Effect of Magnetic Field on the Dielectric Properties $BaTiO_3$-$MgFe_2O_4$ Composite

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1. Abstract

In this study we tried to measure the effect of magnetic field on the dielectric properties of $BaTiO_3$-$MgFe_2O_4$ soft magnetic composite. Composites with different weight percents of ferroelectric and ferromagnetic phases were subjected to magnetic field in the order of 0 to 450 Oe and the variation of the dielectric properties was observed. The Variation of dielectric polarization was discussed in terms of Maxwell-Wagner type polarization in particulate composites.

2. Introduction

Multiferroic materials were of rapidly interested areas in which the possible coupling within the ferroelectric and ferromagnetic phases can lead to new conceptualization of electronic devices[1]. The control of electric polarization was measured by application of magnetic field. Variation of the dielectric properties can be related to several aspects including coupling[2]. In this study we have synthesized a soft magnetic composite with $BaTiO_3$-$MgFe_2O_4$ and the dielectric properties were measured in presence of magnetic field.

3. Experiment, results and discussion

$BaTiO_3$-$MgFe_2O_4$ composite system was synthesized in two steps which involved synthesis of $BaTiO_3$ initially combination with $MgFe_2O_4$ as reported in literature[3]. Composite pillets were thermally annealed at in the 950 to 1150 OC for 2 h in air. Crystal structure, magnetization, and magnetic field dependent dielectric properties were measured. Tetragonality of the $BaTiO_3$ phase was confirmed by the peak splitting at 45 degrees and the lattice parameters calculated were a(=b)= 3.9906(4) Å, c = 4.0278(8) Å[4]. Variation of the magnetization with respect to the increase of the annealing temperature was related with the exchange of the magnetic cations among the tetrahedral and octahedral sites of the spinel lattice[5].

Dielectric properties were measured by applying magnetic field in the range of 0 to 450 Oe. Dielectric constant in accordance with applied magnetic field increased with magnetic field due to Maxwell-Wagner polarization in heterogeneous type of medium proposed by Catalan G[2,6]. However the generation of magnetostriction was certainly possible. These observations can be due to the existence of coupling between the ferroelectric phase and the ferromagnetic phase and the interfacial effect among the ferroelectric and the ferromagnetic phases[2,6]. Since the increase in the dielectric constant was observed above the 100 Oe the grain boundary interfacial effect possibly existed[2,6].

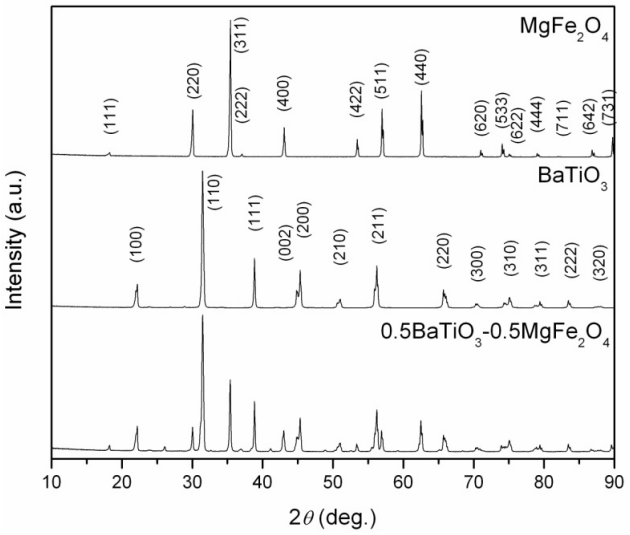

Fig. 1. Diffraction patterns of thermally treated samples at 1050 OC.

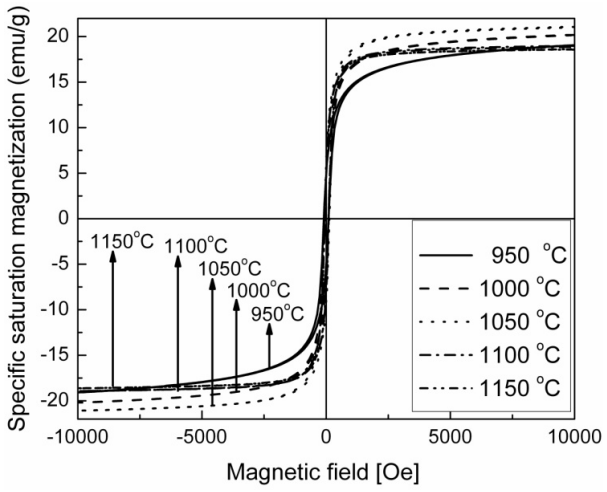

Fig. 2. Magnetization of composite pillets $0.5BaTiO_3$-$0.5MgFe_2O_4$ thermally treated at different temperatures.

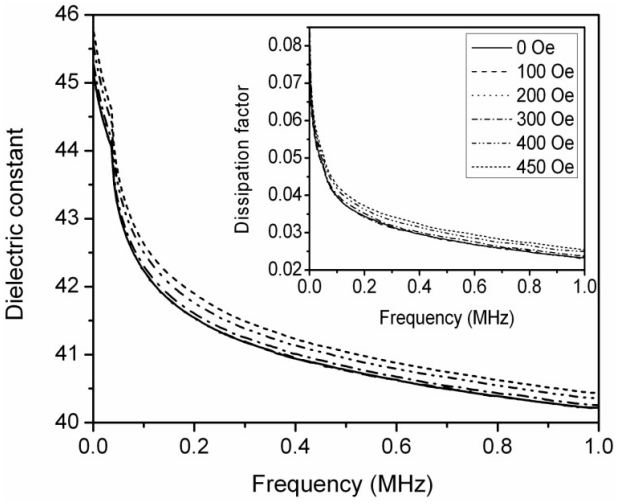

Fig. 3. Variation of dielectric properties of composite pillet $0.5BaTiO_3$-$0.5MgFe_2O_4$ treated at 1050 OC.

4. Conclusion

$BaTiO_3$-$MgFe_2O_4$ composite was synthesized with soft magnetic and dielectric properties. Correlation between applied magnetic field and dielectric properties were investigated in this study. Magnetic field dependent dielectric properties have shown an increase of dielectric constant with increase of applied magnetic filed. Dielectric properties measured in terms of varying magnetic field resulted in increase of dielectric constant. Higher value of dielectric constant was observed for a maximum field of 450 OC.

5. References

[1] S.W. Sheongi et. al, Nat. Materials. 6. 13 (2007).

[2] G. Catalan, App. Phy. Lett. 88. 102902 (2006).

[3] R. Tadi et. al, J. Mag. Mag. Mater. 323. 564 (2011).

[4] A.C. Larson, and R.B.V. Dreele, GSAS, Los Alamos National Laboratory Report LAUR. 86. 748 (2004).

[5] M. Gateshki et. al, J. Appl. Cryst. 38. 772 (2005).

[6] M. Wagner, Ann. Phys. 40. 817 (1913).