1A/2003S1-001

Charge distribution of Mn ion in artificial superlattices $[(LaMnO_3)_m(SrMnO_3)_m]_n$

Hironori Nakao[1], Jun Nishimura[1], Soukichi Kodama[1], Tadashi Satoh[1], Youichi Murakami[1], Aakira Ohtomo[2], Tomoteru Fukumura[2], Masashi Kawasaki[2], Takashi Koida[3], Yusuke Wakabayashi[4], Hiroshi Sawa[4]

[1]Department of Physics, Graduate school of Science and Faculty of Science, Tohoku University
[2]Institute for Materials Research, Tohoku University
[3]Exploratory Research for Advanced Technology, Japan Science and Technology Corporation.
[4]Photon Factory, Institute of Materials Structure Science

Introduction

Fabrication technology of the artificial superlattice structure composed of different compositions has been rapidly developed and opens a new field of materials physics. In the transition metal perovskite system, artificially controlled charge ordered states have been also built up by the film deposition technique. [1] Moreover, it is indicated that the peculiar physical properties of the superlattice are realized by the interface state because the valence state of the transition metal near the interfaces cannot be simply controlled by the stacking pattern. Therefore, the determination of the spatial charge distribution of the transition metal site becomes important for the study of the superlattices. In this study, we focus on the superlattices of $LaMnO_3$ and $SrMnO_3$, $[(LaMnO_3)_m(SrMnO_3)_m]_n$ [2], where the manganese valence is expected to be varied from 3+ to 4+ and the physical properties depend strongly on the periodicity *m*. To investigate the relation between the Mn valence state and the physical properties, we have tried to determine the charge distribution of the manganese ion using the anomalous x-ray scattering term of Mn ion near the *K*-edge.

Experiment

The high quality superlattices have been fabricated by a combinatorial pulsed laser deposition method. [3] X-ray scattering experiments were carried out by a four-circle diffractometer at the beamline 1A. The incident x-ray energy is about 6.55keV of Mn *K*-edge.

Results

To verify the stacking structure of the superlattice, the x-ray diffraction along the stacking direction (*c*-axis) has been measured at *E*=6.52keV (non-resonant energy). The satellite peaks denoted as +-1, +-2, +-3 originating from the superlattice periodicity (2*m*) and the sub-peaks due to the Laue function (*n*=6) are clearly observed around the fundamental perovskite peak, (0 0 2), is shown in the figure. The calculated diffraction pattern (solid line) based on our stacking model shows good agreement with the experimental result. Moreover, we have estimated the charge distribution of Mn ion based on the energy dependence of the scattering intensity near Mn *K*-edge energy.

References

[1] T. Fukumura et al., Appl. Phys. Lett. **77** (2000) 3426.
[2] T. Koida et al., Phys. Rev. B **66** (2002) 144418.
[3] T. Koida et al., Appl. Phys. Lett. **80** (2002) 565.
* nakao@iiyo.phys.tohoku.ac.jp