Preparation And Study Of Some Electrical Properties Of Mn-Ni Fe_2O_4

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Abstract

In this study, Mn-Ni Ferrite was prepared by using two composites of manganese ferrite ($MnFe_2o_4$) and Nicle Ferrite ($NiFe_2O_4$) tested by X-Ray diffraction (XRD) method. The dielectric constant ($\bar{\varepsilon}$) and the dielectric loss tangent ($tan\ \delta$) were studied for the ferrite system prepared at different frequencies (100, 200… and 5000 kHz). It was found that the values of ($\bar{\varepsilon}$) and ($tan\ \delta$) decrease with the increase of frequencies.

Key words: Ferrite, Electrical properties, Preparation

Introduction

Ferrite most widely used magnets comprising 52% of the world market [1] . The advancement of high frequency ferrite was initiated by the work done by Snock [2] who found that associated with excellent properties in the high frequency range , (Mn – Zn Ferrite) , (Cu-Zn Ferrite) and Ni-Zn Ferrite provide a family magnetic materials useful for radio and TV sets as well as carries telephon as cores of industries transformers and so forth . X-ray diffraction study of the cation distribution in the (Mn – Zn Ferrite) is also carried out by Abbas et.al [3] .

Electrical transport properties of Zn substituted Mn ferrite has been studied by Ravinder and Reddy [4] . The (Mn0-8-Zn0-2 Fe2O4) was prepared by flash combustion technique by Mangalaraja et. al. [5] . In 2003 were sintered at 1340°C in controlled atmosphere and characterized for their magnetic initial permeability and electrical properties.

Experimentation

Samples Preparation:

The Ferrite was prepared by using ceramic technique involving solid state reaction using metal oxides in the form of grinding powders. The qualitative of each sample were calculated in terms of weight percentage according to the chemical reaction.

$$NiO + Fe_2O_3 \rightarrow Ni_2\ Fe_2O_4$$

$$MnO + Fe_2O_3 \rightarrow Mn\ Fe_2O_4$$

$$MnO(\ X) + NiO\ (1\text{-}X) + Fe_2O_3 \rightarrow Mnx\text{-}Ni1\text{-}x\ Fe_2O_4$$

Samples of ferrite were prepared by mixing for (5 hrs) . After that the mixture was pressed to pellets with (1×1 cm). These pellets were sintered at (1150Co) in air for (4hrs) .

X –Ray Diffraction Analysis:

The X-ray diffraction meter is an instrument for studding samples of using (Philips X-Ray Diffract meter) with Cukα radiation source source. 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 index (hkl) . The relative intensities were taken from XRD pattern.

Dielectric Measurement:

The dielectric properties of (Mnx-Ni1-x fe2O4) ferrite have measured capacitance method . Air –dried silver epoxy electrical contacts were deposited on the flat surface of sintered pellets and the dielectric constant ($\bar{\varepsilon}$) and dielectric loss tangent ($\tan\delta$) were calculated using the formula:

$$\bar{\varepsilon} = \frac{cd}{\epsilon A}$$

Where c = is the measured capacitance
d = is the thickness of the sample
A = is the area of the capacitors' plate
ϵ= is the permittivity of free space and its value is 8.85 $X10^{-12}$f/m

$$\tan\delta = \frac{\bar{\bar{\varepsilon}}}{\bar{\varepsilon}}$$

Where ($\bar{\bar{\varepsilon}}$) is loss factor being the imaginary part of complex permittivity.

Results and Discussion

X-Ray diffraction analysis

Ferrite samples Mn Fe2O4 , Nife2O4 and Mnx-Ni1-x Fe2O4 , with X=0.5 were prepared by high temperature solid state reaction method . The powder mixture was pressed into pellets of 20mm diameter the samples were sintered in a furnace at 1150 Co for 4 hours for making a homogeneous product. The samples were quenched in air and using X-Ray Diffracion by using (philips x-ray diffracto meter) Cukα radiation. The samples were rotated through an angle of (10-80o) at a scanning speed of (10 deg/min) to identify the phases formed and to confirm completion of the chemical reaction figures { 1,2,3 }.The diffraction patterns were taken on a plotter which were analysis to calculate (inter – atomic spacing) and to index (h,k,l) [6] .by using the relation $d^2 = \frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}$,to calculate lattice constants (a, b, c)which are completely described in tables(1,2,3).

Dielectric Properties

The variation of the dielectric constant and dielectric loss tangent as a function of frequency for Mnx-Ni1-x Fe_2O_4, X=0.5 , ferrite at room temperature are shown in figure (4) and figure (5) . It is clear from the figures that both of the dielectric constant and dielectric loss tangent decrease with the increase of frequencies. The decrease of dielectric and dielectric loss tangent with frequencies is a normal dielectric behavior of spinal Ferrite [7-8] as the frequency of the externally applied field increases gradually .The decrease of dielectric loss tangent by increasing frequencies is due to strong correlation between the conduction mechanism and dielectric behavior of Ferrite [7].

Conclusions

The variation of the dielectric constant and dielectric loss tangent as a function of frequencies for ferrite system shows that both of the dielectric and dielectric loss tangent decrease with the increase of frequencies. The decrease with frequency is a normal dielectric behavior of spinal ferrite.

References

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Table No. (1): X – Ray diffraction data of Ni Fe_2 O_4

2Θ(deg)	d (A)	hkl	ASTM d(A)
18. 59	4.769	111	4.813
30.455	2.933	220	2.948
35.837	2.504	311	2.514
37.419	2.401	222	2.407
43.464	2.080	400	2.085
53.973	1.697	422	1.702
57.527	1.601	511	1.604
63.114	1.472	440	1.474
71.629	1.316	620	1.318
74.709	1.269	533	1.271
75.583	1.257	622	1.257
79.603	1.203	444	1.204

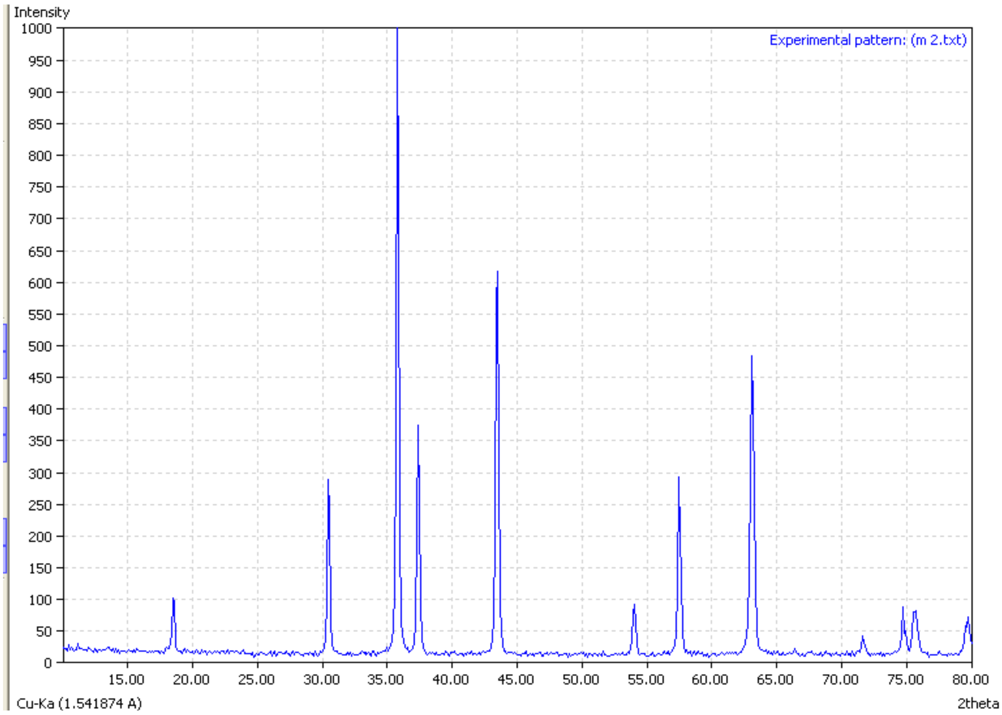
Table No.(2): X – Ray diffraction data of Mn Fe_2 O_4

2Θ(deg)	d (A)	hkl	ASTM d(A)
18.046	4.911	111	4.926
29.654	3.010	202	3.016
34.922	2.567	311	2.570
36.535	2.457	222	2.461
42.445	2.127	004	2.134
52.631	1.738	422	1.738
56.095	1.638	333	1.640
61.581	1.505	440	1.506
72.791	1.298	533	1.298
73.775	1.283	622	1.284

Table No. (3): X – Ray diffraction data of Mn – Ni Fe_2 O_4 With X = 0.5.

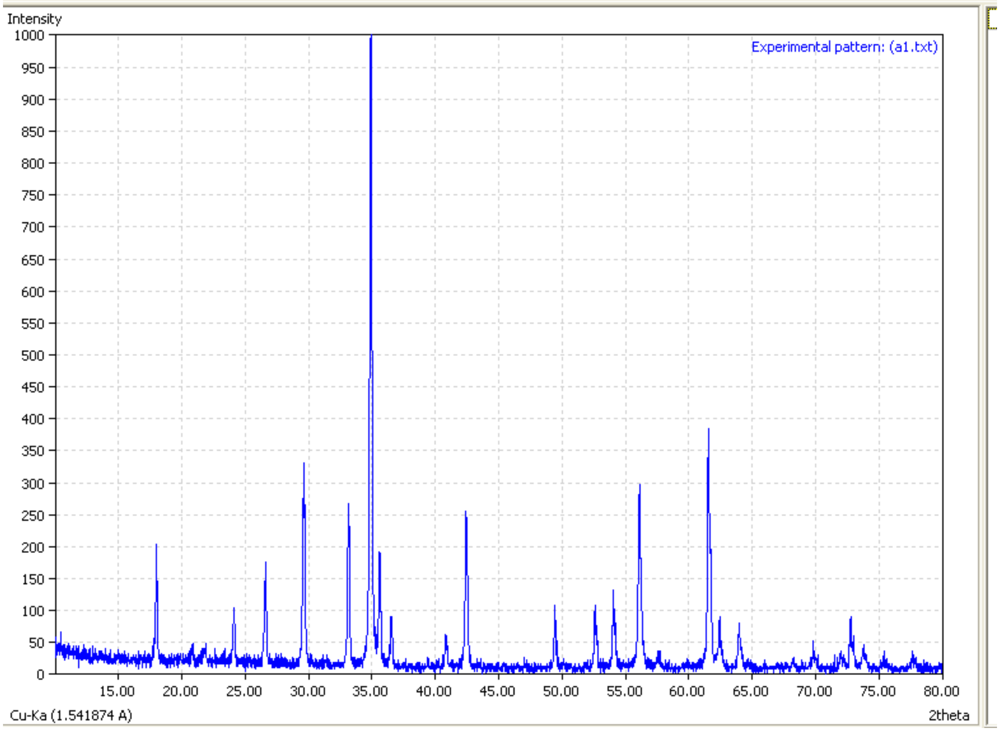
c A	b A	a A
0.699	**0.725**	**1.914**

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



2θ degree

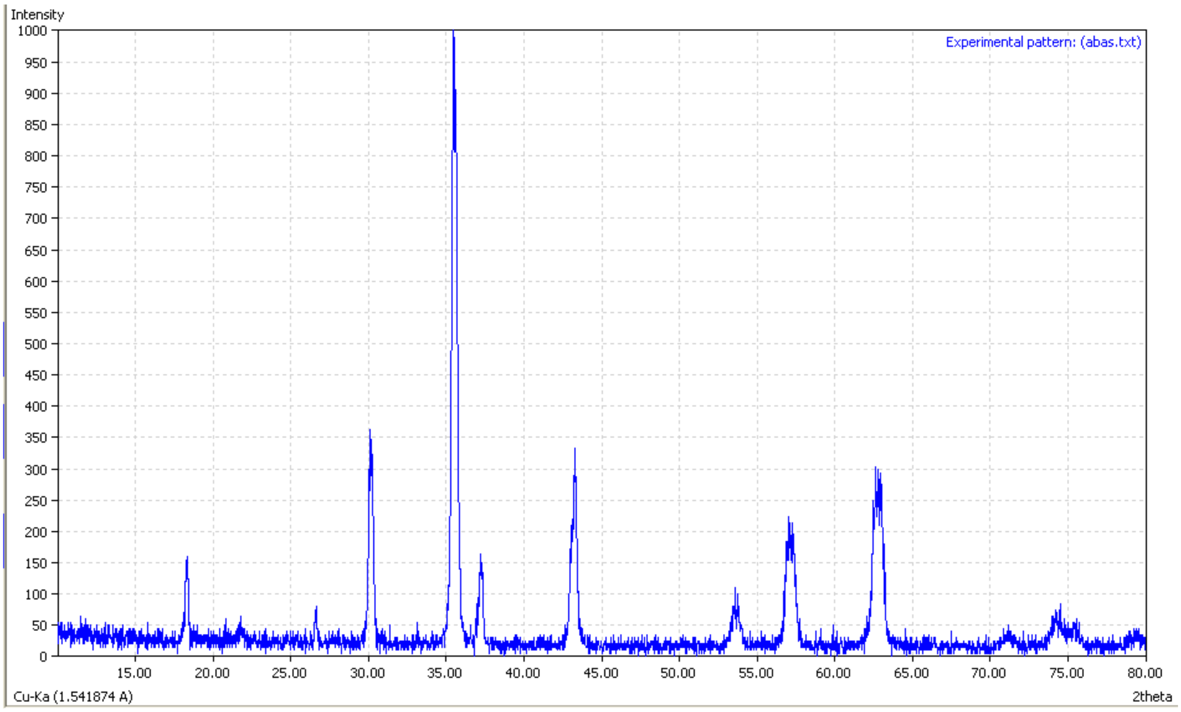
Figure No. (1): X-ray diffraction of Ni Fe_2O_4.



Intensity

2θ degree

Figure No. (2): X-ray diffraction of $MnFe_2O_4$.



2θ degree

Figure No. (3): X-ray diffraction of Mn- Ni Fe_2O_4.

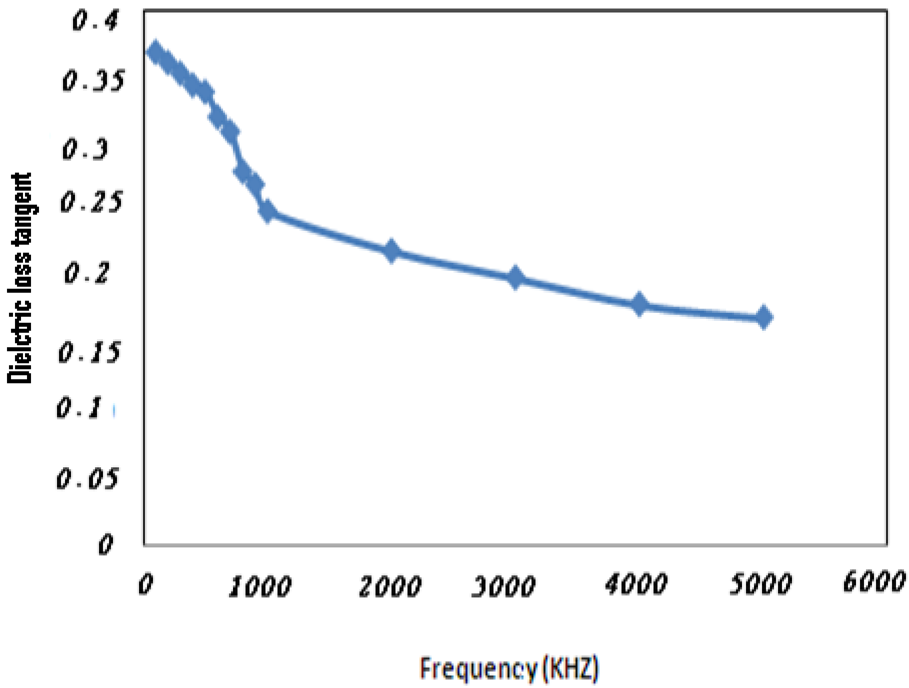


Figure No. (4): Variation of dielectric loss tangent tanδ with frequencies for Mn-Ni Ferrite.

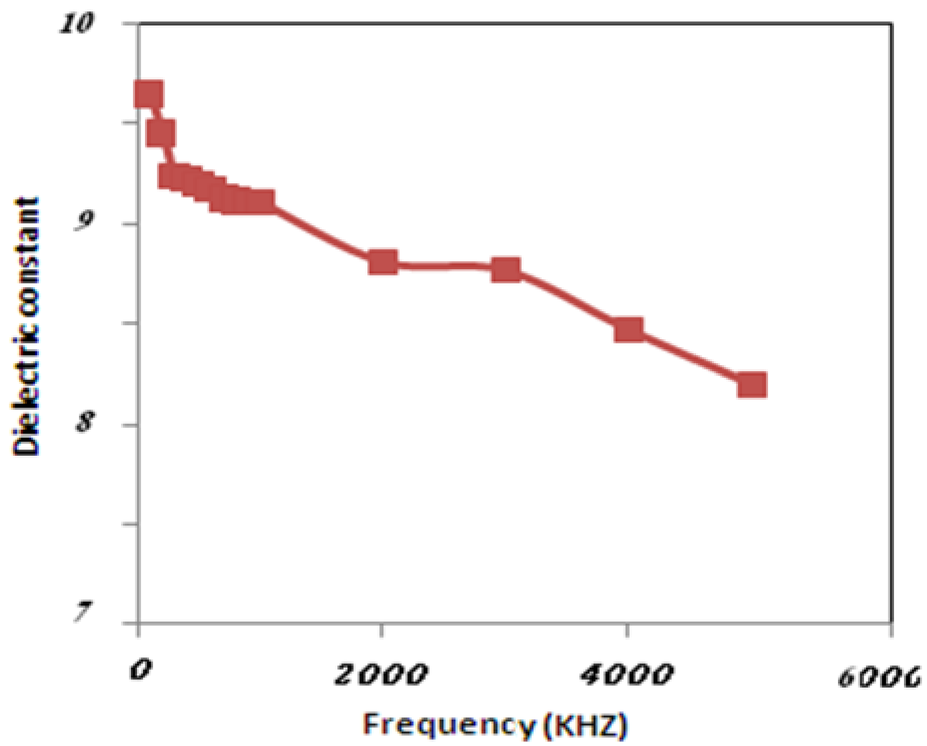


Figure No. (5): Variation of dielectric constant ε with frequencies for Mn-Ni Ferrite.

تحضير ودراسة بعض الخصائص الكهربائية للمركب $(Mn\text{-}Ni\ Fe_2O_4)$

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الخلاصة

في هذه الدراسة حضر مركب(منغنيز – نيكل فرايت) ، (X=0.5) بخلط مركبين منغنيز فرايت ونيكل فرايت ومن ثم قيست بعض الخصائص الكهربائية لهذا النوع من الفرايت ، ولوحظ ان ثابت العزل ومعامل الفقد العزلي يتناقصان مع زيادة الترددات.

الكلمات المفتاحية: فرايت ،الخصائص الفيزيائية ،تحضير