MAH MUL/03051/2012
ISSN: 2319 9318 | Vidyawarta® | Oct. To Dec. 2016 Issue-16, Vol-08

them employable in the present knowledge based world. Such skilled population will in turn contribute to the human capital of the economy. The Government has to put massive effort to form better educational structure especially for skill development sector comprising of industry-oriented training. Skills and knowledge are the driving force of economic growth and social development of any country.

References

Binha, Ganga Kumar. (2015). Skill Development to be Relevant, Souvenir of 68th Annual Conference of Indian Commerce Association held on 6th to 8th November, 2015, hosted by Vinoba Bhave University Hazaribag (Jharkhand), P. 120.

Hazam, Dular and Kumar, Saurabh. (2015). Skill Develpoment : Need of the Business and Industry, Souvenir of 68th Annual Conference of Indian Commerce Association held on 6th to 8th November, 2015, hosted by Vinoba Bhave University Hazaribag (Jharkhand), P. 130.

J Merly Rajanayagam. (2016). Strategies for Developing English Communication Skills for Pre-service Teachers, New Delhi: Association of Indian Universities, University News, 54(43) October 24-30, Pp 23-25.

Padhen, Bhaskar Bhikaji. (2015). Government Initiative in Skill development in India, Souvenir of 68th Annual Conference of Indian Commerce Association held on 6th to 8th November, 2015, hosted by Vinoba Bhave University Hazaribag (Jharkhand), P. 116.

Sethi, Anjanee and Adhikari, Bhavana. (2008). Research & Communication Methodology. Book-3 for M.B.A. of YCMOU Nashik. Noida: Vikas Publishing House Pvt Ltd. Pp. 93-101.

Swami, Bodhananda. (2010). Foundations for A Vision of Indian Management: Ten Salient Features of Indian Worldview that will Constitute Fundamental Impulse of Indian Management. 3D IBA Journal of Management & Leadership. Bangalore: Indus Business Academy; 2(1). P.123.

Tulsian, P.C. and Pandey, Vishal. (2003). Business Organisation and Management. Delhi: Pearson Education (Singapore) Pte. Ltd. Pp. 1.5-1.11.

❑❑❑

12

History, Development and Applications of Ferrites

S.S.Shinde
Dept.of Physics,
A.S.C.College,Naldurg,Dist.Osmanabad (M.S.)

****

Abstract:

Ferrites are ferrimagnetic in structure in which magnetic moments of the atoms on different sub lattices are opposite to each other. The opposing moments are unequal and spontaneous magnetization remains. The simplest ferromagnetic material is spinel ferrite. The first natural magnetic material known was ferrous ferrite (Fe3O4) known as magnetite. The extensive studies on development of new ferrites and their applications have been made by number of workers. Applying the molecular field theory, Neel was the first to give basic theory of ferrimagnetism and concept of magnetic sublattices. Yafet and Kittel extended Neel's theory by postulating triangular spins.There are many applications of ferrites in different branches of science and technology due to their high resistivity in comparison with other magnetic materials.

Keywords: Ferrite, magnetic moment, sublattice, resistivity.

Introduction:

The magnetic properties of solids are of intrest and concern to a wide range of scientists and technologists. Depending upon to the response to the applied magnetic field and net resultant magnetization, which is usually expressed in terms of magnetization per unit magnetic field i.e. susceptibility, the magnetic materials are distinguished as diamagnetic (MgO), paramagnetic(Gd2O3),

ferromagnetic(EuO), ferromagnetic(Fe3O4), and antiferromagnetic (Cr2O3). Among these groups , ferro and ferromagnetic materials find extensive technological applications. The magnetic oxides, which are commonly known as ferrites are ferromagnetic in structure as originally proposed by Neel [1]. The first magnetic material known to man is magnetite (Fe3O4), the ferrous ferrite.

A ferromagnetic material is one in which the magnetic moments of the atoms on different sublattices oppose as in antiferromagnets, but the opposing moments are unequal and spontaneous magnetization remains. This behavior was first recognized in the technological group of material called ferrites.Iron oxide and metal oxides are the main constituents of the ferrites.The simplest ferromagnetic material is spinel ferrite. Other materials in the same class are the hexagonal such as barium ferrite BaFe12O19 and ferromagnetic garnets such as Yttrium iron garnet YIG.

Ferrite has been recognized as one of the most important electroceramic in modern industry. It' processing and application technologies have been improved incessantly in the last thirty years. There are several types of ferrite materials being used in microwave components for obtaining non reciprocal device action like isolation and phase shifting. The properties of the ferrites for use in devices at different frequency ranges are mostly designed by substituting diamagnetic metal ions for Fe3+ ion in the chemical formula unit of the ferrite.

History and Development of Ferrites:

The first natural magnetic material known from prehistoric times was magnetite (Fe3O4), the ferrous ferrite. In twelth centuary, Chinese used lodestone (Fe3O4) in compasses for navigation. Ferrite were first developed by Snoke[2] and his associates. The extensive studies on development of new ferrites and their applications have been made by number of workers [3-5]. Saturation magnetization of magnetite was first measured by De.Bois [6]. The studies on structural properties of spinel crystals were carried out by Barth et.al.[7] with the help of X- rays. They found that in case of spinel ferrites, it is necessary to assume that the divalent metal ions and trivalent iron ions interchange their positions in the crystal. The credit of chemical synthesis of magnetic materials goes to Hilpert [8], who in Bell laboratories prepared magnetite with the view point of reducing eddy current losses. The spinel ferrites have been classified into three categories depending upon distribution of cations on teterahedral and octahedral sites:1) Normal spinel ferrite 2) Inverse spinel ferrite and 3) Intermediate spinel ferrite.Verwey et.al. [9] reported that the electrical conductivity of ferrites is mainly due to hopping of electrons (the exchange of electrons between Fe2+ and Fe3+ ions) through the crystal lattice. His studies on crystal structure of various ferrites showed that the ferrites with inverted spinel structure in magnetic. Whereas ferrites with normal spinel structure is non-magnetic. Verwey, de-Boer and van Santen [10] conducted their X- ray study on a number of oxides having spinel structure an concluded that Mn, Fe, Co, Cu and Ni ferrites, which are magnetic have inverted spinel structure whereas Zn and Cd ferrites which are non-magnetic, have a normal spinel structure.

Neel [1] was the first to give basic theory of ferrimagnetism. Applying the molecular field theory to ferrites, he gave the concept of magnetic sub lattices. Neel's direct mechanism of interaction was found to be inadequate. So a more detailed examination was made by Anderson [11] and Van-Vleck[12] and introduced to two sub-lattices which improved the model. Yafet and Kittel [13] extended Neel's theory by postulating a triangular or canted arrangement of spin, when antiferromagnetic exchange interaction between sub-lattices is comparable to that among the spin moments within the

sub-lattices; formed by Fe3+ ions on tetrahedral and octahedral sites.

The dielectric properties of Ni-Zn ferrites were studied by Koops [14] who gave the formula for a. c. conductivity. Recently work on ferrites has progressed to have better control of structure parameters as in single crystal and epitaxial films. Advance instrumentation has made it possible today to interpret the data of different properties.

During last more than 50 years, scientists and researchers are working to produce various compositions of ferrite materials in order to produce new ferrites with optimum value of their physical, electrical and magnetic parameters.. Right from the beginning and till date it is not possible to produce novel ferrites. Research and development of some types of promising materials are under investigation. Each prepared ferrite material has some advantages as well as disadvantages. Scientists continue their efforts to achieve the optimum properties of ferrites like crystal structure, resistivity, dielectric properties, curie temperature, ac susceptibility, permeability and magnetic loss factor. The optimum conditions depend upon the sintering conditions[15] and methods of preparations [16].

Among all the substitutes used to change the physical, electrical and magnetic properties of ferrites, most important are Mn, Cu, Co and Zn. Combined substitution of these ions can produce new ferrite material with improved physical, electrical and magnetic properties. Among the various types of ferrites, most important and useful are spinel ferrites [17]. They are also called cubic ferrites. High electrical resitivity and low loss of eddy current make the spinel ferrites ideal for their use at microwave frequency

Applications of Ferrites:

Ferrites are important class of magnetic materials having high permeability, moderate to high saturation magnetism, low magnetic loss factor and high specific resistance.They have many applications in different branches of science and technology due to their high resistivity in comparison with other magnetic materials. In high frequency applications of ferrites, eddy currents are very small, whereas at such frequencies eddy currents are main drawback of metals even in laminated form. Technological importance of these ferrites is that using such ferrites we can deal easily with frequencies in the range of 103Hz to 1011Hz Such ferrites are used for water disposal method for factory drains, heat decomposition of NOx gas transformation of solar energy to hydrogen energy using ferrites as catalysts and spinel ferrites are used as rechargeable Lithium batteries [18].

Ferrites are used as sensors for temperature control. They can be made using ferritws with sharp and definite Curie temperature. Position and rotational angle sensors have also been designed using ferrites. A radar absorbing paint containing ferrites has been developed to render an aircraft or submarine invisible to radar. Ferrites are also used for pollution control. Because of their high corrosion resistance, ferrites having the appropriate conductivities have been used as electrodes in applications such as chromium plating. Ferrites are widely used in radio and television circuits. The largest consumption of soft ferrites is in television where half a kilogram is used for each set in the form of deflection Yoke, UI core, U, L, E and I cores. Mn-Zn ferrite possesses the most appropriate properties and parameters for television related applications.

High frequency applications of soft ferrites include large number of microwave components such as circulators, isolators, gyrators, phase shifters, YIG tuned filters, switches and substrates for microwave integrated circuits. The materials which are generally known to be suitable for the above

applications are substituted Yttrium iron garnets such as YAIG, YGdIG, YAlGdIG and spinel ferrites such as Ni-Zn, Mg-Zn, Mg-Mn, Cu-Zn, Cu-Al, Co-Al and Co-Cr ferrites.

By virtue of it's low cost and being suitable (BH)max for isotropic and anisotropic hexaferrites, it finds wide applications in motors, generators, loudspeakers, telephones, meter switches, magnetic separators, toys, flexible and magnets, magnetic latch and magnetic levitation.Among the recording materials, the most commercial materials are the discrete particles of magnetic oxides such as ?-Fe2O3 or Co-doped ?-Fe2O3 and CrO2[19]. In digital computers the ferrite cores are used as the switching and memory elements for transmitting, storing and recording the signal pulse in few microseconds [20].

The multilayer soft ferrite chip inductors are used in cordless telephones, viedo equipments, headphone stereos, T.V. hard disk and personal computers [21]. Mg-based ferrites are used as humidity sensors, carrier for intensifying X-rays in the human system and spinel ferrites are used as rechargeable Lithium batteries.The ferrites are also used in microwave communications e.g. Mg-Mn, Ni-Zn and Lithium ferrites etc. Thin films of defect spinel ferrite are used as write-once read-many media working with blue wavelength. There are several Japanese installations which use precipitation of ferrite precursors to scavenge pollutant materials such as mercury from waste stream. The ferrites produced can be removed magnetically along with the pollutant.

References:

1) Neel L. , Annales de Physique 3 (1948)137.

2) Snoek J.L., "New developments in ferrimagnetism" Elsevier (1949).

3) Standley K.J., "Oxide Magnetic material" Clarendon press, Oxford (1962)

4) Smart J.S., Am.J.Physics, 23 (1955) 356.

5) Gorter E.W., Proc. I.R.E. 43 (1955)1945.

6) De Bois H.E., Phil.Mag 29 (1966) 293.

7) Barth T.F., and Posnjack E., Z. Krist, 82 (1932) 325.

8) Hilpert S., Ber. Deut. Chem. 42 (1909) 2247.

9) Verwey E.J.W., Van Arkel A.E. and Van Bruggen M.G., J.Chem.phys.,55(1936)13.

10) Verwey E.J.W., F.de-Boer, Van Santen, J.Chem.phys.,16(1948)109.

11) Anderson P.W., Phys Rev., 79(1950) 350

12) Van-Vleck J.H., Phys Rev., 78(1950) 266.

13) Yafet Y. and Kittel C., Phys Rev., 87(1952) 290.

14) Koops C.G., Phys Rev., 83 (1951) 121.

15) Barakat M.M., Henaish M.A., Olofa S.A., Tawfik A., Piezoelectric effect and current-voltage relation in Sodiun benzoylacetonate polycrystal, J.Thermal Analysis 37(1991)605.

16) Goldman A.,Modern Ferrite Technology. Van Nostrand Reinhold; New York,1990.

17) Jie S. Lixi W.Naicen X., Qito Z., Microwave electromagnetic and absorbing properties of Dy 3+ doped MnZn ferrite, J.Rare Earths.28(2010)451.

18) Morales J., Sanchez L., Recent Res.Devel in Electrochem.1(1998).

19) Sharrock M.P., Matt.Res.Bull.11(1990)53

20) Papian W.N., "Applications of ferrites to memory Systems", Proc. Of metal Powder, Assoc.Vol.II(1955)183.

21) Sugimoto J., The past, present and future of ferrites., J.Am.Ceram.Soc.82(1999)269.

□□□

PRINCIPAL
Arts Science & Commerce College
Naldurg, Dist.Osmanabad-413602