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International Conference on Mainstreaming and Marginalized : Perspectives in Humanities,Commerce and Science at Mandangad College 'Impact of NanoScience and Nano Technology on Society via Microstructure and Magnetic Properties of Cobalt Zinc Ferrites '

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Introduction

Nanosciences and nanotechnology have become the most interesting and exciting fields in the recent years in Sciences like Physics, Chemistry, Engineering and Biology. In spite of the fact that the field of nanosciences is very young, there is great anticipation that in the near future, breakthroughs in nanosciences will transform present day technology with unimaginable applications.

"Nano" means billionth of a meter (1×10^{-9} meter). Though the systematic study of nanosciences is only of recent origin, functional devices and structures of nanometer dimensions exist on the earth forever. Particles made at the nano scale gives them the potential to exhibit some very interesting properties. Materials with particle size on the nanoscale between 1nm – 100nm lie in the domain between quantum effects of atoms and molecules and the bulk properties of materials. It is therefore that many physical properties of materials are controlled by phenomenons that have critical dimensions on the nanoscale.

Michael Faraday carried out the first scientific study on colloidal gold, silver and other metal aerosols and hydrosols in 1857 and concluded that these solutions contained metallic particles in a "highly divided state." Feynman in his prophetic lecture entitled, "There is plenty of room at the bottom", delivered in December 1959, visualized the field of nanotechnology with far reaching consequences. [1]

The aim of nanotechnology is to learn to exploit these properties and efficiently manufacture and employ these structures.[2]

Ferrites are mixed oxide magnetic materials in which the iron oxide is main component .Ferrites have opened a new era in the Physics of Magnetic Materials. Since they show like semiconductor and are also good dielectrics.

If the high electrical resistivity of ferrites is controlled with useful magnetic properties ; the resultant material could be suitable for high frequency applications.

APPLICATIONS OF FERRITES

Now a day the magnetic materials are found in numerous products such as home appliances, electronic products, automobiles, communication equipments and data processing devices etc. These materials have now become a vital part of everyday life in modern times.

The coercive force Hc is the most important property of magnetic materials that are used in applications at low and high frequency. A large coercivity is an inherent property of hexaferrites, and due to this it finds wide applications in motors, generators, loudspeakers and telephones.In soft ferrites, used for low and high frequency applications, the most important technical properties are Saturation Magnatisation (Ms), Coercivity(Hc), Magnetic moment (μ_B) and losses. The low frequency applications of soft ferrites include magnetic recording heads, inductor and transformer and filter cores. The high frequency applications of soft ferrites include a large number of microwave components such as circulators, isolators, and phase shifters and for high frequency applications, high resistivity and variation of RF, permeability is important. In hard ferrites, a large crystalline anisotropy is a characteristic hence hard materials have large energy product of maximum B_H and are used in permanent magnet applications.

Now a days ferrites are used in radio, television, microwave and satellite communication, bubble devices, audio, video, digital recording. There are other applications of ferrites, which are well illustrated in the form of tree shown in Figure.3

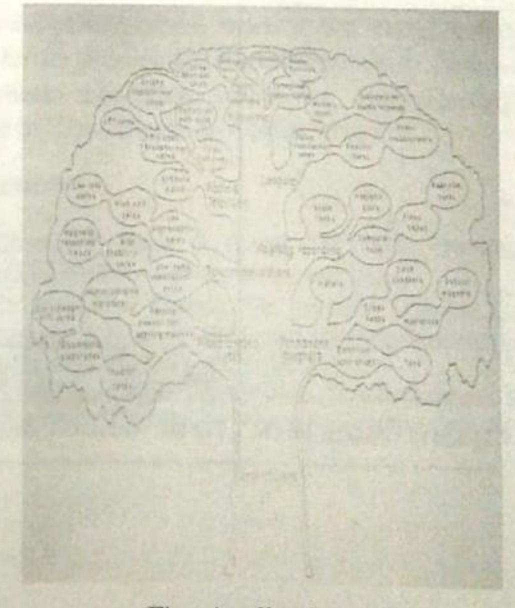


Fig : Application of Ferrites

Synthesis of Cobalt ferrites :- Co- Precipitation:-

Stichometric amount of metal Chloride in aqueous solution were prepared +boiling solution of NaOH within 10 second under constant stirring.

Chemical reaction is as follows

$(1-x)Co^{2+} + xZn^{2+} + 2Fe^{3+} + 8OH^{-} \rightarrow (1-x)Co(OH)_2 \ X \ xZn(OH)_2 \ X \ 2Fe(OH)_3$

Ferritization

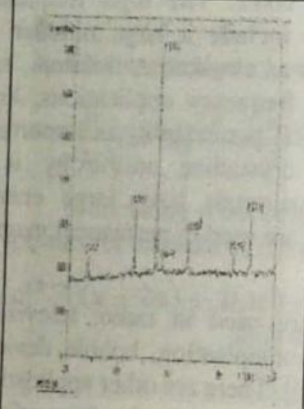
$(1-x)Co(OH)_2 \ X \ xZn(OH)_2 \ X \ 2Fe(OH)_3 \longrightarrow$

Heated in Alkaline Medium $\quad Co_{(1-x)}Zn_xFe_2O_4$

Microstructure Properties

X-Ray Diffraction

Diagrams : Table 3A-3 shows values of lattice parameter (a_0) and Zn^{2+} content in Uncoated and PVA coated Cobalt ferrite.



FigA1: Xrd of $CoFe_2O_4$

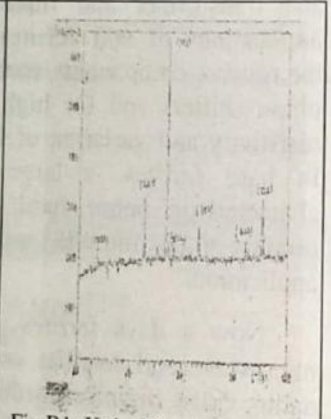


Fig B1: Xrd of $Co_{0.9}Zn_{0.1}Fe_2O_4$

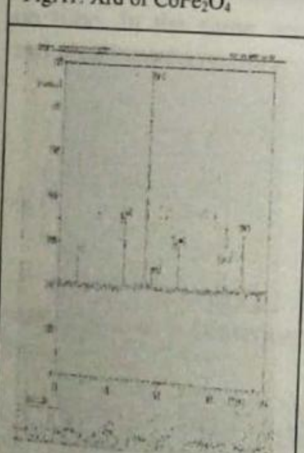


Fig C1: Xrd of $Co_{0.8}Zn_{0.2}Fe_2O_4$

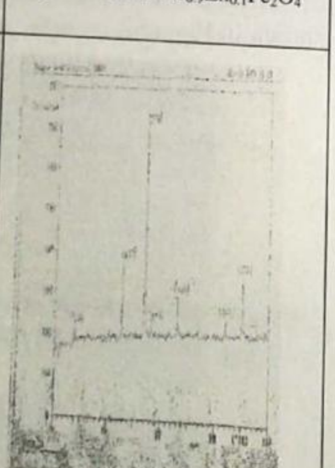


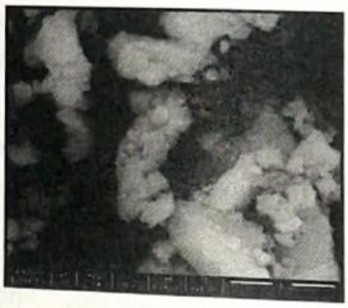
Fig D1: Xrd of $Co_{0.7}Zn_{0.3}Fe_2O_4$

Zn^{2+} content in uncoated Cobalt ferrites.	Lattice Parameter (a_0) for Uncoated Cobalt Ferrite
0.0	8.385
0.1	8.394
0.2	8.403
0..3	8.405

Table 5.1 shows variation of Average grain size obtained from SEM, average grain size from XRD data with Zn content in Uncoated Cobalt ferrite.

Zn content in uncoated Cobalt ferrites.	Average grain size in µm obtained from SEM	Average Grain Size obtained in µm by using XRD data
0.0	0.567	1.97
0.1	1	1.314
0.2	1.55	1.479
0.3	2.059	1.690

SEM



FigA2: SEM of $CoFe_2O_4$

Fig B2: SEM of $Co_{0.9}Zn_{0.1}Fe_2O_4$

Fig C2: SEM of $Co_{0.8}Zn_{0.2}Fe_2O_4$

Fig D2: SEM of $Co_{0.7}Zn_{0.3}Fe_2O_4$

MAGNETIC PROPERTY

Table (4A-1) shows the value of Saturation magnetization (Ms), Magnetic moment (μ_B), Retentivity(Mr) and Coercivity(Hc) with Zn content in Cobalt Zinc ferrites.

Zn^{2+} Content (x)	Saturation Magnetization emu/gm	Magnetic Moment		Retentivity (Mr)	Corecivity (Hc)
		μ_B Obs.	μ_B Cal.	emu/gm	Oe
0.0	53.35	2.241	2.64	3	6
0.1	53.35	2.247	3.31	3.75	6.5
0.2.	124.46	5.257	3.98	8	7.5
0.3	130.49	5.522	4.65	8.25	8

FigA3: Hystersis of $CoFe_2O_4$

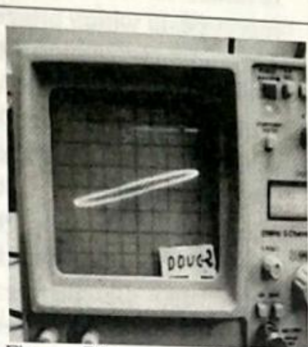


Fig B3: Hystersisof $Co_{0.9}Zn_{0.1}Fe_2O_4$

Fig C3: Hystersis of $Co_{0.8}Zn_{0.2}Fe_2O_4$

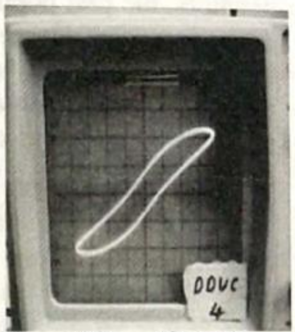


Fig D3: Hystersis of $Co_{0.7}Zn_{0.3}Fe_2O_4$

Conclusion

Single phase Cobalt-Zinc ferrites were successfully synthesized for composition x = 0.0, 0.1, 0.2 and 0.3 by using wet chemical co-precipitation method. The general formula used was $Co_{1-x} Zn_x Fe_2O_4$.

The x- ray diffraction of powdered composition was carried out by using diffractometer, model PW 1710. The diffractogram of all sample, show well defined picks. In case of all sample 311 reflections appears to be more intense. All the planes are allowed planes, which confirm the formation of single phase, cubic spinnel structure. The lattice constant 'a' was calculated and its compositional dependence was found for Uncoated and PVA coated Cobalt-Zinc ferrites. It can be concluded that lattice parameter goes on increasing with increase Zn content in Uncoated and PVA coated cobalt ferrites.

The saturation magnetization retentively, Coercivity and magnetic moments were determined by using high loop trace. It was found that in Uncoated Cobalt- Zinc ferrite saturation magnetization increases with Zn content .The retentivity and Coercivity field values of various compositions (for x= 0.0, 0.1, 0.2, 0.3) for cobalt ferrite was calculated. It was observed for all compositions, the values of retentivity and Coercivity increases with Zn^{2+} concentration .

The calculated value of μ_B for x = 0.0, 0.1, 0.2 are in good agreements with the experimentally found value. For composition x = 0.3 μ_B calculated is greater than μ_B observed which is due to canted spin.

The A.C. susceptibility of the sample was measured in the range 27^0 C- 350^0C using Helmotz double coil set up operated at 263 Hz with constant field 7 0e. The variation of A.C. susceptibility with temperature shows existence of multidomain structure for sample, synthesized for compositions x= 0.0, 0.1, 0.2, and 0.3.

The grain size of the samples was observed through a scanning electron microscope. The grain size is directly dependant on chemical method of preparation and stirring. The grain size of samples goes on increases with Zn concentration in cobalt ferrites. cobalt ferrites for compositions x= 0.1. 0.1, 0.2, and 0.3

Hence it can be concluded that the Cobalt-Zinc ferrites with high saturation magnetization can be synthesized for composition x= 0.0. 0.1, 0.2, and 0.3 by employing wet chemical co-precipitation method.

G. Vaidyanathan *et.al* [29] reported that Cobalt ferrites prepared at low temperature showed decrease in magnetic saturation, coercivity and retentivity with increase in Zinc content in Cobalt ferrite.

However in present work it has been observed that Cobalt ferrite prepared at high temperature shows increase in magnetic saturation, coercivity and retentivity with increase in Zinc content in Cobalt ferrite.

References:

1. Charles P. Poole, J. Frank , J. Owen., Introduction to Nanotechnology (John Wiley and Sons)
2. Dr. Ashutosh Sharma, Dr. Archana Sharma, Dr. Jayesh Bellore, Advances in Nanoscience and Nanotechnology
3. D. U. Bois, Phil. Mag. 29 (1890) 295
4. G. Vaidyanathan, S.Sendhilnathan, R.Arulmurugan . Journal of Magnetism and Magnetic Materials. 313(2007)293-299