Anomalous Phonon Transport Enhancement at First-order Ferromagnetic Transition in $(Gd,Sm,Nd)_{0.55}Sr_{0.45}MnO_3$.

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Carrier-doped perovskite manganese oxides, $(RE_{1-X}AE_X)MnO_3$ (RE: rare-earth ion, AE: alkaline earth ion), undergo a variety of dramatic phenomena such as the colossal magnetoresistance (CMR), the metal-insulator (M-I) transition and the charge/orbital (CO/OO) ordering. In addition to the double-exchange mechanism, the CMR effect is believed to involve the strong electron-phonon interaction, which may originate from the Jahn-Teller (J-T) effect due to Mn^{3+} spins. At around X~0.5, the ferromagnetic (FM) metallic state becomes unstable against the charge-ordered antiferromagnetic (AF) state in these systems. In $Sm_{1-X}Sr_XMnO_3$, for example, the first-order FM transition takes place at around X=0.45,[1] where the FM state competes with the CO/OO state. This FM transition has been theoretically suggested as a possible fluctuation-induced first order transition[2] The first-order FM transition is expected to be closely correlated with the average ionic radius of RE site, that is, with the one electron bandwidth.

In this study, we report the thermal conductivity $\kappa(T)$, thermal diffusivity $\alpha(T)$ and thermal dilatation dL(T)/L of $(Gd_{1-Y}Sm_Y)_{0.55}Sr_{0.45}MnO_3$ (GSSMO) and $(Nd_{1-Z}Sm_Z)_{0.55}Sr_{0.45}MnO_3$ (NSSMO) systems and investigate the relation between the first-order FM transition and the average ionic radius of RE site. We also discuss the origin of the anomalous phonon transport enhancement at first-order FM transition in these systems. In the samples of $0.50 \leq Y \leq 1.0$ of GSSMO and Z=0.75 of NSSMO, the FM transition is the first-order, while it is the second-order for $0 \leq Z \leq 0.50$ of NSSMO. In the samples which exhibit the first order FM transition, $\kappa(T)$ and $\alpha(T)$ are enhanced and dL(T)/L contracts abruptly below the FM transition temperature T_c. These behaviors can be interpreted as to be caused by the reduction of the J-T distortion below T_c, similarly to the case of $La_{1-X}Ca_XMnO_3$ (X=0.25).[3]

[1] H. Kuwahara, Y. Moritomo, Y. Tomioka, A. Asamitsu, M. Sakai, R. Kumai and Y. Tokura; Phys. Rev. **B56** (1997) 9386.
[2] S. Murakami and N. Nagaosa; unpublished.
[3] H. Fujishiro, M. Ikebe, T. Kikuchi and H. Ozawa; Physica **B281&282** (2000) 491.