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Structural And Magnetic Properties Of Ferrite-ferroelectric Me Composite

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Abstract:-*The piezomagnetic-ferrite and piezoelectric-ferroelectric Magnetoelectric (ME) composites with composition (1-x) $Ni_{0.5}Cu_{0.3}Zn_{0.2}Fe_2O_4$ + (x) $BaTiO_3$ in which x = 0, 0.2, 0.4, 0.6, 0.8 and 1 mol were prepared by conventional solid state reaction. The presence of constituent phases in the composites was confirmed by x-ray diffraction studies. The hysteresis behavior was studied to understand the magnetic properties such as saturation magnetization and magnetic moment B. The magnetic properties of above mentioned composites were investigated by using Vibrating Sample Magnetometer (VSM) at room temperature.*

Keywords:magnetization, Composites, X-ray diffraction, ferrite, ferroelectric.

INTRODUCTION

Ferroelectric ceramics are widely used in a broad range of applications, especially in the design of electronic devices such as capacitors, dielectrics materials [1-4]. Barium titanate ($BaTiO_3$) is one of the most used ferroelectric ceramic in electronics due to its high dielectric constant, which makes it a very attractive material to use in capacitors such as boundary layer capacitors (BLC) and multilayer ceramic capacitors (MLCC) [5-7]. Because of its extensive use, it has been widely studied and several methods have been proposed to enhance its dielectric constant.

Composites are class of materials in which different phases mixed together and used for various applications. Composites containing piezomagnetic (ferrite) and piezoelectric (ferroelectric) phases are known as magne toelectric (ME) composites [8]. These magnetoelectric composites have applications in radioelectronics, optoelectronics, microwave, electronics and as transducers in instrumentation [8–10]. The magnetoelectric (ME) effect is a phenomenon in which the application of magnetic field induces electric polarization. ME effect is a property of the composites which is absent in their constituents phases [8]. The ME effect is a two field coupled effect in which the application of electric field induces magnetization and magnetic field induces electric polarization. ME effect is a property of the composites which is absent in their constituents phases. The deformation of ferrite phase causes the polarization of piezoelectric particles of composite material and on the other hand the electrical polarization of piezoelectric material causes change of magnetization of ferrite phase due to mechanical coupling of the piezomagnetic (ferrite) and piezoelectric (ferroelectric) phases [11]. In the present study $BaTiO_3$ (BTO) is used as the ferroelectric phase and $Ni_{0.5}Cu_{0.3}Zn_{0.2}Fe_2O_4$ as the ferrite phase. The $BaTiO_3$ has high dielectric permittivity [12] and the nickel ferrite shows interesting magnetic properties [13].

Experimental:

The components of present composites are BaTio3 as ferroelectric phase and $Ni_{0.5}Cu_{0.3}Mg_{0.2}Fe_2O_4$ as a ferrite phase with general formula (1-x)$Ni_{0.5}Cu_{0.3}Mg_{0.2}Fe_2O_4$ + (x) $BaTiO_3$ in which x = 0, 0.2, 0.4, 0.6, 0.8, and 1 mol were prepared by conventional solid state reaction. The ferrite phase was prepared by NiO, CuO, MgO, and Fe_2O_3 in required molar proportions. These oxides were mixed and grind in agate mortar for couple of hours. The ferroelectric phase was prepared by using BaO and TiO_2 as starting materials. These oxides are also mixed and grind in agate mortar. The ME composites were prepared by mixing ferrite phase with ferroelectric phase respectively with molar proportion. The required molar proportions were mixed and grind for 3 hour. The grind powder mixture was pressed into pellets using hydraulic press. The pelletized sample was final sintered at 850o for 24 hour in programmable furnace and slow cooled to room temperature to yield the final product.

Characterization and property measurement:

The crystal structures of composites and their constituent phases were determined by XRD technique using Philips X-ray diffractometer. The XRD patterns were recorded at room temperature in the 2 theta range 100 to 800 using Cu-K radiation. The magnetic properties such as magnetization, magnetron number, coerciviety, remnance ratio etc. were studied by using vibrating sample magnetometer. All the hysteresis curves were taken at room temperature.

RESULT AND DISCUSSION:

1.Structural Characterization:

Fig.1 and Fig.2 shows the XRD pattern of composites with x=0.2 and x=0.4 respectively. The peaks are characteristics of both ferrite and ferroelectric phases. The intensity as well as number of ferroelectric peaks increases with increase in ferroelectric content in composites. It may be due to increase of molar percentage of ferroelectric. The $Ni_{0.5}Cu_{0.3}Zn_{0.2}Fe_2O_4$ ferrite phase has cubic spinel structure. The ferroelectric phase has tetragonal perovskite structure. The lattice parameters a= 8.3202 A°for ferrite phase and a= 4.0042 A°, c= .4.0450 Ao for ferroelectric phase respectively.

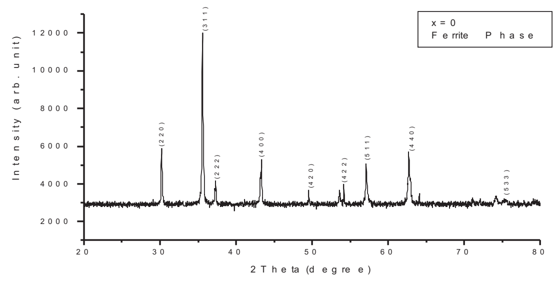

Fig.1 XRD Patterns of (1-x) $Ni_{0.5}Cu_{0.3}$ $Zn_{0.2}$ Fe_2O_4+(x) $BaTiO_3$ for x=0

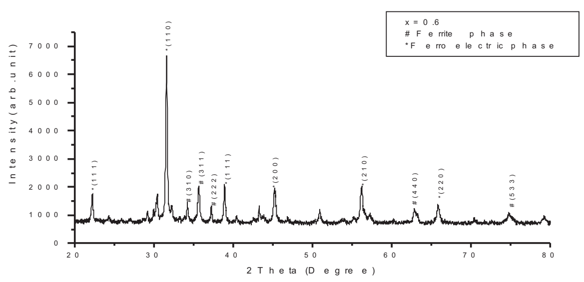

Fig.2 XRD Patterns of (1-x) $Ni_{0.5}Cu_{0.3}$ $Zn_{0.2}$ Fe_2O_4+(x) $BaTiO_3$ for x=0.6

2.Magnetization:

The magnetic properties of above mentioned composites were investigated by using Vibrating Sample Magnetometer (VSM) at room temperature. The hysteresis curves were obtained by plotting graph between magnetic flux and magnetization. The loop is generated by measuring the magnetic flux of a ferromagnetic material when the magnetizing force is changed. The hysteresis loop for all the samples of composite materials under investigation exhibit typical magnetic hysteresis of magnetic materials indicating that the composites are magnetically ordered. It is seen from hysteresis loop that the loop of the composites shifts towards the field axis with decreasing ferrite content. The values of saturation magnetization, remenent magnetization and coercive field are obtained from the Hysteresis loops.

The room temperature magnetic properties of the composites are depicted in Fig. 4, which demonstrates the presence of an ordered magnetic structure. The low coercive forces (Hc) for the composite systems indicate its magnetically soft nature and suitability for device applications. As predicted, the saturated magnetization (Ms) values of the composites rely on the ferrite content. An increase in ferroelectric component corresponds to lower magnetization values. The composite with the highest ferrite content at x=0.00 exhibits the maximum value of saturated (Ms) and remnant (Mr) magnetization.

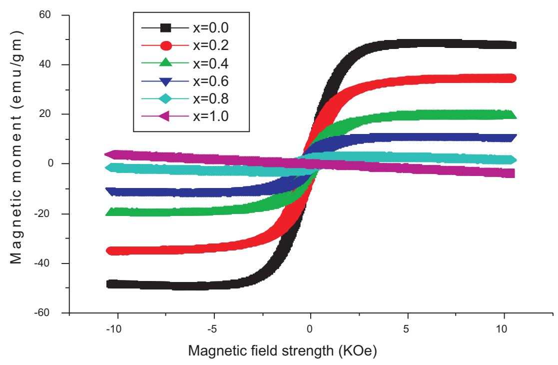

Fig.3 Hysteresis behavior of (1-x) $Ni_{0.5}Cu_{0.3}$ $Zn_{0.2}$ Fe_2O_4+(x) $BaTiO_3$.

In these ME composites it is found that the remnant magnetization, saturation magnetization, spontaneous polarization and coercive field of the composite decreases in proportion to the decrease in ferrite content as shown in Fig.3. This is due to ferrites are magnetic material as the composition of magnetic material decreases the corresponding magnetic properties also decreases.

CONCLUSION:

The ME ceramic composites consisting of $Ni_{0.5}Cu_{0.3}$ $Zn_{0.2}$ Fe_2O_4 and $BaTiO_3$ as composites have been prepared by conventional solid state reaction. Cubic spinel structure for ferrite phase and tetragonal perovskite structure for ferroelectric phase formation was confirmed by XRD studies. The magnetic properties of above mentioned composites were investigated by using Vibrating Sample Magnetometer (VSM) at room temperature. The hysteresis loop for all the samples of composite materials under investigation exhibit typical magnetic hysteresis of magnetic materials, indicating that the composites are magnetically ordered.

REFRENCES:

[1]E. Pedro, Sanchez-Jamenez, L. A. Perez-Maqueda, M. J. Dianez, A. Perejon, J. M. Criado, Composite Structure, 92 (2010) 2236.
[2]G. H. Haertling, J. Am. Ceram. Soc. 82 (1999) 797
[3] F. T. Chen, C. W. Chu, J. He, Y. Yang, J. L. Lin, Ceram. Int. 30 (2004) 1271.
[4]R. Z. Chen, X. H. Wen, Li Lt, Z. L. Gui, Ceram. Int. 30 (2004) 1271
[5]S. Guillemet, Z. Valdez – Nava, C. Tenailleau, T. Lebey, B. Durand, J. Y. Chane, Adv. Materials 20 (2008) 551.
[6]C. S. His, Y. C. Chen, H. Jantunen, MJ Wu, TC Lin, Eur.

Ceram. Soc. 28 (2008) 2581
[7]A.F. M. dos Santos, A. K. Cheetham, W.Tian X.Q. Pan, y. Jia, N.J. Murphy, J.Lettieri, and D. G. Schlom., App. Phys. Lett. 84 (2004) 91.
[8] S.V. Suryanaraya. Bull. Mater, Sci. 17(1994)
[9] H. Schmid Bull. Mater. Sci., 17 (1994) 1411.
[10] J. Van Suchtelene, Philips Res., Rep. 27 (1972) 28
[11] S.S. Lopatin. Ferroelectrics, 162(1994)63.
[12]J. Paletto, G. Crange, R. Goutte and L. Eyraud , J. Phys. Appl. Phys. 7(1974) 78.
[13] N. Ponpandian , P. Balaya and A. Narayansamy , J. Phys.:Conden. Mater. 14(2002)3221.

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