Giant magneto-caloric effect around room temperature at moderate low field variation in $La_{0.7}(Ca_{1-x}Sr_x)_{0.3}MnO_3$ perovskites

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Abstract: Among the perovskite manganites, a series of $La_{1-x}Ca_xMnO_3$ has the largest magneto-caloric effect (MCE) ($|\Delta S_m|_{max}$=3.2-6.7 J/kg K at ΔH=13.5 kOe), but the Curie temperatures, T_C, are quite low (165-270 K). The system of $LaSrMnO_3$ has quite high T_C but its MCE is not so large. The manganites $La_{0.7}(Ca_{1-x}Sr_x)_{0.3}MnO_3$ (x=0, 0.05, 0.10, 0.15, 0.20, 0.25) have been prepared by solid state reaction technique with an expectation of large MCE at room temperature region. The samples are of single phase with orthorhombic structure. The lattice parameters as well as the volume of unit cell are continuously increased with the increase of x due to large Sr^{2+} ions substituted for smaller Ca^{2+} ions. The field-cooled (FC) and zero-field-cooled (ZFC) thermomagnetic measurements at low field and low temperatures indicate that there is a spin-glass like (or cluster glass) state occurred. The Curie temperature T_C increases continuously from 258 K (for x=0) to 293 K (for x=0.25). A large MCE of 5 J/kg K has been observed around 293 K at the magnetic field change ΔH=13.5 kOe for the sample x=0.25. The studied samples can be considered as giant magneto-caloric materials, which is an excellent candidate for magnetic refrigeration at room temperature region. © 2009 Elsevier B.V. All rights reserved.

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References:
- Tishin, A.M., (1999) Hand Book of Magnetic Materials, 12. , Buschow K.H.J. (Ed), Elsevier, Amsterdam (Chapter 4)
- Callen, H.B., (1981) Thermodynamics, , Wiley, New York (Chapter 14)
- Pecharsky, V.K., Gschneidner, K.A., (1999) J. Magn. Magn. Mater., 200, p. 44
- Bruck, E., Ilyn, M., Tislim, A.M., Tegus, O., (2005) J. Magn. Magn. Mater., 290-291, p. 8
- Zhang, X.X., Tejada, J., Xin, Y., Sun, G.F., Wong, K.W., Bohigas, X., (1996) Appl. Phys. Lett., 69, p. 3566
- Huang, H., Guo, Z.B., wang, D.H., Du, Y.W., (1997) J. Magn. Magn. Mater., 173, p. 302
- Bohigas, X., Tejada, J., Del Barco, E., Zhang, X.X., Sales, M., (1998) Appl. Phys. Lett., 73, p. 390
- Szewezyk, A., Szymczak, H., Wisniewski, A., Piotrowski, K., kartaszynski, R., Dabrowski, B., Kolesnik, S., Bukowski, z., (2000) Appl. Phys. Lett., 77, p. 1026
- Luong, N.H., Chau, N., Huong, P.M., Minh, D.L., Chau, N.N., Cong, B.T., Kurisu, M., (2002) J. Magn. Magn. Mater., 242-245, p. 760
- Chau, N., Niem, P.Q., Nhat, H.N., Luong, N.H., Tho, N.D., (2003) Physica B, 327, p. 214
- Choudhury, Md.A., Akhter, S.A., Minh, D.L., Tho, N.D., Chau, N., (2004) J. Magn. Magn. Mater., 272-276, p. 1295
- Phan, M.H., Tho, N.D., Chau, N., Yu, S.C., Kurisu, M., (2005) J. Appl. Phys., 97, p. 103901
- Phan, M.H., Phan, T.L., Yu, S.C., Tho, N.D., Chau, N., (2004) Phys. Stat. Sol. (b), 241, p. 1744
- Phan, M.H., Peng, H.X., Yu, S.C., Tho, N.D., Chau, N., (2005) J. Magn. Magn. Mater., 290, p. 199
- Chau, N., Nhat, H.N., Luong, N.H., Minh, D.L., Tho, N.D., Chau, N.N., (2003) Physica B, 327, p. 270
- Luong, N.H., Hanh, D.T., Chau, N., Tho, N.D., Hiep, T.D., (2005) J. Magn. Magn. Mater., 290, p. 690
- Chau, N., Cuong, D.H., Tho, N.D., Nhat, H.N., Luong, N.H., Cong, B.T., (2004) J. Magn. Magn. Mater., 272, p. 1292
- N. Chau, N.D. The, C.X. Huu, in: Proceedings of the Second International Workshop on Nanophysics and Nanotechnology, Hanoi, Vietnam, October 22-23, 2004, p. 51Guo, Z.B., Du, Y.W., Zhu, J.S., Huang, H., Ding, W.P., Feng, D., (1997) Appl. Phys. Lett., 88, p. 1142
- Hueso, L.E., Sande, P., Miguens, D.R., Rivas, J., Rivadulla, F., Lopez-Quintela, M.A., (2002) J. Appl. Phys., 91, p. 9943
- Sun, Y., Xu, X., Zhang, Y.H., (2000) J. Magn. Magn. Mater., 219, p. 183

- Hiep, T.D., Chau, N., Tho, N.D., Luong, N.H., (2004) Proceedings of the Ninth Vietnam Biennal Conference on Radio and Electronics (REV'04), p. 339. , Hanoi, Vietnam, November 26-27
- Mira, J., Rivas, J., Hueso, L.E., Rivadulla, F., Lopez-Quintela, M.A., (2002) J. Apply. Phys., 91, p. 8903
- Foldeaki, M., Chahine, R., Bose, T.k., (1995) J. Appl. Phys, 77, p. 3528
- Arulraj, A., Santhoh, P.N., Gopalan, R.S., Guha, A., Raychaudhuri, A.K., Kumar, N., Rao, C.N.R., (1998) J. Phys. Condens. Matter, 10, p. 8497
- Wang, Z.H., Ji, T.H., Wang, Y.Q., Chen, X., Li, R.W., Cai, J.W., Sun, J.R., Yan, C.H., (2000) J. Appl. Phys., 87, p. 5582
- Dankov, S.Y., Tishin, A.M., Pecharsky, V.K., Gschneidner Jr., K.A., (1998) Phys. Rev. B, 57, p. 3478