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Hysteresis measurements in composite non - magnetic ion substituted Li-ferrite

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ABSTRACT

Characterization of magnetic cores is an indispensable task in order to securely accomplish the requirements of a power electronic design and prevent failures. The hysteresis cycle of the material is one of the more complex features to characterize due to the well-known nonlinear and memory effects. Lithium ferrites with different cation substitutions have attracted the attention of researchers for a long time and been developed as a replacement for yttrium iron garnet (YIG) due to their low cost. They are important components for the microwave devices and memory core owing to their high Curie temperature, high saturation magnetization and especially hysteresis loop properties offer performance advantage over other spinel structure. In this view an attempt has been made in the present paper to study the hysteresis measurements in Cd, Mn and Ti substituted Li ferrite.

KEYWORDS

Ferrite;
Hysteresis;
Saturation magnetization.

INTRODUCTION

Lithium ferrites suitably substituted with a variety of cations in the crystalline structure exhibit a wide range of properties for use in many applications at microwave frequencies. There is adequate choice for the design engineer to select appropriate material as per his requirement from the number of possible series of the materials developed. The high Curie temperatures and rectangular B-H loop characteristics have made these materials useful for latching devices (such as phase shifters). For increasing the power handling capability of the material in high power devices, fast relaxing ion substitutions in ferrite is a versatile method adopted. The electric and magnetic properties of Lithium ferrites can be modified by the substitution of Fe^{3+} on either the tetrahedral A or octahedral B sub-lattices thus allowing the material to be tailored for specific applications[1]. They have high Curie temperature, square loop hysteresis, high saturation magnetization values and are less stress sensitive[2,3]. Literature survey suggests that the work on non magnetic ion substitution in Li ferrites is very much poor though there is a possibility of reducing the magnetic losses. Hence in the present paper, results of hysteresis measurement in composite non- magnetic ion (Cd and Ti ions) substitution in Li-Mn ferrite are communicated.

EXPERIMENTAL

The following series labeled A and B were prepared using Ceramic method.

$Li_{0.5}Cd_xTi_xMn_{0.1}Fe_{2.4-2x}O_4$ (series A) and $Li_{0.35}Cd_xTi_xMn_{0.1}Fe_{2.55-2x}O_4$ (series B) with x = 0, 0.1, 0.2, 0.3, 0.4, 0.5. The magnetization studies were carried out on the ferrite system using VSM technique EG and GPARC Model-4500 at National Chemical Laboratory, Centre for Materials Characterization (CMC), Pune.

RESULTS AND DISCUSSIONS

The XRD showing confirmation of spinel phase formation is the present samples is communicated elsewhere[4]. The Hysteresis loop (or B-H Curve) of one representative sample is shown in Figures 1 which again confirms the soft ferrite formation The hysteresis loops are narrow which indicate that all compositions are multidomain (MD) type. . Hc- the coercive force and Mr/Ms the squareness ratio exhibit decrease with substitution of $Cd^{2+}Ti^{4+}$ in $Li_{0.5}Cd_XTi_XMn_{0.1}Fe_{2.4-2x}O_4$ system. From table 1, it is clear that, the saturation magnetization (MS) and magnetic moment (nB) decreases continuously in $Li_{0.5}Cd_xTi_xMn_{0.1}Fe_{2.4-2x}O_4$ ferrite with increase in composition parameter X and is obvious as non magnetic ion substitution. But surprisingly, again from table 1 $Li_{0.35}Cd_xTi_xMn_{0.1}Fe_{2.55-2x}O_4$ compositional variation of M_S and n_B with $Cd^{2+}Ti^{4+}$ (i.e. X) shows increase of M_s and n_B up to X = 0.3. The decrease of M_s and n_B for X>0.3 is attributed to canted spin due to substitution of Cd^{2+} and additional canting due to excessive addition of Ti^{4+} in system. This canting effect may be masked in the first series labeled as A, because of the content of Li being comparatively higher and lower value of ferric ion being replaced. The possibility of microstructural changes like microstress and strain developed during formation of the series A cannot also be ruled out.

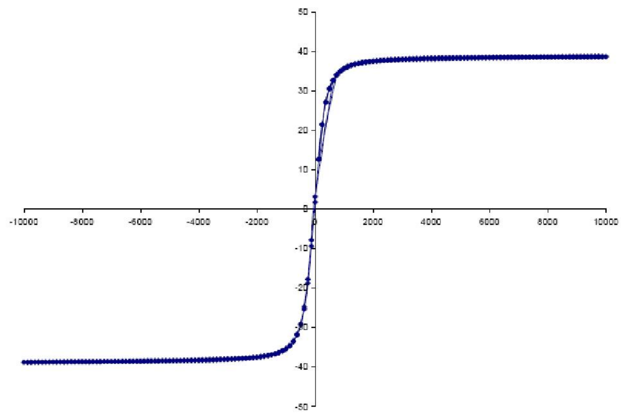

Figure 1 : Magnetisation(M) ⟶ magnetic field (H) for $Li_{0.35}Cd_{0.3}Ti_{0.3}Mn_{0.1}Fe_{1.95}O_4$

TABLE 1 : Compositional variation of $4\pi M_s$, n_B, Hc and M_r/M_s for ferrite series A and B.

X	$4\pi M_s$(emu)		nB		Hc Oe		M_r / M_s	
	SeriesA	SeriesB	SeriesA	SeriesB	SeriesA	SeriesB	SeriesA	SeriesB
0	3752	2321	2.34	1.45	---	24	---	0.831
0.1	3124	2324	2.02	1.47	15	13	0.931	0.834
0.2	3027.	2301	1.96	1.49	10	10	0.766	0.844
0.3	2307	2422	1.51	1.59	9	9	0.733	0.854
0.4	1924	1750	1.27	1.16	6	7	0.823	0.869
0.5	816	1537	0.55	1.02	5	6	0.590	0.896

CONCLUSIONS

The achievement of the present work is that both magnetization and resistivity (communicated in 4) showed an increase in value when compared with the values of other non magnetic ion substituted ferrites synthesized by Pran Kishan[5], Nitendar Kumar[6], Yen- Pei Fu[7] using other refined techniques.

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