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Spin-Magnetic Form Factor of Ferromagnetic $YTiO_3$ Measured by the X-ray Magnetic Diffraction

Masahisa ITO[1], Hiromichi ADACHI[2], Hironori NAKAO[2], Youichi MURAKAMI[2], Yasujiro TAGUCHI[3], Yoshinori TOKURA[3], Kenichi KATO[4], Eiji NISHIBORI[4], Masaki TAKATA[4], Makoto SAKATA[4], Hayato MIYAGAWA[5], Susumu NANAO[5], Shigeaki UEMURA[6], Hiroshi MARUYAMA[6]

[1]*Himeji Institute of Technology, Kouto 3-2-1, Kamigori, Ako, Hyogo 678-1297, Japan*

[2]*KEK-PF, Tsukuba, Ibaraki 305-0801, Japan*

[3]*School of Engineering, The University of Tokyo, Hongo 7-3-1, Bunkyo-ku, Tokyo 113-0033, Japan*

[4]*School of Engineering, Nagoya University, Furoucho , Chikusa-ku, Nagoya 464-0814, Japan*

[5]*Institute of Industrial Science, The University of Tokyo, Roppongi 7-22-1, Minato-ku, Tokyo 106-0032, Japan*

[6]*Faculty of Science, Okayama University, Tsushimanaka 3-1-1, Okayama 700-0082, Japan*

Introduction

$YTiO_3$ is known to have the perovskite structure and to exhibit the orbital ordering of 3d electrons of Ti^{3+} ions which are coordinated octahedrally by oxygen atoms[1,2]. The electronic configuration of 3d electrons of Ti^{3+} is $(t_{2g})^1$. This compound is ferromagnetic below 28K.

Models of the ordered orbitals were proposed theoretically[1,2] or experimentally by the neutron diffraction[3] and the ATS scattering[4]. These experimental models were based on the assumption that the orbital moments of 3d electron of Ti^{3+} are completely quenched.

In the present study we made the X-ray magnetic diffraction (XMD) measurement of ferromagnetic $YTiO_3$, and observed the spin-magnetic form factor (spin component of the magnetic form factor) utilizing the ability of the XMD of LS separation (LS; orbital and spin moment). Obtained spin-magnetic form factor will provide us more precise knowledge about the ordered orbitals.

Experimental

The XMD measurement was performed using a five-circle diffractometer with an electromagnet and a refrigerator of liquid He flowing type. Magnetic field strength was 3 kOe and the temperature of the specimen crystal was kept at 5 K.

The reflection plane of the specimen was (001), and the scattering angle at the specimen was 90 degree. The magnetization direction was aligned along the scattering vector by applying the magnetic field along the easy magnetization axis [001]. This configuration made us observe the spin-magnetic form factor selectively at the reciprocal lattice points 00*l*(*l*:odd). The magnetic form factor was obtained by measuring the change in the diffraction intensity caused by reversing the magnetic field direction. Preliminary measurement of the magnetization of the specimen crystal showed that the magnetic field strength of 3 kOe was enough to saturate the magnetization of the specimen when the magnetic field was applied along the easy axis [001].

Result and Discussion

Obtained spin-magnetic form factor $\mu_S(k)$ for the reciprocal lattice points of 0 0 *l* (*l*=6,8,10,12) is shown in Fig. 1. The values for 0 0 *l* (*l*=2,4) could not be obtained because the X-ray energies for these reciprocal lattice points are too low to be detected on a hard X-ray beamline. The observed spin-magnetic form factor shows almost negative values. This result is different from those of other 3d transition metal elements of Fe[5,7], Ni[6] and Co[8] which show almost positive values of the magnetic form factors for the magnitude of the scattering vectors in Fig. 1. The obtained spin-magnetic form factor should be related to the ordered orbitals. Further analyses and experiments are needed to elucidate the ordered orbitals through the XMD measurements.

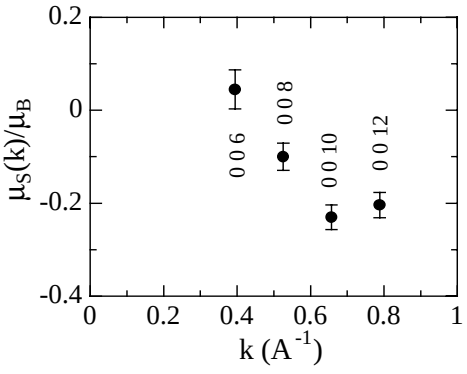

Fig. 1

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* itom@sci.himeji-tech.ac.jp