Review Of Research

ISSN: 2249-894X Impact Factor : 3.8014(UIF) Volume - 6 | Issue - 3 | December - 2016

MAGNETIC PROPERTIES OF $Y_{3-X}Eu_XFe_5O_{12}$ (x= 0.0 to 0.5) SYSTEM

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ABSTRACT:
Samples of $Y_{3-X}Eu_XFe_5O_{12}$ (X= 0.0 to 0.5) were prepared by using high purity Y_2O_3, Eu_2O_3, Fe_2O_3 and using ceramic technique. The oxides were mixed thoroughly in stoichiometric proportions to yield the desired composition and wet ground. The mixture was dried and presintered at 1050^{0}C for 24 hours in air and cooled to room temperature. The powder was reground and pelletized using hydraulic press. The cylindrical pellets were finally sintered at 1350^{0}C for 24 hours and slowly cooled to room temperature at the rate of 2^{0}C per minute to obtain garnet phase. The magnetization results suggest that magneton number decreases with Eu substitution.

KEYWORDS:
Saturation magnetization, magneton number, Yttrium iron garnet.

INTRODUCTION:

Ferrite garnets are uncompensated anti-ferromagnetism and exhibit many interesting anomalies which shade light on the nature of anti-ferromagnetization and on the relationship between physical property and crystal structure.

The ferromagnetic oxide yttrium iron garnet (YIG) is an important material for a number of technical applications.

Depending on the type of application, it is used in the form of bulk, single crystal, epitaxially grown thin film or polycrystalline sintered samples. These three forms are necessarily properties, e.g. resistivity, optical absorption, lattice constant and photo magnetic properties [1].

Yttrium iron garnet (YIG) is a microwave ferrite and in polycrystalline from has specific characteristics. Yttrium iron garnet in solid solution have become technologically significant for making devices, owing to their efficient for handling of microwave power [2]. It is well know that the microstructure of these materials depends on the microstructure of these materials depends on the initial powers and methods used in the synthesis of garnets. They can be prepared by not pressing [3], co-precipitation, hot spraying yttrium iron garnet show wide variety of interesting magnetic properties [4-5].

Thus, the study of electrical and magnetic properties of pure yttrium iron garnet and substituted yttrium iron garnet is important from the theoretical and application point of view. The magnetic crystallographic properties of pure yttrium iron garnet and substituted yttrium iron garnet have been studied extensively [6-8]. To our knowledge very few reports of the structural, electrical and magnetic properties of substituted yttrium iron garnet are available in the literature [9-11]. In the present work, systematic investigations of magnetic properties of $Y_{3-X}Eu_XFe_5O_{12}$ (x= 0.0 to 0.5) system were carried out.

EXPERIMENTAL:

The magnetization measurements were carried out using high field hysteresis loop technique [12] at 300K. Using hysteresis loop technique the saturation magnetization (σ_s) and magneton number (n_B) were obtained.

RESULT AND DISCUSSION:

The values of saturation magnetization'σ_s' and magneton number 'n_B' (the saturation magnetizations) per formula unit in Bohr magneton) at room temperature were obtained from

Table 4.1: Saturation magnetization (σ_s) and magneton number n_s (μ_B) for $Y_{3-x}Eu_x Fe_5O_{12}$ system (x = 0.0 to 0.5)

Com 'x'	σ_s (emu/g)	Magneton number n_s (μ_B)		Magneton number n_s (μ_B) normalized	
		Obs.	Cal.	Obs.	Cal.
0.0	33.67	4.448	5.000	1.000	1.000
0.1	27.19	3.624	4.778	0.816	0.956
0.2	21.76	2.923	4.556	0.657	0.911
0.3	18.65	2.527	4.334	0.568	0.867
0.4	16.58	2.265	4.112	0509	0.822
0.5	15.54	2.141	3.900	0.481	0.780

From the field dependence of magnetization and observed magnetic moment (Table 4.1), it can be seen that both saturation magnetization and magneton number decreases with increase in 'x'. The variation of magneton number with Eu substitution is represented in Fig. 4.5. It is evident from Fig. 4.5 that the decrease in 'n_s' is sharp up to x =0.3. For x > 0.3, the decrease in 'n_s' is rather slow.

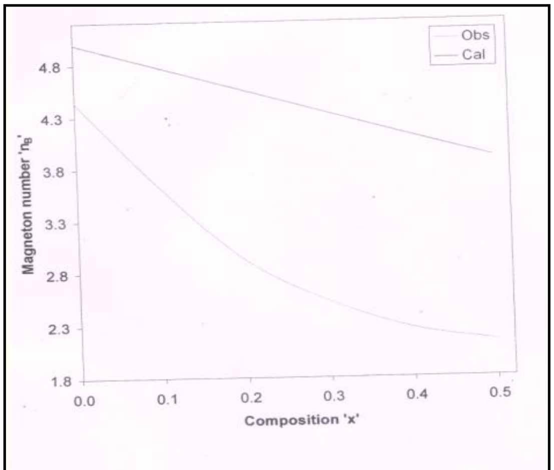

Fig.4.5 Variation of observed and calculated magneton number 'n_B' with concentration 'x' for the system $Y_{3-x}Eu_xFe_5O_{12}$

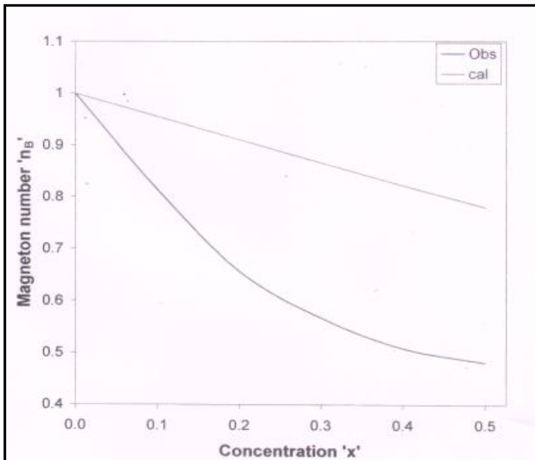

Fig. 4.6 Variation of normalized calculated and observed magneton number 'n_B' with concentration 'x' for the system $Y_{3-x}Eu_xFe_5O_{12}$

This indicates that ferromagnetic behaviour decreases with increasing Eu substitution. In the present series of $Y_{3-x}Eu_xFe_5O_{12}$, the magnetic Eu^{3+} ion occupies dodecahedral(c) site. Though, the magnetic moment of dodecahedral (c) site increases because of magnetic Eu substitution (0.74μ_B), but the net magnetic moment of the garnet system $Y_{3-x}Eu_xFe_5O_{12}$ decreases. Hence, we observe decrease in magnetic moment of $Y_{3-x}Eu_xFe_5O_{12}$ with Eu substitution. The value of magnetic moment of pure yttrium iron garnet (YIG) i.e. for x=0.0 in the present series, calculated in this manner agrees fairly well with the reported values [13]. According to Neel's model' the magnetic moment per formula unit in μ_B, n_B^N at OK is expressed as [14]

$$n_B^N = M_D(x) - (M_A - M_c)$$

Were,M_D, M_A and M_c are the d, a and c sub-lattice magnetic moment in μ_B respectively.

Using the cation distribution (eq. 4.8) and taking ionic magnetic moments of yttrium (Y^{3+}), europium (Eu^{3+}) and ferric (Fe^{3+}) as 0 μ_B, .74 μ_B and 5 μ_B respectively, we have calculated the Neel's magnetic moment of all the samples of $Y_{3-x}Eu_x Fe_5{}^d O_{12}$. The calculated moment values of all the samples are given in Table 4.1. It is clear from Table 4.1 that calculated magneton number decreases with increasing in Eu substitution. The variation of calculated magnetic moment is shown in Fig. 4.5. Since the calculated Neel's moment are valid at OK, we have calculated the ratio of $n_B(x) / n_B$ (o) for x = 0.0 to 0.5 and the values are presented in Table 4.1.

Fig. 4.6 depicts the variation of normalized calculated and observed magneton number with Eu substitution.

CONCLUSION:

The magnetization results suggest that magneton number decreases with Eu substitution. The observed and calculated magneton number shows discrepancy in their values. The plots of x_T/x_{RT} (RT = room temperature) exhibit normal ferromagnetic behaviour which reduces with Eu substitution.

ACKNOWLEDGEMENT:

The author is thankful to Prof. Dr. K. M. Jadhav, Department of Physics, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad for his guidance and support.

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