The Magnetic Entropy Change on $La_{0.7}Ba_{0.3}Mn_{1-X}Fe_XO_3$ Compound

J. S. Hwang, D. M. Jang, K. S. Kim and S. C. Yu*

[1]BK21 physics Program and Department of Physics, Chungbuk National University, 12 Gaesindong Cheongju 361-763 Chungbuk, Korea

I. Introduction

The magnetic caloric effect (MCE) is intrinsic to magnetic solids and is induced via the coupling of the magnetic sub-lattice with the magnetic field, which alters the magnetic part of the total entropy due to a corresponding change in the magnetic field. It can be measured and calculated as the adiabatic temperature change ΔT_{ad} (T, ΔH) or as the isothermal magnetic entropy change ΔS_M (T, ΔH). Traditionally, diluted paramagnetic slats and rare earth intermetallic compounds that display significant MCE have been considered as attractive materials for cryogenic applications [1,2]. Especially, double perovskite Ba_2FeMoO_6 (BFMO) shows room temperature magnetoresistance and a ferrimagnetic phase transition with a Curie temperature of 310 ~ 330 K [3,4]. Therefore, it would be very interesting to study the magnetocaloric effect for this kind of materials because of the Curie temperature being near room temperature. We have already published reports on the magnetocaloric effect of $Ba_{1.9}La_{0.1}FeMoO_6$ compound [5]. The magnetic entropy change can be tuned by suitable sintering process. In this work, the magnetocaloric effect of $La_{0.7}Ba_{0.3}Mn_{1-x}Fe_xO_3$ compound was investigated. Materials with proper Curie temperature and large spontaneous magnetization have many peculiar properties that are attractive for applications as magnetic refrigerants.

II. Experiments

Polycrystalline $La_{0.7}Ba_{0.3}Mn_{1-x}Fe_xO_3$ (x=0.0, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07) samples were prepared by standard solid-state reaction in a stream of 5% H_2/Ar gas at sintering temperatures of 1273 K for 12 h. A stoichiometric mixture of high purity Fe_2O_3 (99.99%), FeO_3 (99.99%), BaO_3 (99.99%) and MnO_2 (99.999%) powders were fired in an Al_2O_3 crucible at 1573 K in an electric furnace. X-ray diffraction patterns were taken with a Phillips diffractometer using Cu Kα radiation. The temperature dependence of the magnetization was measured with a commercial vibrating sample magnetometer (VSM) at various temperatures from 80 K to 500 K in fields up to 10 kOe.

III. Results and discussion

Figure 1 shows the temperature dependence of magnetization for $La_{0.7}Ba_{0.3}Mn_{1-x}Fe_xO_3$ compound measured at 100 Oe from 80 K. The magnetic transition temperature, T_c defined as the minimum temperature of the *dM/dT vs. T* curve. The sharp decrease in magnetization implies the occurrence of magnetic ordering. As shown in figure 1, the Curie temperature decreased from 346 to 132 K with increasing Fe concentration.

Figure 2 show the temperature dependence of the magnetic entropy change for $La_{0.7}Ba_{0.3}Mn_{1-x}Fe_xO_3$ compound with an external field of 10 kOe. The magnetic entropy change, a function of temperature and magnetic field,

produced by the variation of the magnetic field from 0 to H_{max} is calculated by $|\Delta S_M| = \sum_i \frac{M_i - M_{i+1}}{T_{i+1} - T_i} \Delta H$. As can be seen in figure 2, with a magnetic field varying from 0 to 10 kOe, ΔS_M, is about 0.415 J/kg K ~ 1.140 J/kg K. Our results show that the maximum value of ΔS_M obtained at x=0.2 compound. The magnetocaloric effect is taken place around room temperature, especially. The superior features of this compound make it a competitive candidate for a working material in room temperature magnetic refrigeration because of proper substitution of Fe. This opens promising applications in magnetic cooling systems, probably.

IV. Conclusion

The magneto-caloric effect and magnetization behavior have been analyzed in the double-perovskite $La_{0.7}Ba_{0.3}Mn_{1-x}Fe_xO_3$ compound with the sintering temperature at 1273 K. Samples were fabricated by conventional solid-state reaction method. X-ray diffraction measurements revealed that all the samples are single phase in cubic structure. The T_C decreased with increasing Fe content. The magnetic entropy changes, ΔS_M of about 0.42 ~ 1.93 J/kg K were obtained in the temperature range of 145 K ~ 350 K. The maximum values of ΔS_M obtained at x=0.02 compound with Curie temperature of 297 K.

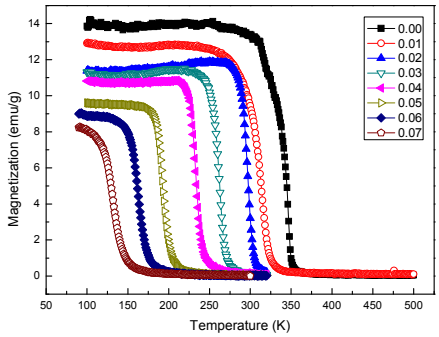

Fig. 1 Temperature dependence of magnetization for Measured at 100 Oe on $La_{0.7}Ba_{0.3}Mn_{1-X}Fe_XO_3$ compound.

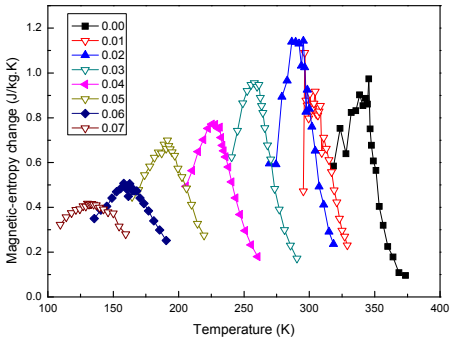

Fig. 2 Temperature dependence of the magnetic entropy change for $La_{0.7}Ba_{0.3}Mn_{1-X}Fe_XO_3$ compound.

References

[1] K. Pecharsky and K. A. Gschneidner Jr, J. Appl. Phys. 86, 565 (1999).

[2] M. Földeàki, R. Chahine, and T. K. Bose, J. Appl. Phys. 77, 3528 (1995).

[3] C. X. Huu, N. Chau, N. D. The and N. Q. Hoa, J. Kor Phys. Soc. **53**, 763 (2008).

[4] N. Chau, D. T. Hanh, B. C. Tinh, N. H. Luong, N. D. Tho and N. H. Hai, J. Korean Phys. Soc. **52**, 1431 (2008).

[5] M.S. Lee, C.M. Heo, K.S. Kim, B.S. Kang, S.C. Yu, Y.S. Kim, J.Y. Kim and B.W. Lee, J. Kor. Phys. Soc. 57, 1897 (2010).