1-Introduction

Ni-Zn polycrystalline ferrites(NZF)are low-cost materials that are attractive for microwave device applications ,with spinel structure has a promising potential as high performance microwave devices owing to its high resistivity, mechanical hardness, high Curie temperature, chemical stability, and soft magnetic properties at high frequencyItis well known that the intrinsic parameters of these ferrites depend on the composition, Properties of ferrites are known to be sensitive to the processing technique [A. Verma 2000].Soft ferrites such as, Ni–Zn are well known ferrites covering wide-ranging applications.These ferrites have been widely used in electronic applications such as transformers, choke coils, noise filters, and recording heads.By introduction of a relatively small amount of foreign ions, an important modification of both structure and magnetic properties can be obtained [Rezlescu E,RezlescuN 1992,1993].The electrical resistivity of ferrite at room temperature depending upon the chemical composition which lies between about 10^3 Ohm-cm and 10^8 Ohm- cm. Low resistivity due to hopping of bonding electrons are caused by the simultaneous presence of Fe^{3+} and Fe^{2+} ions on crystallographically equivalent latticesites. The resistivities of several ferrites are found to depend sensitively on firing conditions, temperature and atmosphere and on the ions that substitute Fe^{3+} / Fe^{2+} ions.Ferrites with the properties of large resistivity, low corecivity and low eddy currents are being used for a variety of high frequency applications. Substitution of divalent ion in to the spinel structure has been reported to lead to structural distortion. That induces strains in the material and to affect the electrical and magneticproperties significantly. There are several synthesis techniques such as solid-state reaction method, hydro-thermal method, precipitation/co-precipitationmethod and sol–gel auto-combustion method for the preparation of nanoferrites.Among these processes, co-precipitation has lately shown to be a very promising technique for the preparation of ultrafine ferrite particlesof controlled size and morphology with a number of applications. [W.Y. Huang,2005,A. Verma (1999)]

Most of the work on the preparation of ferrite through hydrothermal processing has been carried out using (NaOH) and the major impurity present [M.T. Johnson (1992)].
The aim of this work was to evaluate the influence of the variousCadmium ions on the ceramic parameters of a(NiZn) ferrite The dielectric and magnetic properties.

2. Experimental

The powders of Ni- ferrites, Zn- ferrites & Cd- ferrites were prepared usingCo-precipitation uto-combustion method from $FeCl_3$, $Ni(NO_3)$, $ZnC_4H_6O_4.2H_2O$&$CdCO_3$ as starting material . Each one dissolved in(400) ml Distil water, Ferrites have been synthesized using aqueous ammonia to avoid incorporation of sodium. Control of synthesis parameters has resulted in the production of ferrite particles , having a meta stable cation distribution as revealed from micro structural and magnetic studies. The pH of the solution was adjusted to 7-9 using ammonia solution. The solution was uniformly heated at100°C with constant stirring to transform it into a gel and then filtered gel was obtained by dehydration process. The dried gel was combusted with the evolution of large amount of gases and it resulted in the formation of loose powder [M.T. Johnson (1992) M.C.Dimri, (2006)]. The prepared powder was then calcined at 800˚C.Three type of ferrite were synthesized which are of Ni- ferrites, Zn- ferrites & Cd-ferrites to formed final production with composition $(Ni\ Zn)_x\ Cd_{1-x}\ Fe_2O_4$ x=(0.7,0.4,0.2, 0.0)by mixing every one with properly construction of x- value ,then it was pressed(5tons) as rings(R_n) and (3tons/Cm^2)as pelt (D_n). the temperature of final sintering in this case was kept at 1100˚C.The pellet samples were well polished to remove any roughness and the two surfaces of each pellet were coated with silver paste as contact material for electrical and dielectric measurements. Using*L.C.R type* (micro test 6379),dielectric measurement as a function of frequencyin the range(20 Hz–3MHz) at room temperature. Thereal part of dielectric constant was calculatedusing the formula

$$\varepsilon r = \frac{C\,d}{\varepsilon^{\circ} A} \text{ ----- (1)}$$

Where$C$ is the capacitance measured of the pellet in pF, d the thickness of the pellet, A the cross-sectional Area of the flat surface of the pellet and ε° the constant of permittivity for free space.

The imagery dielectric constant(ε_r) and loses factor(tanδ)was measured over thesame frequency range(20Hz-3MHz)to calculatethe imaginary part of dielectric constant using the formula

$$\text{Tan}\delta = \frac{\varepsilon i}{\varepsilon r} \text{ ------- (2)}$$

Also the magnetic properties was measured by the same equipment,(*initial permeability*μ)was calculate after measuring the inductors(L)then by using the formula(MMPA 1998)

$$\mu i = \frac{L}{L^{\circ}} \text{ ------- (3)}$$

$$L^{\circ} = 4.6\ N^2\ d\ \text{Log}(r_{out}/r_{in}) * 10^{-9} = L_o$$

where $r_{in}$is the innerradius and $r_{out}$is the outer radius, dis thickens of samples , L= the inductors of sample, N=the numbers of turns

3. **Results and discussion:**

3-1.XRD discussion

The phase identification and lattice constant determination were performed by x-ray diffraction pattern (XRD). Typical XRD pattern of ferrites sample is shown inFig.(1),(2),(3),and(4).

All the samples show good crystallization, with well-defined diffraction lines The structure can be indexed as a single-phase cubic spinal structure.It is obvious that the characteristic peaks for spinel ferrites appear in the samples asthe main crystalline phase. The peaks (2 2 0), (3 1 1), (2 2 2), (4 0 0),(4 2 2), (5 1 1) and (4 4 0) correspond to spinal structure ,

lattice parameterwas determined (a)&crystal Density was Calculated from equ.

Where Z is the number molecules per unite cell of spinel lattice ,M is the molecular weight of the samples,Nis the Avogadro s number and a is the lattice parameter .

Then porosity p%will beCalculated from equ.

$$P = 1 - \frac{DB}{Dx} \times 100 \quad \%$$

when D_B was bulk density , $D_{x:}$:was crystal density

the lattice parameter 'a' as a function of Cd^{2+} content x is depicted intable(1) . It is noticed that the lattice parameter increases with the cadmium content in the lattice. Thisvariation can be explained on the basis of an ionic size differenceof the component ions. The Cd^{2+} ions have a larger ionic radius (0.97Å) than the Zn^{2+} ,Ni^{2+} (0.65 Å) ions [D.N. Bhosale (1999)].

The Cd^{2+} ions successively replace the Ni^{2+}&Zn^{2+}ions in B-site.The unit cell expands to accommodate the larger ions. Thus addition of Cd^{2+} at the expense of the Ni^{2+}&Zn^{2+} in the ferrite is expected to increase the lattice parameter.

3-2 Real & imaginary part of dielctric constant (ε_r,ε_i): The dielectric behavior in ferrite can be explained based on the assumption that the mechanism of dielectric polarization is similar to that of conduction. Many scientists have established a strong correlation between the conduction mechanism and dielectric constant of ferrite [K. Iwauchi, (1971) , C. Jain (1982)].It have been explained that dielectric behavior based on a numberofavailable Fe^{2+} ions. The

electronic change such as $Fe^{2+} \leftrightarrow Fe^{3+}$ results in a local displacement of electron, which determines the polarization and thus the dielectric constant of ferrite.It have been observed that from Fig.(5) which shows the variation of the(ε_r)behavior with increasing frequency then Fig (6) gave us the magnitude of(ε_r) with change X-value by using some magnitude of frequency,Fig.(7) which shows the dielectric dispersion curves can be explained on the basis of Koop's two layer model and Maxwell- Wagner polarization theory. To interpret the frequency response of dielectric constant in ferrite and dielectric materials , Koop's [C. G. Koops (1951).] suggests a theory in which relatively good conduction grains and isolating grain boundary layers of ferrite material can be represent with the behavior of an inhomogeneous dielectric structure. A assembly of space charge carriers in the inhomogeneous dielectric structure, is discussed by Maxwell and Wagner [J. C. Maxwell (1982)].Since an assembly of space charge carrier in the inhomogeneous dielectric structure described requires finite time to line up their axis parallel to an alternating electron field, the dielectric constant naturally decrease, if the frequency of reversal field increases.

$$\tau = \frac{1}{\omega} \quad , \quad \omega = 2\pi f_{max}$$

$$\therefore \tau = \frac{1}{2\pi f_{max}}$$ where τ: the relaxation time ω: angular velocity

3-3A.C Conductivity :

Figs (10) shows the variation of a.c conductivity behavior with frequency for $(NiZn)_xCd_{1-x}$ Fe2O4 systems at room temperature in the range of about (20 Hz-3MHz), with different x-value while Fig(11) shows the magnitude variation of a.c conductivity with same parameters ,According to Maxwell- Wagner theory, two layers forming dielectric structure. The first layer consist of ferrite grains of fairly well conducting (ferrous ions), which is separated by a thin layer of poorly conducting substances, which forms the grain boundary. These grain boundaries are more active at lower frequencies; hence, the hopping frequency of electron between Fe^{3+} and Fe^{2+} ions is less at lower frequencies. As the frequency of the applied field increases the conductive grains become more active by promoting the hopping of electron between Fe^{2+} and Fe^{3+} ions, thereby increasing the hopping frequency. Thus, we observe a slight increase in conductivity with frequency.

3-4Vibrating Sample Magnetometer (VSM)

Figure 12shows the magnetic hysteresis loops of $(NiZn)_x Cd_{1-x}$ Fe2O4 samples taken by vibrating sample magnetometer at room temperature showing typical magnetic behavior having a non-zero coercivity and remanance. The value of magnetic saturisation, coercivity and remanance that Concluded was shown at table No.(2) . Low area hysteresis curve shows that the material formed is of soft magnetic material. The hysteresis loops of all ferrite samples towards to paramagnetic behavior with increase of the cadmium content in the ferrites then it will be as super paramagnetic behavior at X=0.0 when the synthesis will be $CdFe_2O_4$. The Cd^{2+}&Zn^{2+}ion strongly occupies the tetrahedral A-site [S.A. Patil (1998), O.M. Hemeda, (2001).]while Ni^{2+} the octahedral B-site [G.K. Joshi, (1988)] and Fe^{3+} ions occupies both tetrahedral and octahedral site. The addition of cadmium a nonmagnetic divalent metal ion (Cd^{2+} ion) content in ferrites reduces the amount of Ni^{2+} ions and increases the amount of Fe^{3+} ions in ferrites on B-site was responsible for thesuper paramagnetic behavior . The occupancy of Cd^{2+} ion at tetrahedral site (A-site) successively replace Fe^{3+} ions from A-site and transfers equal amount of Fe^{3+} ions to B-site. The decrease of magnetic moment of tetrahedral site with increase of Cdion content is due to the decrease of Fe^{3+} ions content on A-site. The addition of Cd^{2+} ion in the ferrites decreases the amount of Ni^{2+} ion and increases the amount of Fe^{3+} ions on B-site, increases the magnetic moment of octahedral site (B-site).

In this work an effort was made to synthesize ferrite powder by a very simple process of co-precipitation which gained a reasonably incredible success, resulting good magnetic properties as shown by hysteresis curve.

3-5 Magnetic Permeability (μ_i)

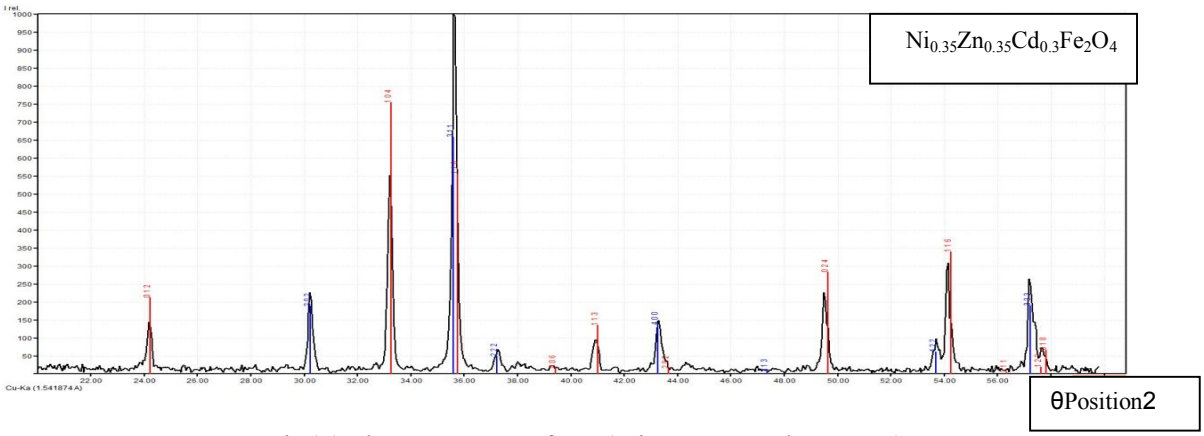
Figs.13 shows variation the behavior of real part of permeability as a function of frequency. As its clear from figs.13 permeability decrease with increased frequency, that's due to the relation between magnetic inductance and frequency which act as the major caused in this decrease, whereas increasing frequency caused dipoles oscillations more aligned, that's cause inverse current, so that the inductance current decrease abruptly at low frequency, then changes become very small as its clear seem behavior for all samples.
while fig.14 shows variation the magnitude of magnetic permeability with frequency & X-value change for $(NiZn)_XCd_{1-x}Fe_2O_4$ system.

4-CONCLOSIONS:

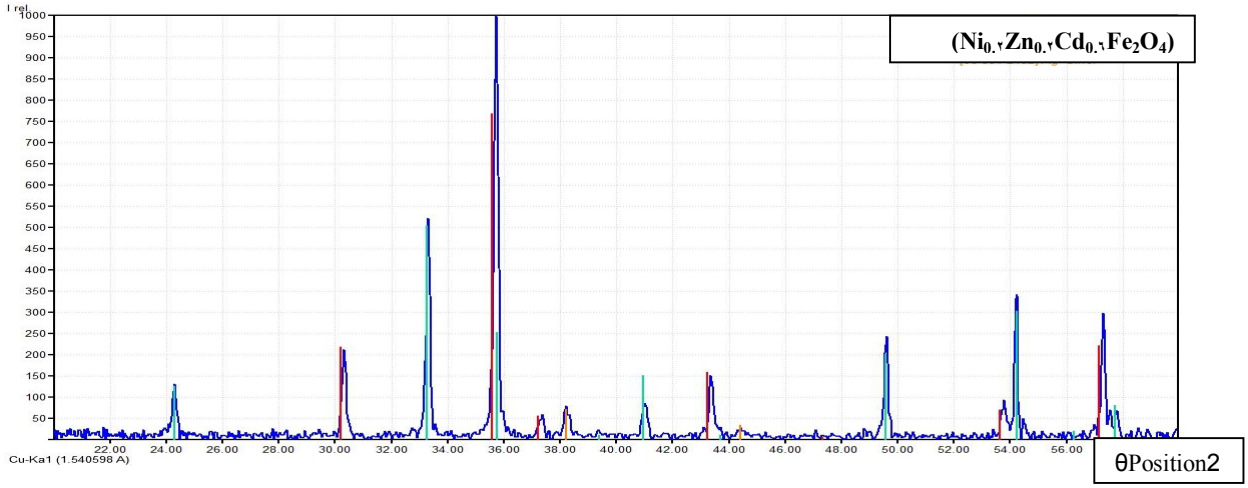
1. decreasing dielectric constant &dielectric losses factor ($\varepsilon_{r,}\varepsilon_i$) with increasing frequency ,the sample D4 ($Ni_{01}Zn_{01}Cd_{0.8}Fe_2O$) was the highest magnitude of these parameter .
2. increasing the A.c condactivity$\sigma_{(a.c)}$ with increasing the frequency
3. the hysteries loop for the All sample has smal area As sofet ferrite except ($CdFe_2O$).
4. decreasing the magnetic Permeability (μ_i) with increasing frequency.

Table (1)X-value for sample No. with some Parameter calculated by XRD test

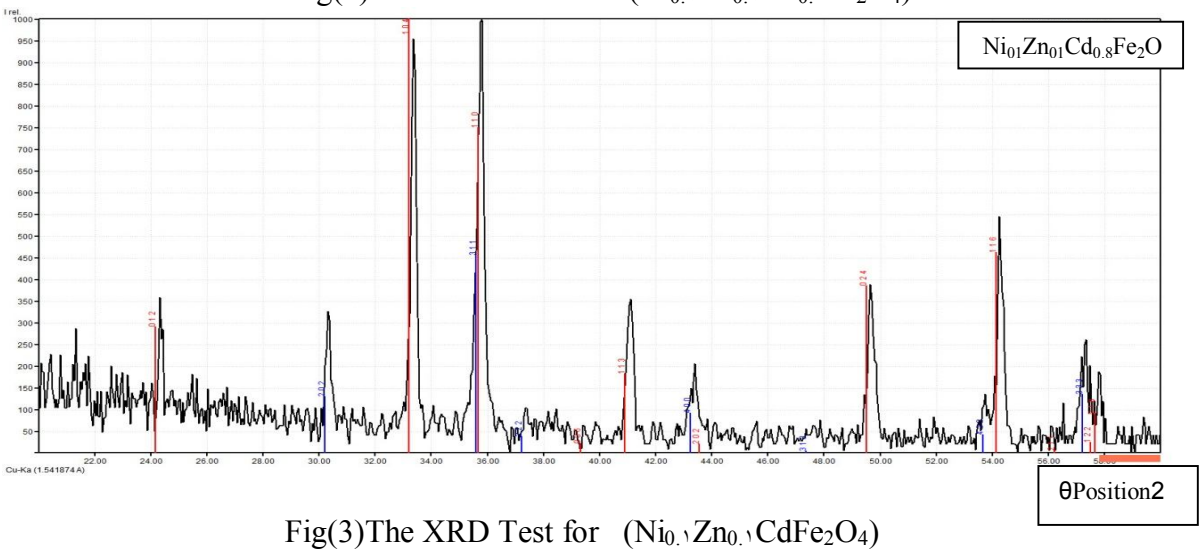
Sample No.	X-Value equivalent to Cd^{2+}ion content	Lattice Parameter (a) A°	Crystal density $D_x(g/Cm^3)$	Bulk density $D_B(g/Cm^3)$	Porosity P%
D2	٠,٧	٨,٧٠	٥,٠٣	3.77	22%
D3	٠,٤	٨,٧٢	٥,٣٢٢	4.2	20%
D4	٠,٢	٨,٧٤	٥,٥٣٢	4.33	18%
D5	٠,٠	٨,٧٧	٥,٦٦	4.72	17%



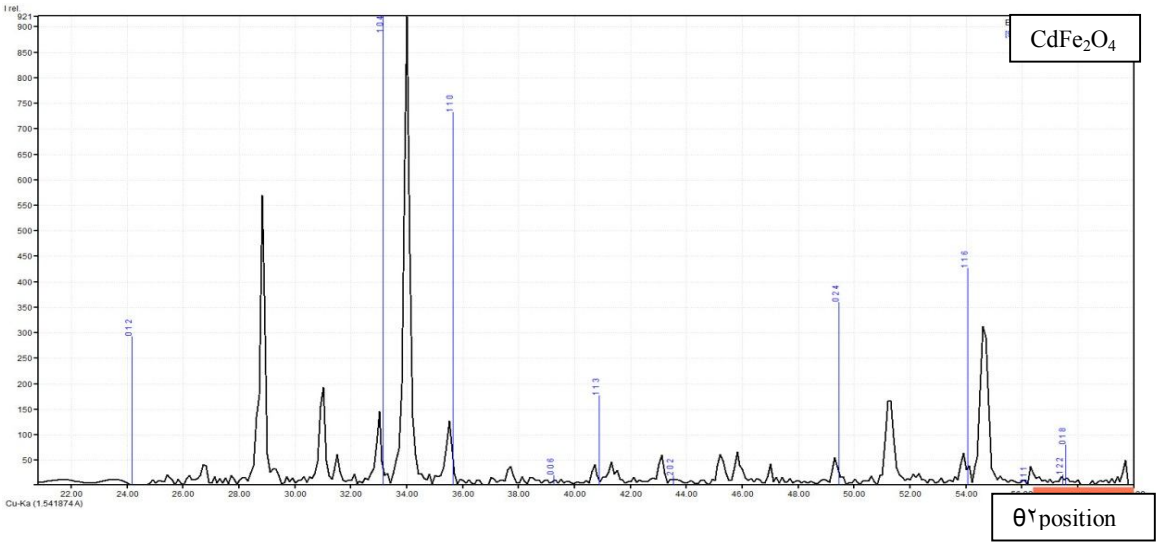
Fig(1)The XRD Test for $(Ni_{0.35}Zn_{0.35}Cd_{0.3}Fe_2O_4)$



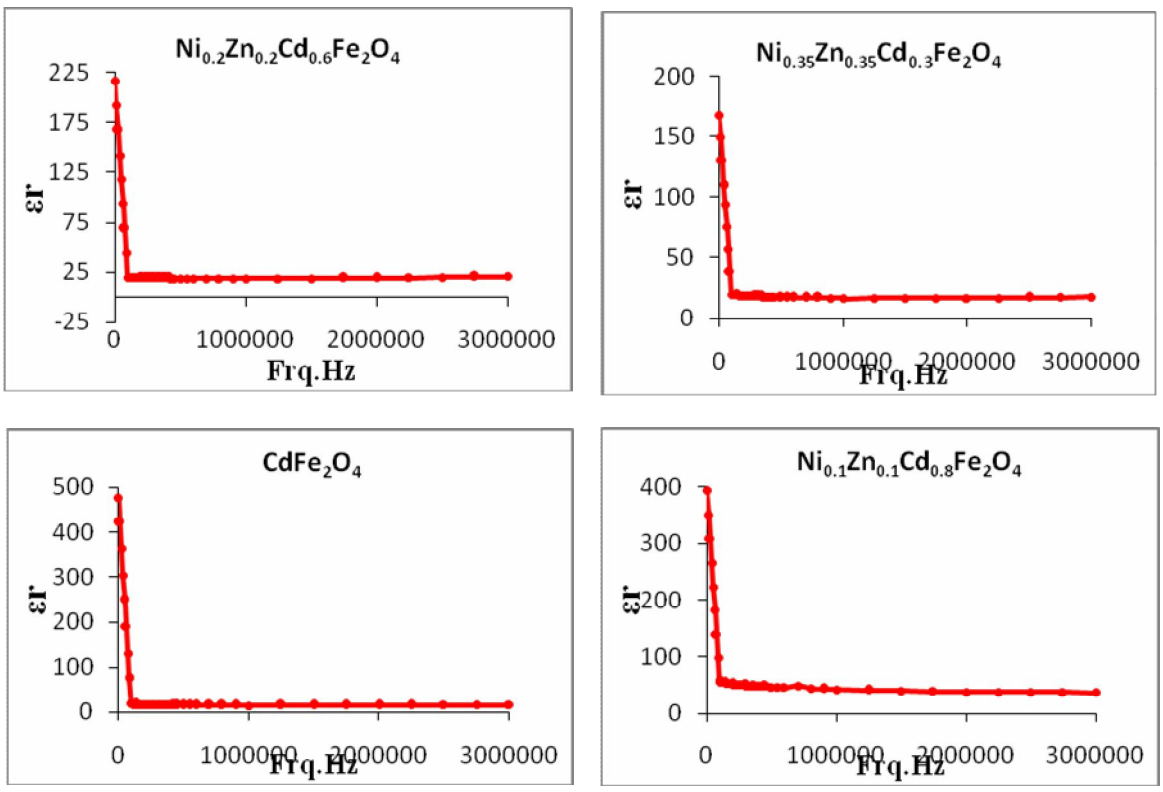
Fig(2)The XRD Test for $(Ni_{0.2}Zn_{0.2}Cd_{0.1}Fe_2O_4)$



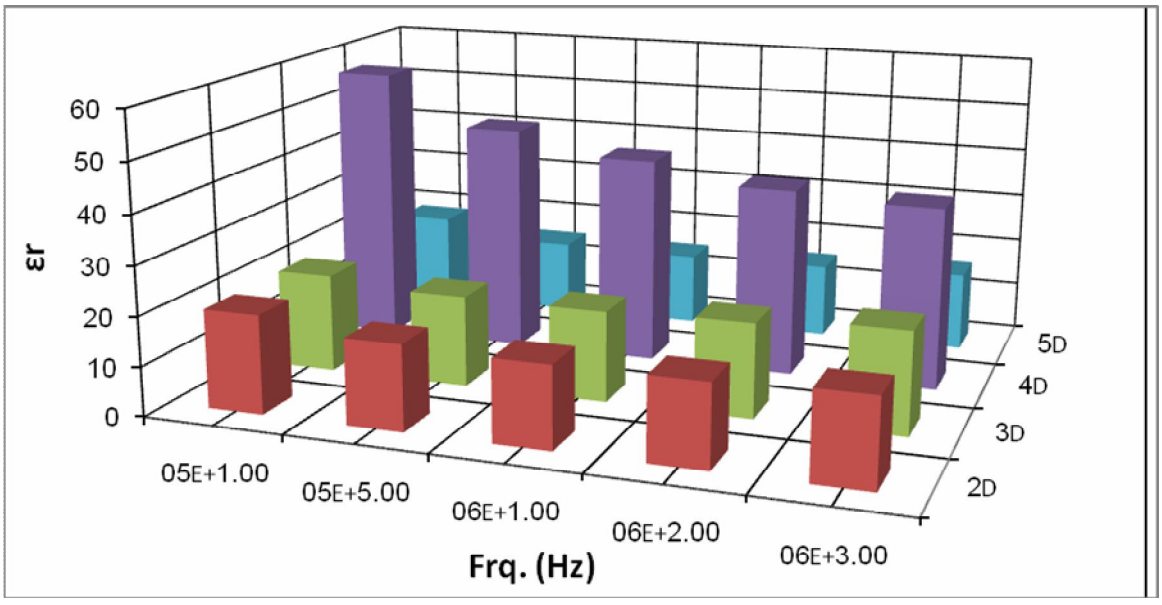
Fig(3)The XRD Test for $(Ni_{0.1}Zn_{0.1}CdFe_2O_4)$



Fig(4)The (XRD)Test for$CdFe_2O_4$



Fig(5)Variation of dielectric constant behavior with frequency for$(NiZn)_XCd_{1-x}Fe_2O_4$ system



Fig(6)Variationmagnitude of dielectric constant with frequency& X-value change for$(NiZn)_XCd_{1-x}Fe_2O_4$ system

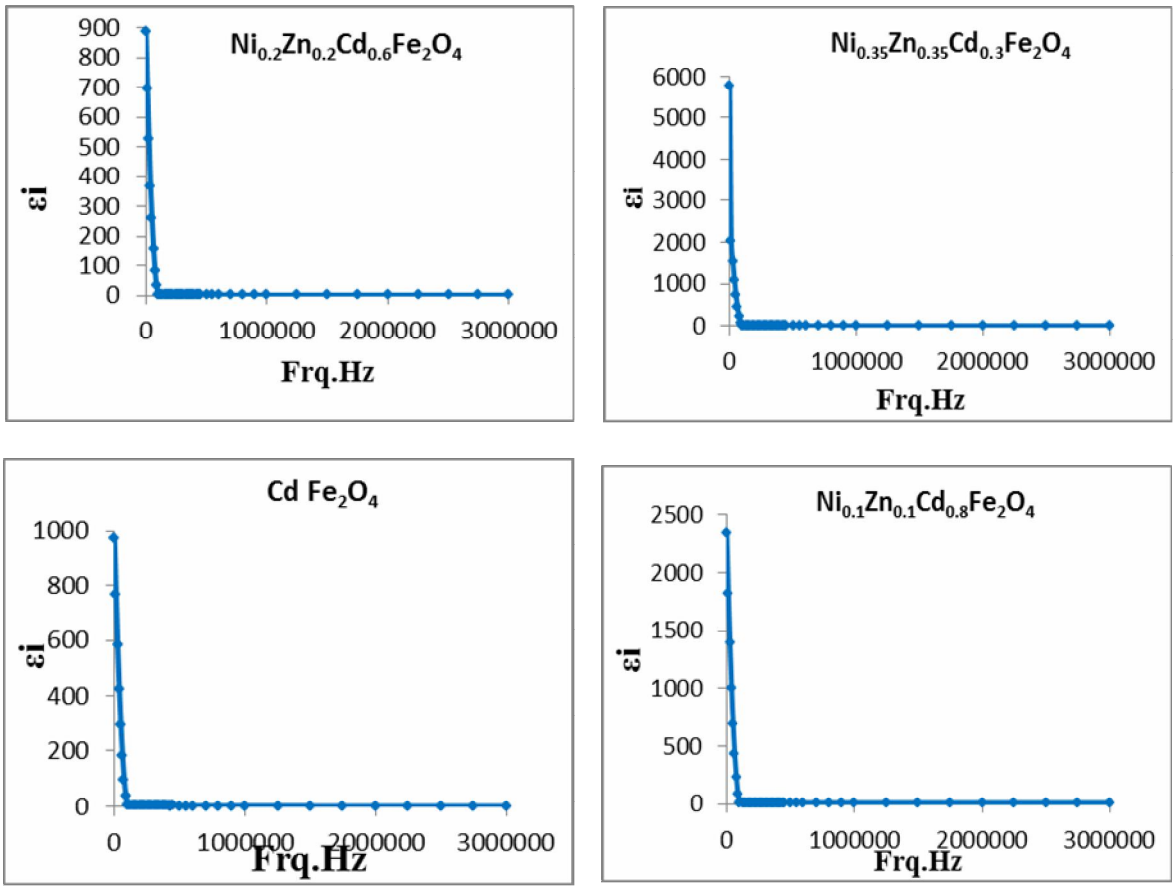
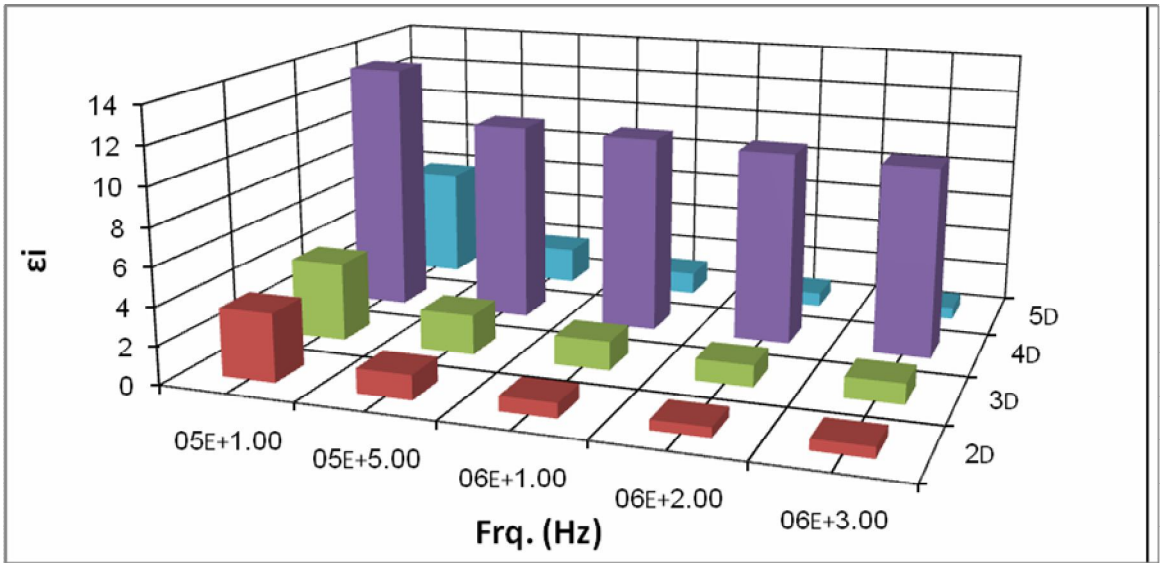


Fig (7)Variation of dielectric loss factor beheviar versus frequency for $(NiZn)_xCd_{1-x}Fe_2O_4$system



Fig(8)Variationmagnitude of dielectric loss factor with frequency & X-value change for $(NiZn)_XCd_{1-x}Fe_2O_4$ system

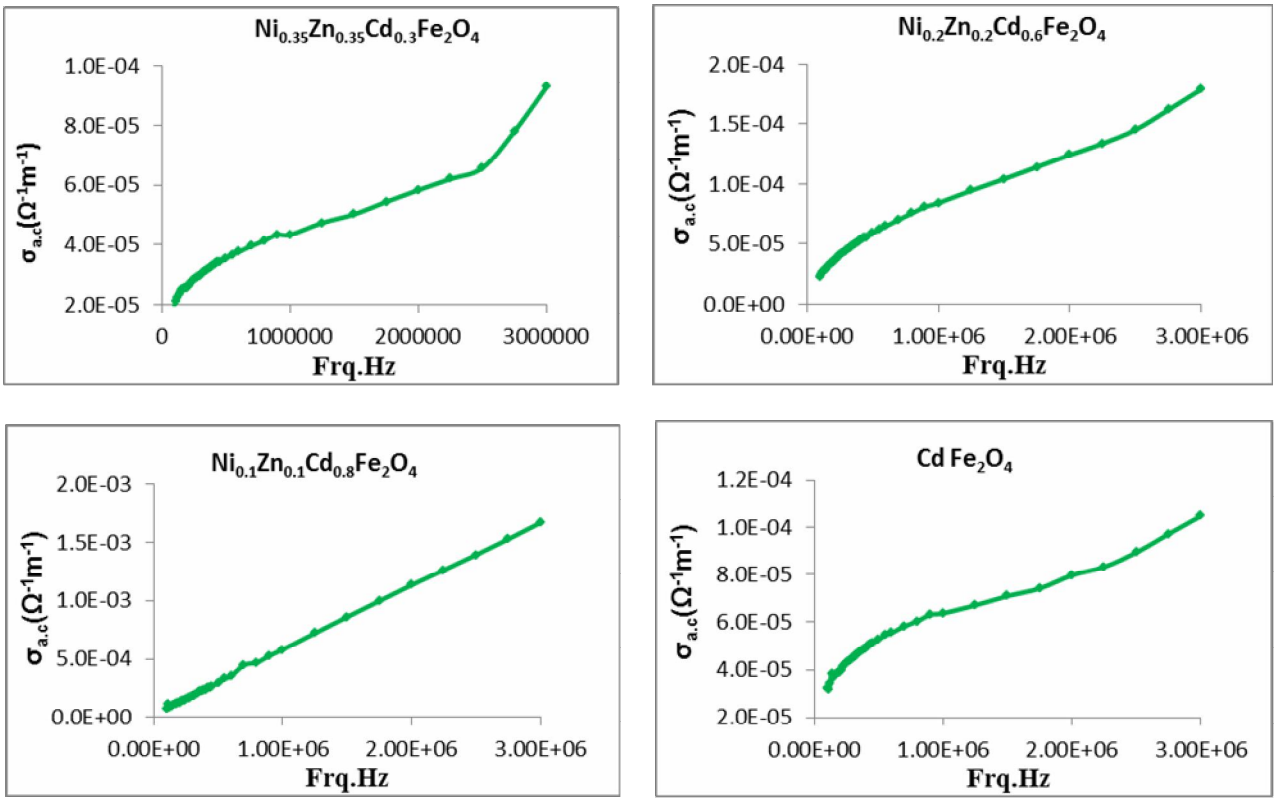
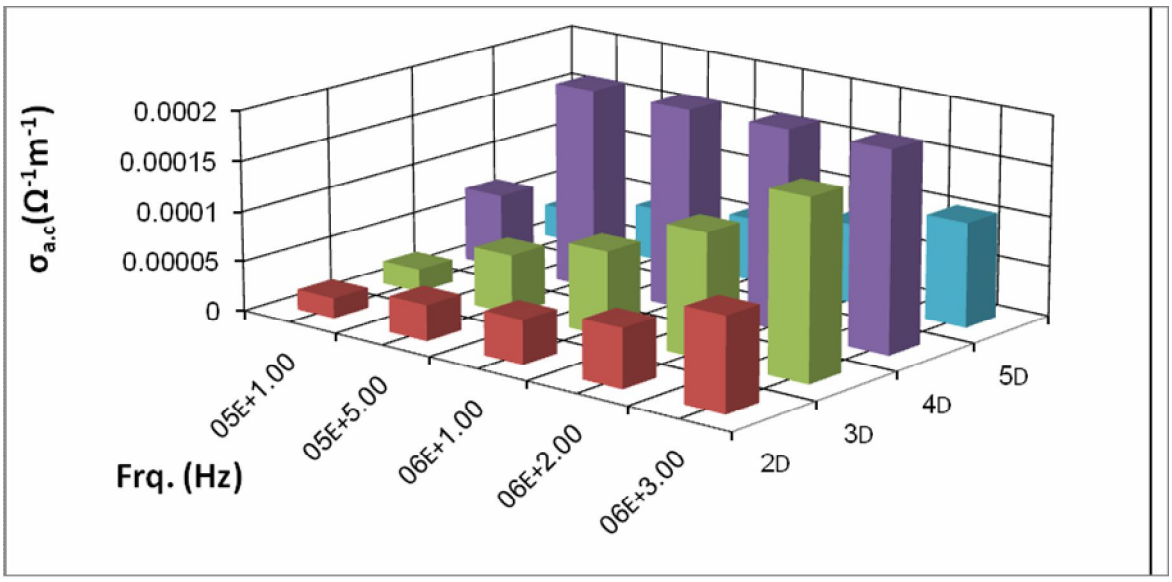


Fig (9)Variation of conductivity behavior with frequency for (NiZn)x$Cd_{1-x}Fe_2O_4$ system



Fig(10)Variationmagnitude of conductivity with frequency & X-value change for (NiZn)$_X$$Cd_{1-x}Fe_2O_4$ system

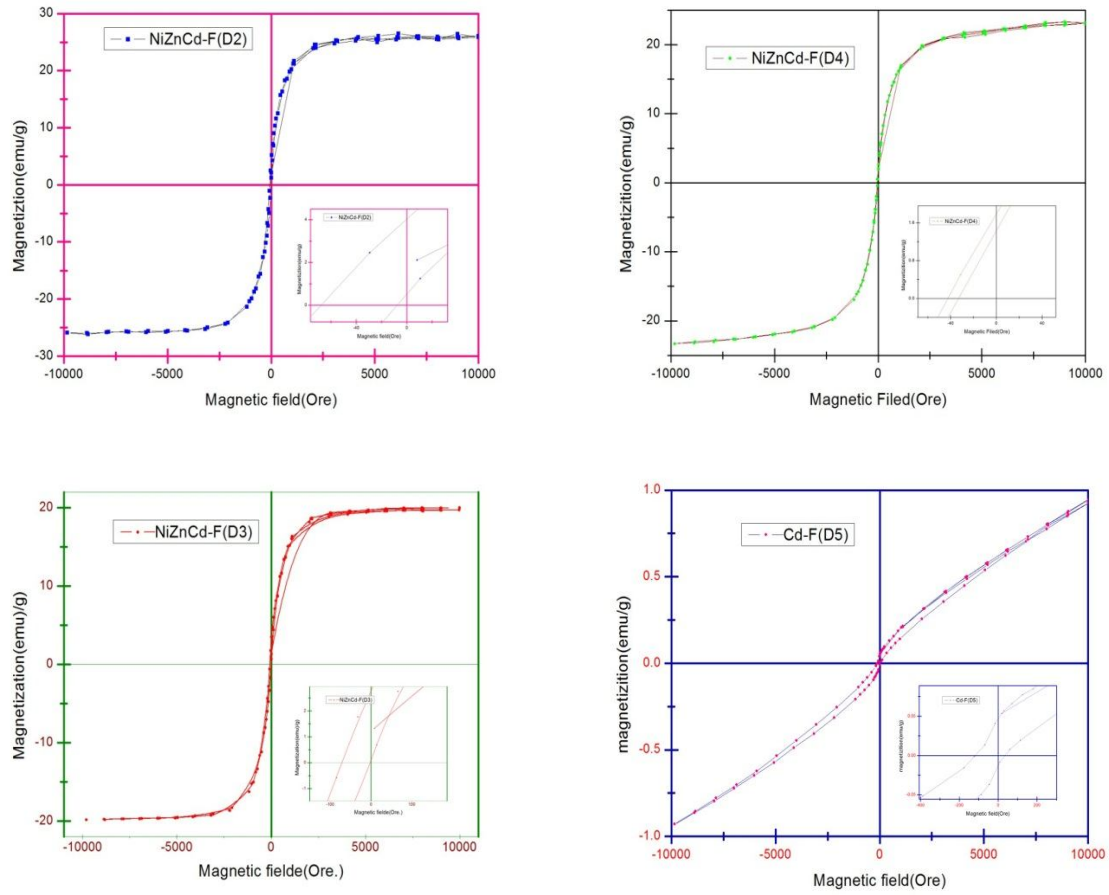


Fig.(11) Variation of hysterics lope for $(NiZn)_XCd_{1-x}Fe_2O_4$ system

Table (2)Show the magnetic parameter which calculated from hysterics lope diagram

D5 X=0.0	D4 X=0.2	D3 X=0.4	D2 X=0.7	Sample No. / parameter
0.945	23.03	20.03	26.1064	σ_s
0.0469	1.722	2.69	4.05	σ_r
77	4.74	34.2	30.1	H_c

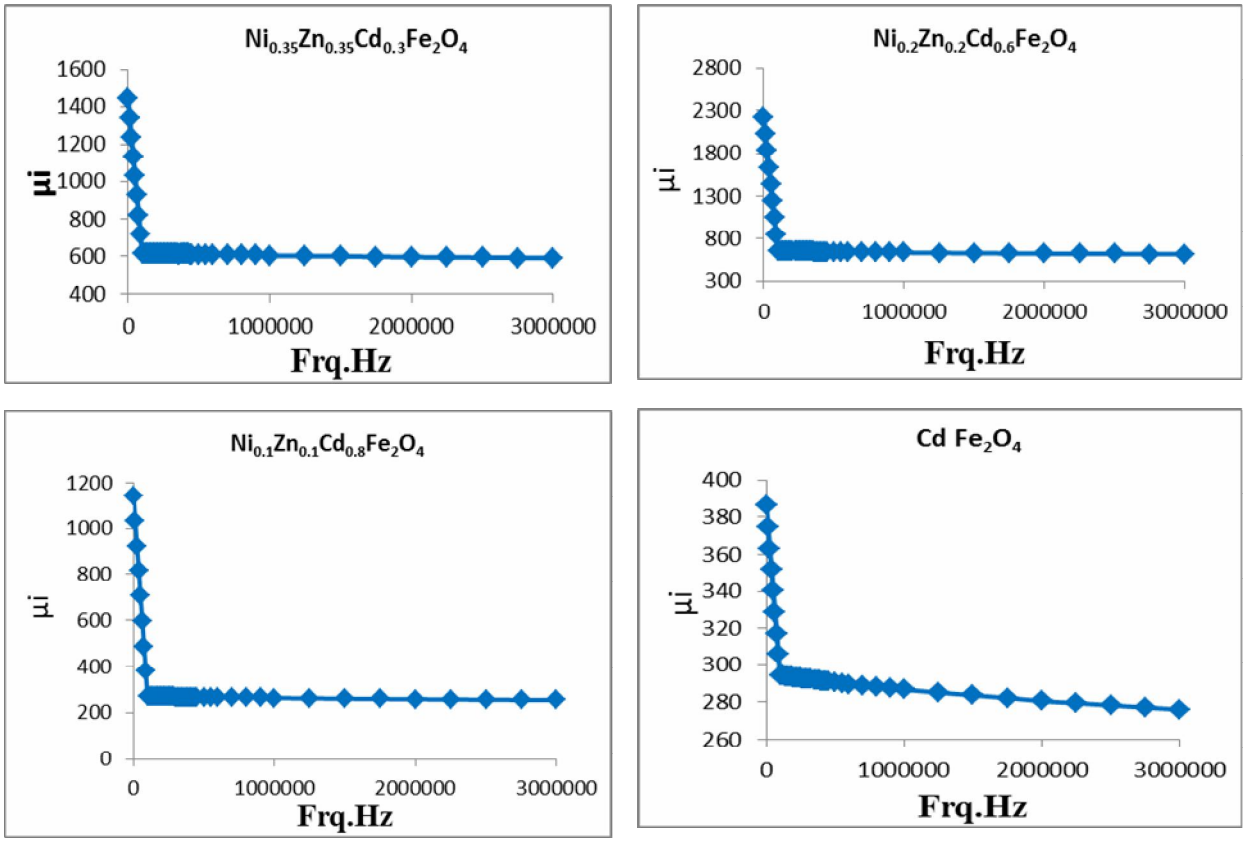
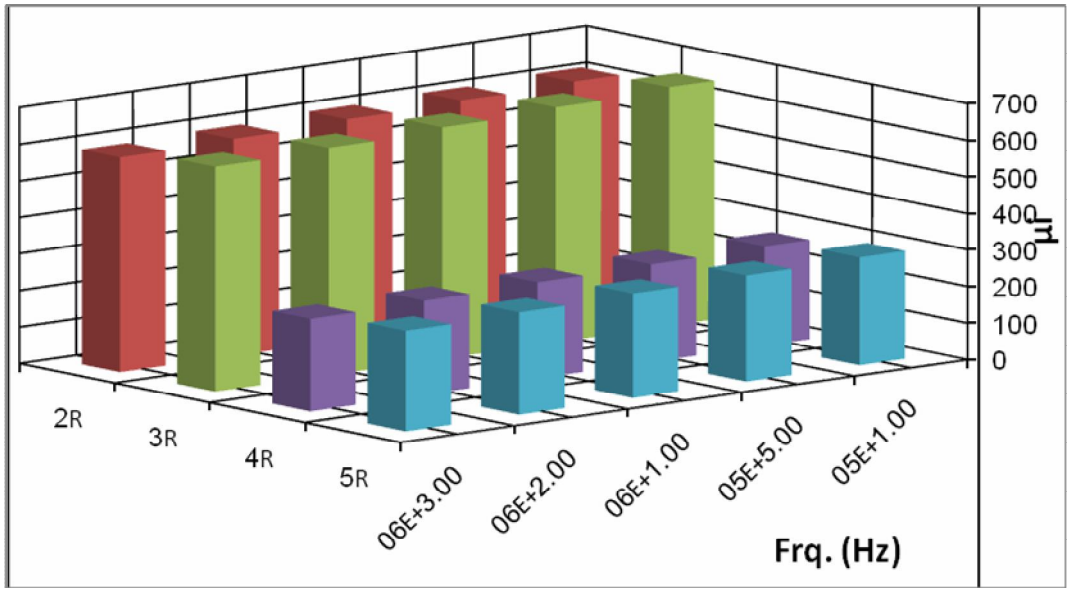


Fig (12)Variation of magnetic permeability behavior with frequency for $(NiZn)_XCd_{1-x}Fe_2O_4$ system



Fig(13)Variationmagnitude of magnetic permeability with frequency & X-value change for $(NiZn)_XCd_{1-x}Fe_2O_4$ system

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