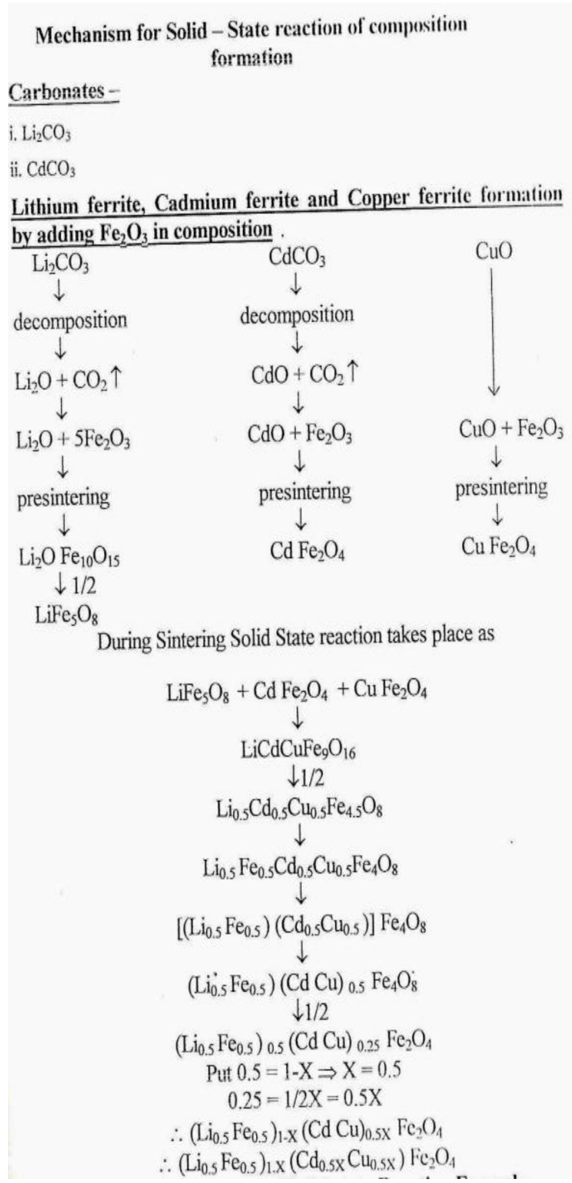
Ferrite arte homogeneous ceramic materials. Such material expressed by the molecular formula as MFe2O4 , where M is an oxide of divalent metal.

The process leading the formation of ferrite from their oxide component belongs to the class of solid state reaction. This solid state reaction is between two solids resulting in the formation of new solid.

The ferrite preparation methods have been classified in three category

1. Ceramic Method.
2. Pre- cursor Method.
3. Wet chemical Method.

For formation of sample we use ceramic method , and sintering process play an important role in ferrite sample preparation. as shown



Mechanism

Such mechanism has been discussed on the basis of the simple diffusion couple, involving divalent metal and iron oxide. To initiate the mechanism , homogenous mixture of the metal oxide(MO) and ferrite oxide (Fe2O3).is heated at an elevated temperature.

MO	Fe2O3

One phase boundary

MO	MFe2O4	Fe2O3

Two phase boundary

Transfer Mechanism

Such transfer mechanism can be discussed in three mode as Mode1, Mode2, Mode3.

Mode1-

In such mode only cations migrate in the opposite direction and oxygen ions remains stationary.

Mode2-

In such mode diffusion of cations is compensated by an associated flux of anions instead of another cation migration.

Mode3-

In such mode the diffusion of iron through ferrite layer in the reduced state Fe 2+

Sample preparation

The general formula of ferrite system is $(Li_{.5}Fe_{.5})$1-x$(Cd_{.5x}Cu_{.5x})Fe_2O_4$where x=0,0.1,0.2,0.3,0.4,0.5,0.6,0.8 and 1. The AR grade of oxides of Li_2O_3,$CdCo_3$,CuO,Fe_2O_3were used for the preparation of the sample.

By putting x=0,0.1,0.2,0.3,0.4,0.5,0.6,0.8 and 1 in the general formula. We have calculated weights of Li_2O_3,$CdCo_3$,CuO,Fe_2O_3.Then according to calculated weights carbonates and oxides were weighted on a sensitive mono- pan balance.

Table 1

Sample Notation	Composition
M0	X=0
M1	X=0.1
M2	X=0.2
M3	X=0.3
M4	X=0.4
M5	X=0.5
M6	X=0.6
M7	X=0.8
M8	X=1

3.3 Procedure-

A schematic set up of the curie temperature measurement of ferrite sample is as shown.

Fig.2 Photograph of set up

The electromagnet and soft iron rod were well insulated from each other using porcelain sheet.

The soft iron rod kept at the centre of the furnace got magnetized due to induced magnetation.

One end of chromel- alumel junction was kept in the vicinity of the sample in order to measure temperature of furnace and as result Curie temperature of a sample. A digital multivoltmeter was used for the temperature measurement equivalent to emf.

A sample of which T_C was to be measured , introduced into the furnace with the aid of metallic lid . the current in the heating coil was raised gradually to heat the sample upto its Curie point. When temperature reached at which ferrite looses its magnetation and drops under gravity,this temperature was measured by digital multivoltmeter.

IV. RESULT AND DISCUSSIONS

The data of Curie temperature obtained by Loria technique is presented in Table 2.

Table 2

Sample Notation	Composition	Curie temperature ^oC
M0	X=0	645 ^oC
M1	X=0.1	540 ^oC
M2	X=0.2	470 ^oC
M3	X=0.3	420 ^oC
M4	X=0.4	365 ^oC
M5	X=0.5	370 ^oC
M6	X=0.6	330 ^oC
M7	X=0.8	345 ^oC
M8	X=1	280 ^oC

We observed that the curie temperature decreases with addition of Cu^{2+},Cd^{2+} ions which tends to decrease the number of A-B interactions. This may be due to A-O-B distance.

Due to thermal vibrations, the magnetic A-B interactions in spinet ferrites are broken at Curie temperature.

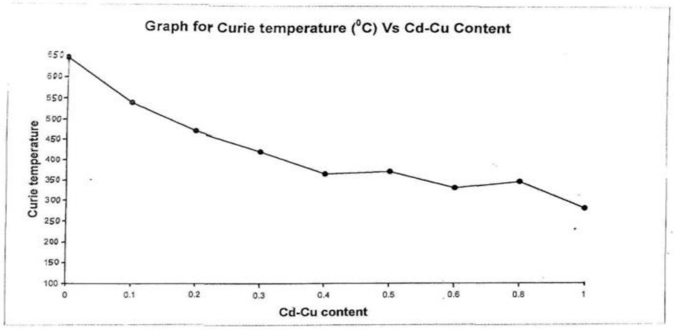


Fig.3 Variation of Curie temperature

Graphical variations of T_C with increasing Cd-Cu content is shown in Fig.3.This graph shows that all compositions are magnetic, which is verified also by Hysteresis loops. It is also observed that T_C decreases with deceases of Li concentration, which is attributed to decrease of A-B interaction force.

V. CONCLUSIONS

1. T_C value of Li ferrite agrees well with reported values [1].
2. The magnetic A-B interactions in spinet ferrites are broken at Curie temperature.
3. The addition of Cd^{2+} ions tends to decrease number of A-B interactions.

NOMENCLATURE

Cu^{2+}- Copper divalent metal ions.
Cd^{2+} -Cadmium divalent metal ions.
T_c - Curie temperature.
M- Oxide of divalent metal.
A-B interactions.
M0- Sample notation for X=0

REFERENCES

[1] Vijan"Magentic Properties of Materials" Inter university Electronic series Vol 13,88,Mac Graw Hill Publication ,1977.

[2] M.S.Sagare Ph.D Thesis, Shivaji University Kolhapur,1994.

[3] Loria K.K. and Sinha A.P.B ,Indian J.Pure and Applied Physics.Vol1,pp215-219(1993)

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