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The Effect of Silica Sio_2 on the Dielectric and Physical Properties of Mn –Ni Ferrite

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Abstract

The effect of SiO) $_2$Silica) on the dielectric and physical properties of Mn_x-Ni_{-1} $_x Fe_2O$،،$_4$X=0.5 is studies. The samples are prepared by the conventional manufacturing method. We found that the physical and dielectric properties of Mn-Ni ferrite change considerably with the substituent samples . the variation of dielectric constant as a function of frequency of ferrite system decrease with frequency increases and increase with the increase the concentration of SiO. $_2$It was found that the increase of SiO $_2$concentration of all our samples produce an increase in mass density and decrease with porosities .
Key words: Ferrite – Silica – additives Dialectical and physical properties

Introduction

Ferrite have widely been used in different electrical engineering applications including radio and TV sets as well as carrier telephone as cores of inductors , transformers and so forth for their good electrical mechanical properties . The magnetic properties and grain boundary structure of Mn- Zn ferrite with addition Nb_2O_5 is studied by Inaba , et ,al in 1994 [1] .The addition to the main constituents small amounts of cationic additions are often used in ferrites Mn- Zn ferrites to improve the magnetic and electrical properties [2] are addition that appear at the grain boundary as a second phase very having . The effect is to increase bulk electrical resistivity of the ferrite on so reduce eddy currents for this purpose the usual additions are SiO_2 and CaO [2].

The kind and amount of substitution determines the properties. It is known that Mn-Zn ferrite with small amounts of additives such as SiO_2 , CaO,Ta_2O_5, Nb_2O_5 have good magnetic properties at high frequency [3] . A.A .SATTAR, et .al [4, 5] studied the rate earth substitution effect on the electrical and magnetic properties of Cu-Zn ferrites. Marked changes were observed for both electrical and magnetic behavior.

Experimental

The Ferrite Mn – $NiFe_2O_4$, x=0.5 was prepared by using ceramic technique involving solid state reaction using metal oxides in the form of grinding powers. The X – ray diffractometer is an instrument for studying samples. For phase identification and study of preferred orientation a full scan of 2□ from (10 -80 degrees), which were analyzed to calculate (d) (interatomic spacing) at to index (hkl). The relative intensities were taken from XRD pattern, using highest peak as reference Fig (1) , Table (1). The samples of the formula Mn_x-Ni_{1-x} Fe_2O_4 where X=0.5 and additives at different concentrations from Silica SiO_2 (1, 2, 5, 10, 15 wt%) were prepared by the ceramic method . The samples of composition were mixed for (5 hrs). After that, the mixture was pressed tp pellets with diameter 1cm and thickness 1 cm . These pellets were sintered at (1150 C^o) in air for (4 hrs) . The samples were then slowly cooled at rate of (2 C^o min) . The total porosity Pt is calculated according to the relation

Pt={ } 100%

where *Ws* is the weight in the air of the sample saturated with water , *Wd* is the dry sample weight in the air and *Wss* is the weight of saturated of water suspended in water .

Mass densities were measured by using Archimedes method with water as the immersion medium. The dielectric constant was measured by using Precision LCR meter model HP 4284 with scale 20Hz to 5 MHz . The surfaces of discs are polished. Air – dried silver epoxy electrical contacts were deposited , and the dielectric constant and dielectric loss tangent () were calculated using the formula :

= cd /A , =

where C is the measured capacitance , d is the thickness of the sample , A is the area of the capacitor plate ,$_o$ is the permittivity of free space and its value is $8.85x10^{-12}$ F/M - " is the loss factor being the imaginary part of complex permittivity .

Results and Discussion

Bulk density

Figure (2) shows the bulk density measured on the pellets sintered at (1150 C^o) in air for (4 hrs). It can be seen from the figure that with increase of SiO_2 – concentration the bulk density (ds) was found to be increase, as also discussed by Verma for different compositions [6]. Increase in bulk density can be attributed to the difference in specific gravity of the ferrite components.

Porosity

The variation of Porosity with SiO_2 concentration wt % for Mn-Ni ferrite was showed by Figure(3) . The higher temperature sintering generally brings about reduced porosity. According to references [7] and [8] at a higher sintering temperature , the number of pores is reduced consequently, grains come closer to each other. The grain to grain contact produces an increase of area which to leads to greater densification or less porosity.

Dielectric Properties

Figure (4) shows variation of the dielectric constant as a function of frequency for Mn-Ni Fe_2O_4 ferrite with different additives SiO_2 . concentration was found the dielectric constant decrease with the increases of frequency . The decrease of the dielectric constant with frequency is a normal dielectric behavior of spinal ferrite [9] and is due to reason that as the frequency of the externally applied field increases gradually though the number of the ferrous Ions is present in the ferrite materials , the dielectric constant decreases. The reduction occurs because beyond a certain frequency of the externally applied electric field , the electronic exchange between ferrous and ferric ions , i,e , Fe^{2+} Fe^{3+} , cannot follow the alternating field [10] . Figure (5) shows variation of the dielectric constant as a function of SiO_2 – concentration wt % for ferrite. It is clear from the figure the value of dielectric constant was found to increase with the increasing SiO_2 content , as polarization in ferrites has largely been attributed to the presence of Fe^{2+} ions which give rise to heterogeneous spinal structures [11] .

Conclusions

The effect of small amount from SiO_2 on the properties Mn-Ni ferrite was investigated in this study, and the results are summarized as follows:-

- He bulk density of Mn-Ni ferrite increases with the increase of SiO_2 content.
- The porosity of Mn-Ni ferrite decreases by the increase of SiO_2 content.

- The dielectric constant of Mn-Ni ferrite decrease by increasing frequency.
- The dielectric constant of Mn-Ni ferrite increases with the increase of SiO_2 content.

References

1.Inaba, H; Abe, T.; and Kitano , Y. (1994), magnetic materials, journal of Magnetism and magnetic materials ,133 (1-3) 487 – 489 .

2.Hussan ,S.S; Cameran ,M.; and kham, A. (1997) ,principles of material science and engineering, Science and Education. Z – 171.

3.Famt ,J.N; Bakb D. (1997),preparation of Ferrites by Wet method, J.Phys.College,7,Ci-73.

4.Sattar, A.A,and El . SHOKROFY, K.M. (1997) ,Ferromagnetic materials, J.Phy. Tv-Colege – (France) 7-C1 – 245.

5.Sattar, A.A ; WALK, A.H. ; EL . SHOKKOFY, K.M. and EL . TABBY M.M . , (1999) ,Theory and application of Ferrites,Phys – state .sol (a) 171 – 563.

6.Verma A. ; Geol T.C. ; Mendiratta R.G; and Aiam M.T. , (1999),Newdevelopments in Ferromagnetic materials, materials Sciene and Eng, B 60, 156 – 162 .

7.Mangalaraja, R.V. ; Anantha ,S and. Monohar, P ,Materials Letters , (2004),Soft Ferrities and applications, 58 :593 – 1596 .

8.Moinudin, M.K; and Ramana, S. (1993) ,Electricity and magnetism, Journal of alloys and compound, 194,105-107,

9.Abdeen, A.M. (1999) ,Introduction to fine Ceramics, Journal of Magnetism and magnetic materials , 192 ,121-129 .

10.Ranga, G. ; Ravinder, D. ; Ramana, A . V. and Boyanov B.S , (1999),The physical properties of magnetism, Masterials letters 40 ,34 – 45 .

11.Verma, A. ; Thakur, O.P. and Mendirata , R.G. (2005) , Materials Science and Engineering , B, 116 (1) :1-6 .

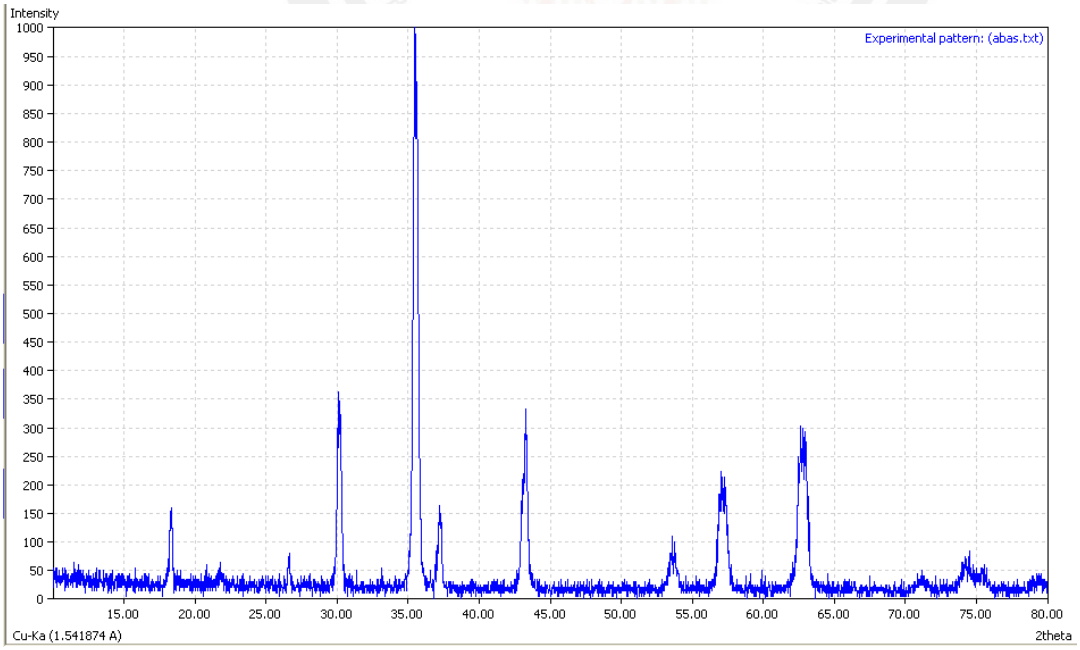

Fig.(1): X-ray diffraction of Mn- Ni Fe2O4
a= 1.914, b= 0.725, c=0.699

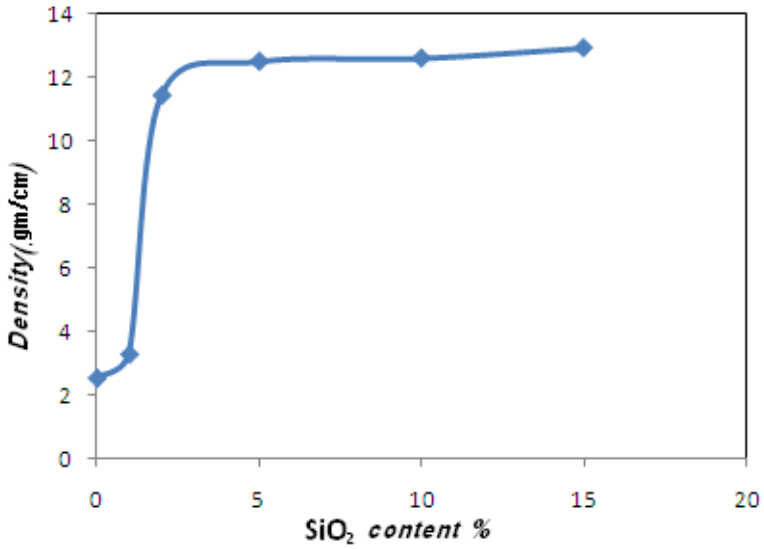

Fig.(2): Variation of density with SiO2 concentration wt % for Mn-Ni ferrite

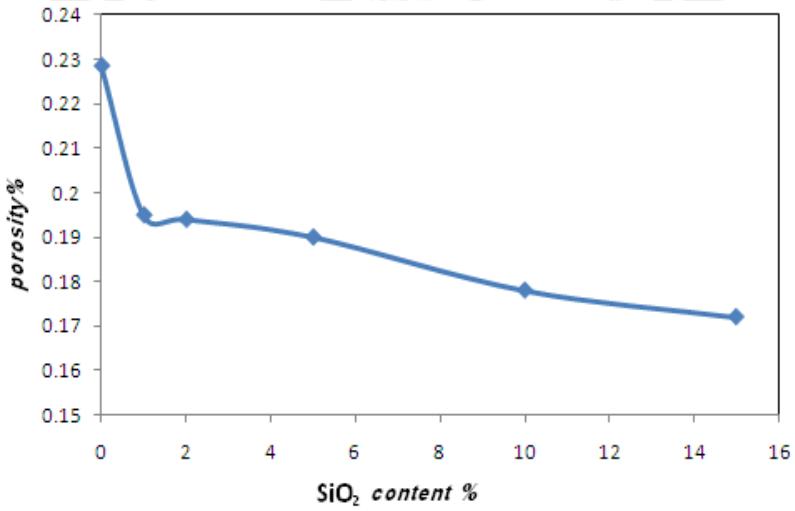

Fig. (3): Variation of Porosity with SiO2 concentration wt % for Mn-Ni ferrite

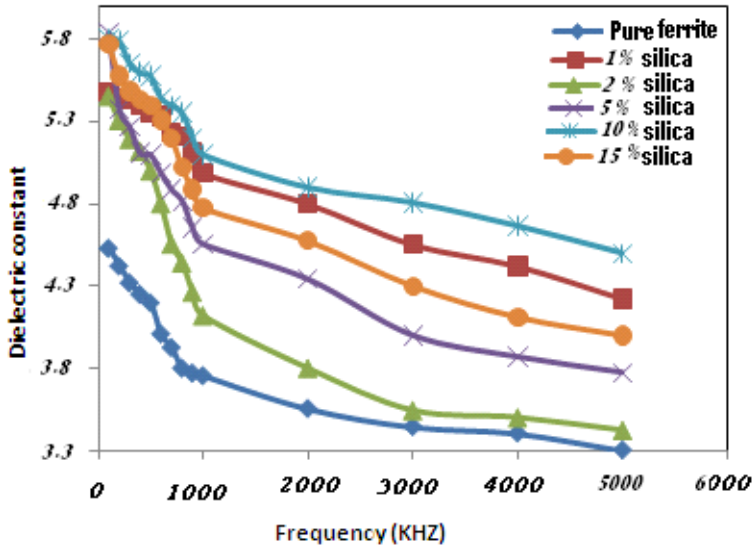

Fig. (4): Variation of dielectric constant e with frequencies for SiO2 ferrite

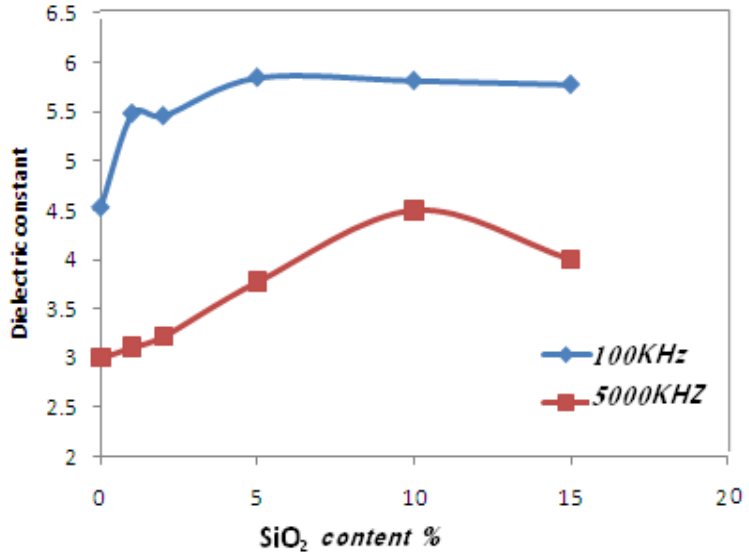

Fig. (5): Variation of dielectric constant e with SiO2 concentration wt % for ferrite

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تأثير السليكا SiO_2 في الخواص العزلية و الفيزيائية للمركب $n-Ni_1$ فرايت

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الخلاصة

درس تاثير السيليكا (SiO_2) في الخواص الفيزيائية والعزلية للمركب منغنيز – نيكل فرايت (Mn–Ni ferrite) ، والنماذج المستخدمة قد حضرت بطريقة التصنيع التقليدية .لوحظ من الدراسة الحالية بان ثابت العزل يتناقص مع الزيادة في الترددات. وقيم ثابت العزل تزداد مع زيادة تراكيز السليكا .اما بخصوص الكثافة الكتلية فوجدت انها تزداد مع زيادة تراكيز السليكا في حين لوحظ ان المسامية تتناقص مع زيادة التراكيز.
الكلمات المفتاحية: الفرايت ، السليكا ، الخواص الفيزيائية والعزلية ، الاضافات.