Materials Science

4C, 16A/2006G043

Orbital Ordering in $Nd_{0.5}Sr_{0.5}MnO_3$ Thin Films on Perovskite (011) Substrates

Yusuke WAKABAYASHI*[1], Daisuke BIZEN[2], Hironori NAKAO[2], Yoichi MURAKAMI[2], Masao NAKAMURA[3], Yasushi OGIMOTO[4], Kenjiro MIYANO[5] and Hiroshi SAWA[1]
[1]KEK-PF, Tsukuba, Ibaraki 305-0801, Japan
[2]Dept. of Physics, Tohoku University, Sendai 980-8578, Japan,
[3]Department of Applied Physics, University of Tokyo, Tokyo 113-8586, Japan,
[4]SHARP Corporation, Nara 632-8567, Japan,
[5]Research Center for Advanced Science and Technology, Univ. of Tokyo, Tokyo 153-8904, Japan

Introduction

Charge order and orbital order (CO/OO) are the characteristic phenomena of the correlated electron system. Manganese oxides are good examples of such system because of their various ground states and complicated roles of charge, spin and orbital degrees of freedom. Vast numbers of studies on this system reveal that OO structure can be controlled by using thin film technique [1], and films on (011) substrate sometimes show first-order metal-insulator transition while those on (001) substrates do not [2]. We have revealed the orbital structure in the low-temperature insulating phase in a thin film of half-doped manganite $Nd_{0.5}Sr_{0.5}MnO_3$ on $SrTiO_3$ (011) substrate through atomic arrangement by means of resonant and non-resonant x-ray scattering method made at BL-4C and 16A2, PF [3,4].

Experiment and Results

The x-ray diffraction experiments were carried out at BL-4C and BL-16A2 of the Photon Factory, KEK. The beamlines are equipped with standard four-circle diffractometers connected to closed-cycle refrigerators. An epitaxial film was grown by the pulsed laser deposition method. The thickness of the sample was 80nm.

The lattice parameters as functions of temperature are shown in Fig. 1. The lattice parameters *b* and *c* split at 175K, the metal insulator transition temperature.

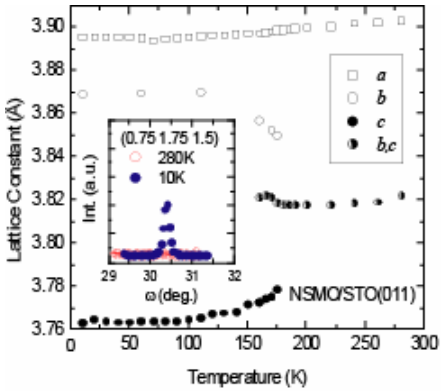

Fig.1 Temperature dependence of the lattice parameters. (inset) Intensity distribution around (3/4 7/4 3/2) measured at 10K and 250K.

Superlattice reflections were observed below 150K as shown in the inset to this figure. The energy spectra for several superlattice reflections are shown in Fig.2.

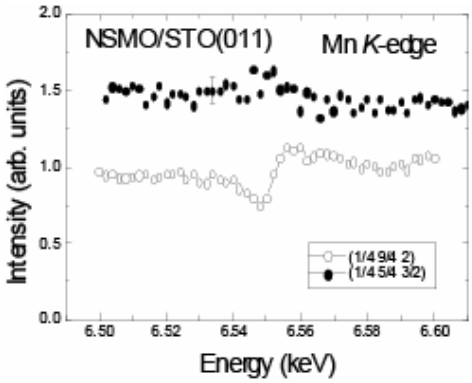

Fig.2 Energy spectrum of the (1/4 9/4 2) and (1/4 5/4 3/2) superlattice reflection intensity around the Mn K-edge.

Assuming a strong coupling between the lattice and orbital, the flat feature observed in the spectrum of (1/4 5/4 3/2) around Mn K-edge denies that the wavevector of the OO structure is (1/4 1/4 1/2), and the clear kink at the absorption edge in the spectrum of (1/4 9/4 2) implies the OO structure is characterized by the wavevector (1/4 1/4 0), the wavevector observed in bulk $Nd_{0.5}Sr_{0.5}MnO_3$.

We have clarified that the structure of the orbital ordering in a manganite thin film on a perovskite (011) substrate is the same as bulk manganite. Similar measurements on many films on (011) substrates are in progress.

References

[1] Y.Konishi et al., J. Phys. Soc. Jpn. **68** 3790 (1999)
[2] Y.Ogimoto et al., Phys. Rev. B **71**, 060403(R) (2005)
[3] Y.Wakabayashi et al., Phys. Rev. Lett. **96**, 017202 (2006)
[4] Y.Wakabayashi et al., AIP Conference Proceeding **879**, 1711 (2007)

* yusuke.wakabayashi@kek.jp