International Journal of Recent Research and Review, Vol. X, Issue 4, December 2017
ISSN 2277 – 8322

Electromagnetic Properties for Ferrite Hard/Soft and Composite

Raghad A. Majed[1], Tahsein H. Mobarak[2]
[1] *Department of physics, Faculty of science, Diyala University, Iraq*
[2] *Department of physics, Faculty of science, Diyala University, Iraq*
Email: rag.adnan9090@gmail.com

Abstract - In present work, were prepared hexagonal hard ferrites of barium and strontium according to the chemical formula ([$Ba_{(1-x)}Sr_{(x)}Fe_{12}O_{19}$]) and the values of (X=0,0.25,0.5,0.75,1) by using sol – gel method with auto-combustion. The powder was calcined at 900 ° C for one hour. Then it was prepared soft nickel ferrite, and prepared the composites Consisting of hard and soft ferrite Where it was selected sample for largest magnetic saturation and mixed with nickel ferrite according formula [$(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{(1-x)}(NiFe_2O_4)_{(X)}$]. And by using VSM test getting a hysteresis loop is large for hard ferrite inverse soft ferrite it has small hysteresis loop, and can be note the hysteresis loop will be larger as the added hard ferrite more of the soft nickel ferrite for composite.

Keywords **- Barium hexaferrite, Strontium hexaferrite, hysteresis loop, ferrite.**

I. INTRODUCTION

Hexagonal M ferrites are the most commercially important magnetic materials and widely used as permanent magnets [1]. The high demand for these materials is due to their low production cost, high magnetic anisotropy and superior corrosion resistivity [2,3]. Sol–gel [4], citrate precursor method [5], hydrothermal [6], auto-combustion synthesis [7] . It has been reported that barium and strontium ferrites can be heat treated in presence of nitrogen, hydrogen or carbon containing gasses to achieve high saturation magnetization and low coercivity values which makes these materials suitable for using in recording media such as hard disks, cassette and video tapes [8]. And it has a lot of type's ferrites like Hexagonal hard such as $SrFe_{12}O_{19}$ and $BaFe_{12}O_{19}$ are considered to be the most particulate media for perpendicular recording due to their chemical, morphological and magnetic characteristics such as mm-devices, master tapes, magnetic heads and several others [9]. Spinel nickel ferrite (NiFe2O4) has attracted highly attentions due to its room temperature magnetic behavior, high chemical stability, and high Curie temperature. It has technological applications in catalysis [10], high frequency microwave devices [11], magnetic recording devices [12] and spintronics devices [13].And the composite is consists of two (or more) discrete materials, which is composed of groups, ceramics, metals, and polymers. The objective of a composite is to synthesis a complex of characteristics that is not present by any individual material, and also to combine the best properties of whole of the ingredients materials. A great number of composite categories exist that are performed by different integration of ceramics, metals, and polymers. The biggest advantage of modern composite materials is that they are light as well as strong. By choosing an appropriate combination of matrix and reinforcement material, a new material can be made that exactly meets the requirements of a particular application. Composites also provide design flexibility because many of them can be molded into complex shapes. The downside is often the cost. Although the resulting product is more efficient, the raw materials are often expensive [14].

II. EXPERIMENTAL PART

The practical part includes several stages: First: Hexa-ferrite barium and strontium were prepared according to the chemical formula [$Ba_{(1-x)}Sr_{(x)}Fe_{12}O_{19}$]and X=(0,0.25,0.5,0.75,1) from this values and formula can be get five sample from ferrite barium and strontium and different ratios, these compounds are prepared by using(sol – gel) auto-combustion technique, and then treated heat at temperature 900°CFor one hour only Were obtained of Ferrite-hexagonal without secondary phases, After the preparation of the powder ferrite, the samples were formed as rings and were calcined at 900 ° C for two hours. When the VSM test was done for these samples, the hysteresis loop were found for them and the data were known to have a magnetic resonance ($Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$) The highest magnetic permeability. Second: Prepared spinel ferrite nickel by using (sol – gel) auto-combustion technique and were calcined at 900 ° C for one hour. Were obtained of nickel ferrite without any secondary phase After the preparation of the powder nickel ferrite, the samples were formed as rings and were calcined at 900 ° C for two hours. When the VSM test was done for these samples, the hysteresis loop for nickel ferrite is small. Third: after Prepared hard and soft ferrite, then Prepared composites which is the mixing of the hard and soft ferrites. Where a sample of hard ferrite was selected after the examination of the hysteresis loop, Where the sample was found ($Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$) and is the sample that has the highest magnetic permeability (μ_s). To be mixed with the soft ferrite according to the chemical formula [$(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{(1-x)}(NiFe_2O_4)_{(x)}$] & X =(0.2,0.4,0.6,0.8). Thus we get four samples for the composites.

III. RESULTS AND DISCUSSION

In figs.(1-5) The hysteresis loop of hard ferrite is large and The magnetic susceptibility and coercive force are larger because barium and strontium are hexagonal hard ferrite that retain their magnetism even after the extinction of the extruded outer space. Where the values of ($\mu_s, \mu_{r,} H_c$) Change from one sample to another,In case (1): barium ferrite ($BaFe_{12}O_{19}$) The value of () is higher than the value of the strontium ferrite ($SrFe_{12}O_{19}$). Note that the addition of strontium to the barium The value of (μ_s) is less than in the case of pure barium or strontium, In the case of the addition of equal percentages of barium and strontium in the sample ($Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$),The ($\mu_s$) have the highest value. (H_c) is the highest value in the sample ($Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$) where the values of ($H_c$) between (2900 – 5500), As for magnetic permeability, its value as its predecessors is the highest value in the sample ($Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$). As shown in fig.(6) the hysteresis loop of the nickel ferrite, it's very narrow (semi-applicable) and long because of the fact that nickel ferrite from soft ferrites and these ferrites characterized by Narrow hysteresis loop, the loss of energy is very small, as for the values (μ_r, H_c, μ_s) are very few where the values are as follows (10.96,100,48.53). Also figs.(7-10) for the composite, it was observed that the higher the value of the nickel ferrite the less the value of the added hard ferrite, the more the hysteresis loop will be larger ie, the more the quantity of hard ferrite($Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$) the larger loop, which is similar to the hysteresis loop of hard ferrite, As well as for the values of (μ_r, H_c, μ_s) increases with the addition of added hard ferrite. These values can be illustrated for (μ_r, H_c, μ_s) for hard, soft and composites ferrites in the following table:

Sample		μ_s	H_c	μ_r
Hard	$BaFe_{12}O_{19}$	59.38	4940.96	32.28
	$Ba_{0.75}Sr_{0.25}Fe_{12}O_{19}$	49.58	2900.20	27.18
	$Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$	59.68	5500	33.56
	$Ba_{0.25}Sr_{0.75}Fe_{12}O_{19}$	52.85	5479.79	30.17
	$SrFe_{12}O_{19}$	51.22	5321.31	29.37
Soft	$NiFe_2O_4$	48.53	100	10.96
Comp.	$(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{0.8}(NiFe_2O_4)_{0.2}$	54.09	1800	30.05
	$(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{0.6}(NiFe_2O_4)_{0.4}$	53.33	1400	28.47
	$(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{0.4}(NiFe_2O_4)_{0.6}$	53.21	300	26.58
	$(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{0.2}(NiFe_2O_4)_{0.8}$	51.88	150	23.24

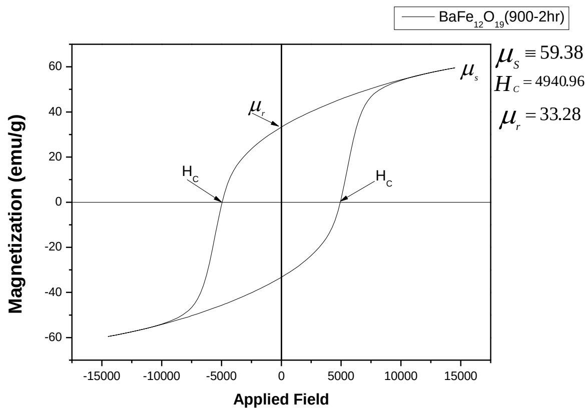

Fig. 1 shows the hysteresis loop of the hard barium ferrite ($BaFe_{12}O_{19}$) at 900 C^0

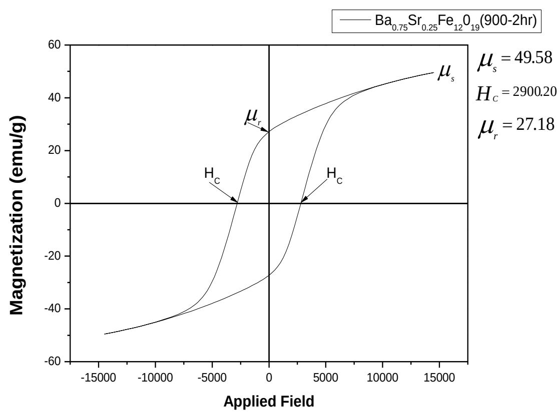

Fig. 2 shows the hysteresis loop of the hard barium strontium ferrite ($Ba_{0.75}Sr_{0.25}Fe_{12}O_{19}$) at 900 C^0

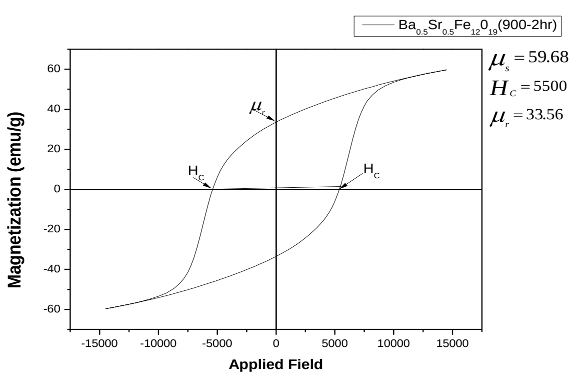

Fig. 3 shows the hysteresis loop of the hard barium strontium ferrite ($Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$) at 900 C^0

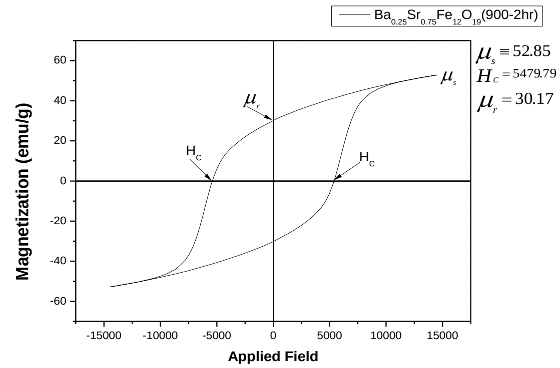

Fig. 4. shows the hysteresis loop of the hard barium strontium ferrite ($Ba_{0.25}Sr_{0.75}Fe_{12}O_{19}$) at 900 C^0

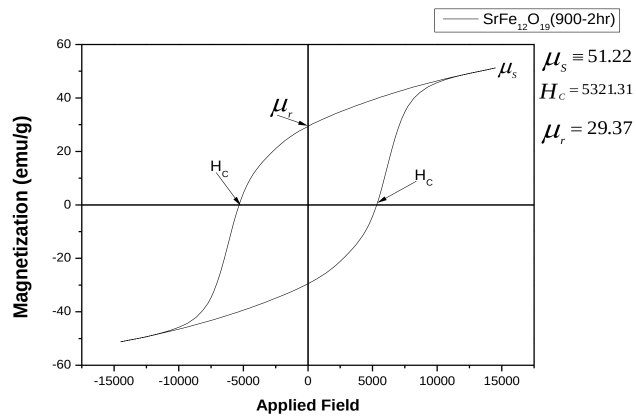

Fig. 5. shows the hysteresis loop of the hard barium strontium ferrite ($SrFe_{12}O_{19}$) at 900 C^0

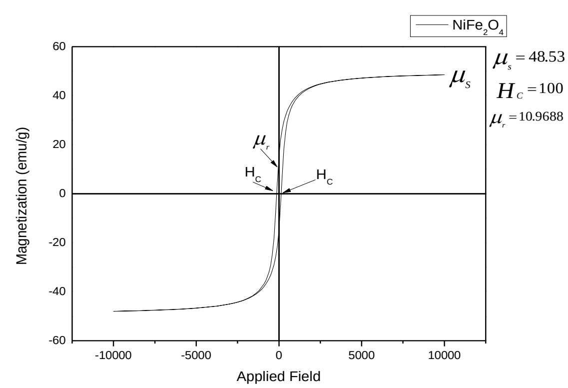

Fig. 6. shows the hysteresis loop of the soft nickel ferrite ($NiFe_2O_4$) at 900 C^0

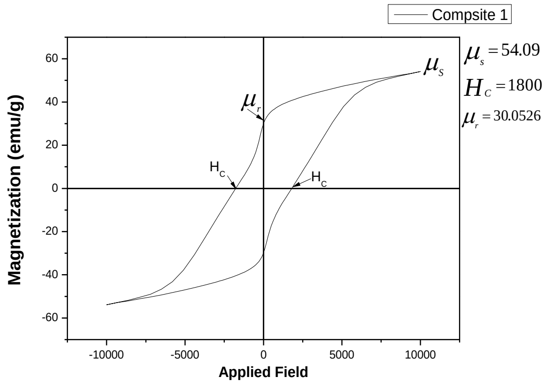

Fig. 7. shows the hysteresis loop of the composities $(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{1-x}(NiFe_2O_4)_x$ at 900 C^0,when (x=0.2)

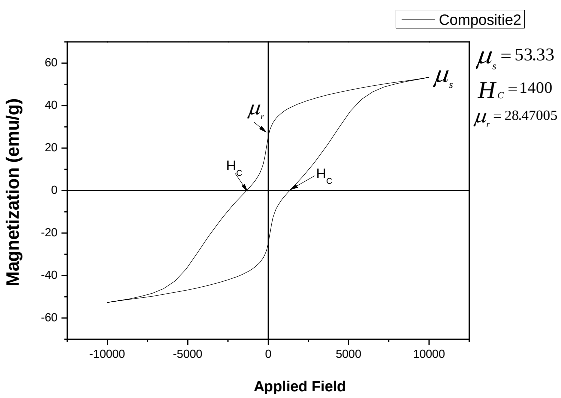

Fig. 8. Shows the hysteresis loop of the composities $(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{1-x}(NiFe_2O_4)_x$ at 900 C^0,when (x=0.4)

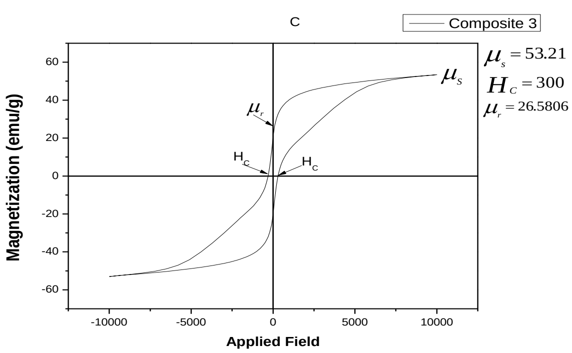

Fig. 9. shows the hysteresis loop of the composities $(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{1-x}(NiFe_2O_4)_x$ at 900 C^0,when (x=0.6)

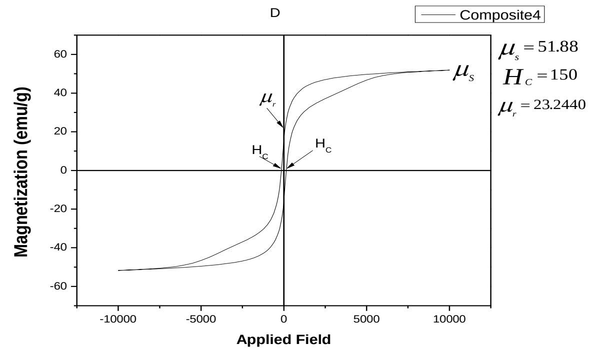

Fig. 10. Shows the hysteresis loop of the composities $(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})_{1-x}(NiFe_2O_4)_x$ at 900 C^0,when (x=0.8)

IV. CONCLUSIONS

In this research we can conclude that the energy losses in the hard ferrite are higher than in the soft and composite ferrite, due to the fact that hysteresis loop of the hard ferrite is greater as well as for the magnetic susceptibility also be larger so that the ferrites have a permanent storage, because they do not lose their magnetism as quickly as in soft ferrite so they are used in permanent magnets.

V. ACKNOWLEDGEMENT

At the conclusion of my research, I extend my thanks and appreciation to all that helped me and Yvotni to extend my sincere thanks to the Deanship of the Faculty of Science at the University of Diyala.

VI. REFERENCES

[1] Smit J, Wijn HPJ. Ferrites. Eindhoven: Philips Technical Library; 1959.

[2] Campbell P. Permanent Magnet Materials and Their Application. Cambridge: Cambridge University Press; 1994.

[3] Zhang L, Su XD, Chen Y, Li QF, Harris VG. Radio-frequency magnetron sputter-deposited barium hexaferrite films on Pt-coated Si substrates suitable for microwave applications. Scr Mater 2010;63:492–5.

[4] Li Y, Wang Q, Yang H. Synthesis, characterization and magnetic properties on nanocrystalline BaFe12O19 ferrite. Curr Appl Phys 2009;9(6):1375–80.

[5] Dimri MC, Kashyap SC, Dube DC. Electrical and magnetic properties of barium hexaferrite nanoparticles

prepared by citrate precursor method. Ceram Int 2004;30:1623–6.

[6] Liu Y, Drew MGB, Wang J, Zhang M, Liu Y. Efficiency and purity control in the preparation of pure and/or aluminum-doped barium ferrites by hydrothermal methods using ferrous ions as reactants. J Magn Magn Mater 2010;322(3):366–74.

[7] Shirtcliffe NJ, Thompson S, O'Keefe ES, Appleton S, Perry CC. Highly aluminium doped barium and strontium ferrite nanoparticles prepared by citrate auto-combustion synthesis. Mater Res Bull 2007;42:281–7.

[8] Bahgat M, Radwan M, Hessien MM. Reduction behavior of barium hexaferrite into metallic iron nanocrystallites.J.Magn Mater 2007;310:107–15.

[9] D. Speliotis, IEEE Trans. Magn. MAG 23 (1987) 25.

[10] Z. Wang, Y. Du, Y. Liu, B. Zou, J. Xiao, J. Ma, Degradation of organic pollutants byNiFe2O4/peroxymonosulfate: efficiency, influential factors and catalytic mechanism.RSC Advances. 6 (2016) 11040.

[11] Z.H. Shi, J. Zhang, D.Q. Gao, Z.H. Zhu, Z.L. Yang, Z.P. Zhang, D.S. Xue, Magnetic resonance of the NiFe2O4 nanoparticles in the gigahertz range. Nanoscale Res. Lett., 8 (2013) 404.

[12] P.J. Van Der Zaag, J.J.M. Ruigrok, M.F. Gillies, New options in thin film recordingheads through ferrite layers. Philips J. Res. 51 (1998) 173.

[13] J. Panda, S.N. Saha, T.K. Nath, Room temperature giant positive junction magnetoresistance of NiFe2O4/n-Si heterojunction for spintronics application. Physica B: Condensed Matter.448(2014)184.

[14] William D. Callister, Jr.“ Materials Science and Engineering”7th Edition,(2007).