Study the Physical and Dielectric Properties of Ferrite – Sic Composite

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Abstract

The effect of ferrite ceramic Mn-$NiFe_2O_4$, x=0.5 on the Physical and dielectric properties of (Sic) is studies . The sample are prepared by the conventional manufacturing method .

We found that the Physical and dielectric properties of Sic chandes considerably with the substituent samples . The variation of dielectric constant as a function of frequency of (ferrite – Sic) composite decrease with increasing frequency and increase with increasing the concentration of ferrite system .

It was found that the increase of ferrite system concentration of all our samples produce increasing in mass density and decreasing with A. Porosity.

Keyword: (Ferrite – Sic) composite – Dielectric and Physical Properties.

دراسة الخواص الفيزيائية و العزلية للمركب فرايت – كاربيد السليكون

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الخلاصة

تأثير المركب منغنيز – نيكل فرايت على الخواص الفيزيائية العزلية لكاربيد السليكون قد تم دراستها .والنماذج حضرت بطريقة التصنيع التقليدية .لوحظ من خلال تغير ثابت العزل مع التردد بأن ثابت العزل يتناقص مع زيادة الترددات

وقيم ثابت العزل ازداد مع زيادة تراكيز المركب منغنيز – نيكل فرايت .إما بخصوص الكثافة الكتلية وجدت أنها تزداد مع زيادة تراكيز المركب منغنيز – نيكل فرايت في حين أن المسامية الظاهرية تتناقص مع زيادة تراكيز هذا المركب .

الكلمات المفتاحية: مركب من فرايت – كاربيد السليكون , الخواص الفيزيائية و العزلية

Introduction

Ferrite have widely been used in different electrical engineering application including radio and TV sets as well as carrier telephone as cores of inductors , transformers and so forth for their good electrical mechanical properties . Manganese – Zinc ferrites of high permeability and low losses are extensively used in the telecommunication field over a wide frequency rang [1]. The Kind and amount of substitution determine the properties .

It is known that Mn-Zn ferrite with small amount of additives such as Sio_2 , Cao , Ta_2O_5 , Nb_2O_5 have good magnetic properties at high frequency [2]. The rare earth substitution effect on the electrical and magnetic properties of Cu-Zn ferrites [1] . marked changes were observed for both electrical and magnetic behavior .

As Mn-Zn ferrites are mor important from the technological applications point of view , it was of interest to extend our work to include Mn-Zn ferrites . therefore the purpose of this work is to study the effect of substitution of rare earth ions on the grain size [1] .The Ni-Zn ferrites has been widly used in various components for application at high-frequency rang due to their high electrical resistivity , mechanical hardness , and chemical stability [3] .

Experimental

The ferrite Mn-$NiFe_2O_3$, x=0.5 was prepared by using ceramic technique involving solid state reaction using metal oxide in the form of grinding powders .

The X-Ray diffractometer is an instrument for studying samples . for phase identification and study of preferred orientation a full scan of 2θ 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.The samples of the formula Sic and additives at different concentration from Mn-Ni ferrites (1,2,5,10,15 wt%) were prepared by the ceramic method .

The samples of composition were mixed for (5 hr) .After that ,the mixture was pressed to pellets with diameter 1cm and thickness 1cm .These pellets were sintered at (1150 c^o) in air for (4 hr) .

The samples were then slowly cooled at rate of (2 c^o in min) . The A. porosity P_t and Mass densities were measured by using Archimedes with water as the immersion medium .The dielectric constant was measured by uses precision LCR meter model HP 4284 with the scale 20 HZ to 5 MHZ. The surface of discs are polished .Air – dried silver epoxy electrical contact were deposited.

Results and Discussion

X-Ray diffraction analysis

The x-ray pattern of $MnMiFe_2O_4$ ferrite with x=0.5 produced by solid state reaction method, sintered at (1150 °C) has been show in figure (1). The pattern confirms the ferrite structure MnNi ferrite as an impurity phase. The x-ray data of $MnNiFe_2O_4$ ferrite is listed in table (1). The lattice parameters has been calculated using the value of d-spacing which were calculated by using Bragg law [4] and compared to values reported in JCBDS (joint committee on powder diffraction standard cards) [5].

Bulk density

Figure (2) shows the balk density measured on the pellets sinterd at (1150 c^o) in air for (4 hr) .It can be seen from the figure that with increasing Ferrites – concentration the bulk density (d_s) was found to be increasing ,as also discussed by verma for different composition [6]. Increase in balk density can be attributed to the difference in specific gravity of the ferrite components.

Porosity

$P_t = [(W_s - W_d)/(W_s - W_{ss})] * 100\%$ where W_s is the weight in the air of the sample saturated with water, W_d is the dry sample weight in the air and W_{ss} is the weight of saturated of water suspended in water.

The variation of porosity with ferrite-concentration Wt% for Sic was showed by figure (3). The higher temperature sintering generally brings about reduced porosity . [7,8]. At a higher sintering temperature ,the number of pores is reduced consequently , grains come closer to each other . The grain to grain contact produce increase of area which to leading to greater densification or less porosity.

Dielectric Properties

$$\varepsilon^{-} = \frac{cd}{\epsilon A}$$

Where c is the measured capacitance , d is the thickness of the sample, A is the area of the capacitor plate, ϵ is the permittivity of free space and its value is $8.85 \times 10^{-12}\ f/m$.

Figure (4) shows variation of the dielectric constant as a function of frequency for Sic with different additives ferrite system concentration was found the dielectric constant decrease with increasing frequency . The decrease of the dielectric constant with frequency is a normal dielectric behavior of ferrite – Sic composite [7] and is due to reason that as the frequency of the externally applied field increasing gradually though the number of the ferrous ions is present in the ferrite materials ,the dielectric constant decrease [9] . Figure (5) shows variation of the dielectric constant as a function of ferrite system concentration Wt% for Sic .It is clear from the figure the value of dielectric constant was found to increase with increasing ferrite concentration ,as polarization in ferrites has largely been attributed to the presence of Fe^{+2} ions which give rise to heterogeneous spend structures [10] .

Conclusions

The effect of small amount from ferrite system on the properties Sic was investigated innthis study ,and the results are summarized as follows :

1. The bulk density of Sic increase with increasing ferrite content .
2. The A.Porosity of Sic decrease by increasing ferrite content .
3. The dielectric constant of Sic decrease by increasing frequency .
4. The dielectric constant of Sic increase with increasing ferrite content .

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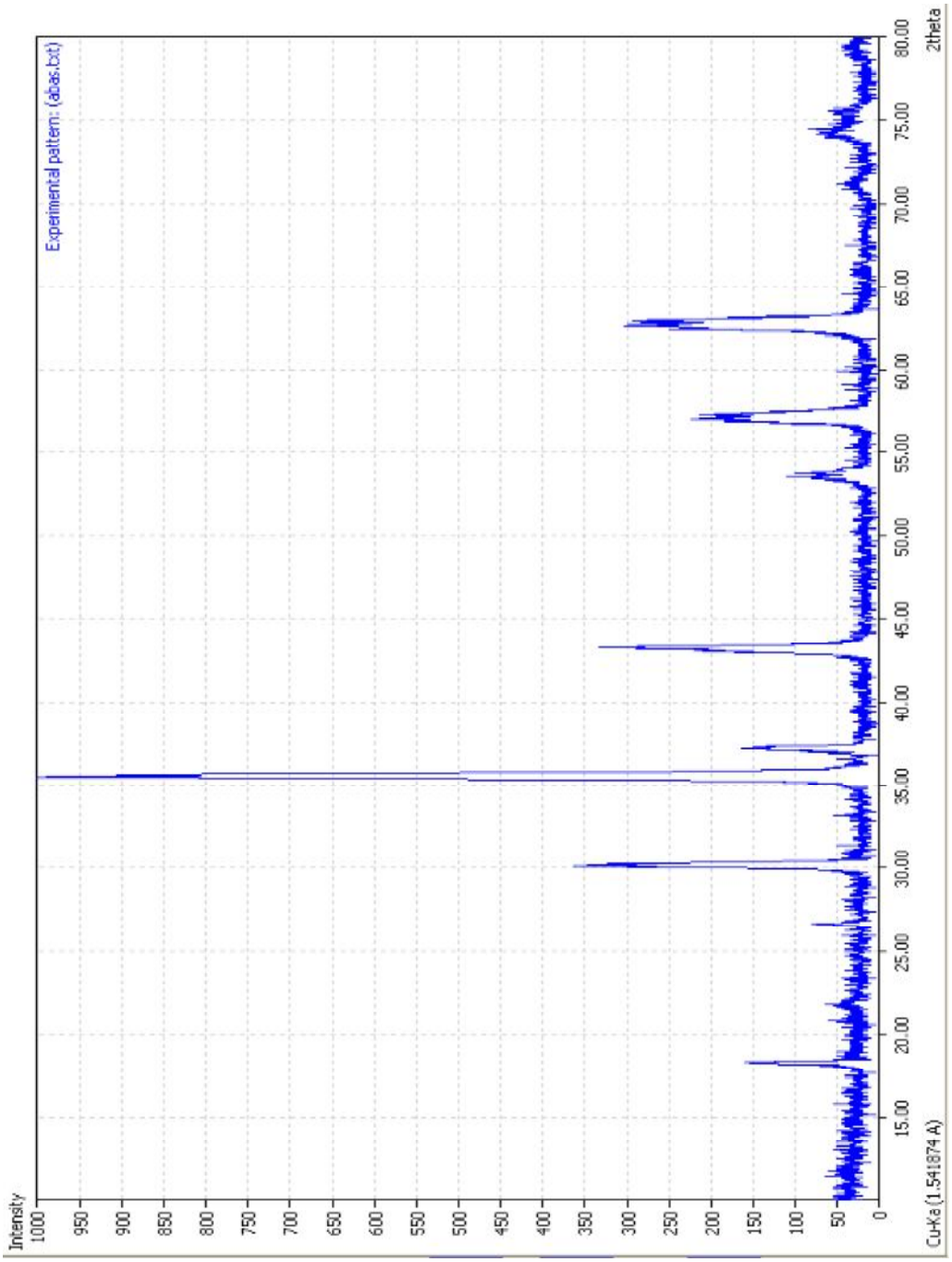

Fig. 1: X-ray diffraction of Mn- Ni Fe2O4

Table (1) x – Ray diffraction data of Mn – N_i Fe_2 O_4 With X = 0.5

a A	b A	c A
1.914	0.725	0.699

2Θ(deg)	d (A)	Hkl
18.358	4.828	111
30.162	2.960	220
35.537	2.524	311
37.242	2.412	222
43.228	2.091	400
53.602	1.708	422
57.025	1.614	333
57.305	1.606	511
62.883	1.474	440
74.040	1.279	622
74.301	1.275	622

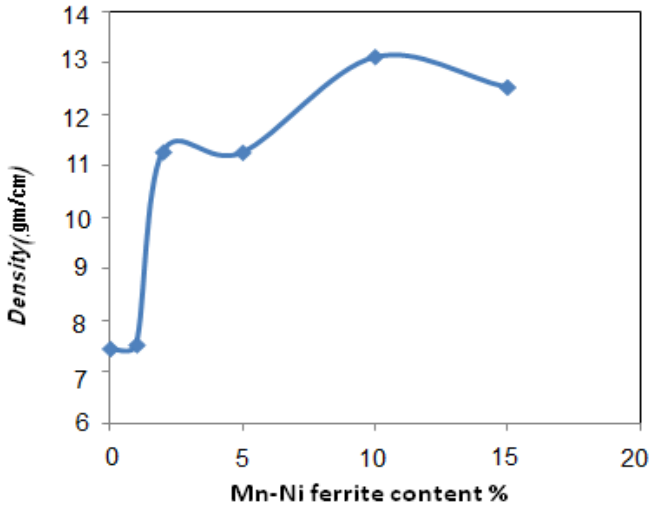

Fig (2) variation of density with ferrite concentration for sic

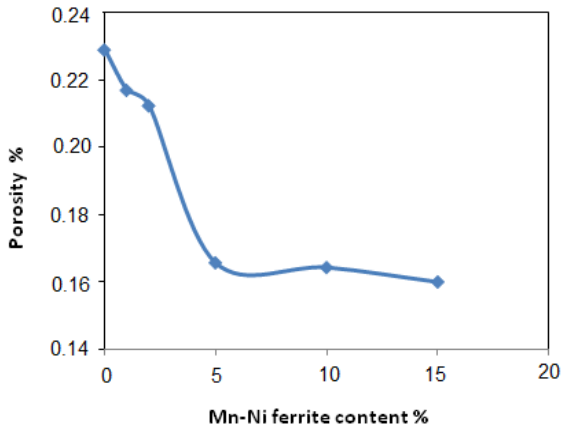

Fig (3) variation of porosity with ferrite concentration for sic

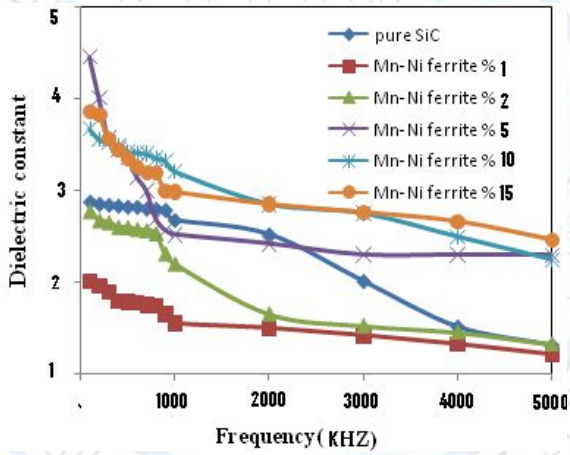

Fig (4) variation of dielectric constant with frequency for ferrite – sic

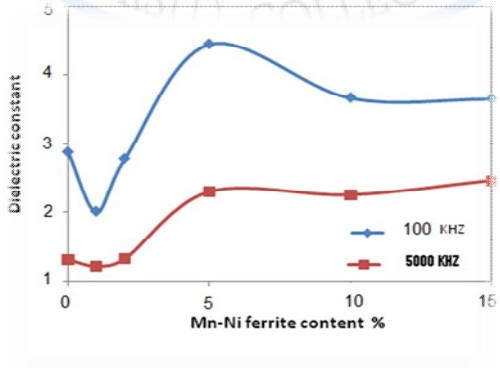

Fig (5) variation of dielectric constant with ferrite – concentration wt % for sic