7A, 7C/2004G319

Spin reorientation transition in ultrathin Co films on Ru(0001) induced by Ru capping

J. Miyawaki[1], D. Matsumura[2], H. Abe[1], T. Otsuki[1], E. Sakai[1], K. Amemiya[1], T. Ohta*[1,3]
[1]Graduate School of Science, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan
[2] Japan Atomic Energy Agency, Sayo-cho, Sayo-gun, Hyogo 679-5198, Japan
[3]SR center, Ritsumeikan University, Noji-higashi, Kusatsu, Shiga 525-8577, Japan

Introduction

Co/Ru multilayers are well known to show strong interlayer antiferromagnetic coupling and many studies have been dedicated to the understanding of that property from the viewpoints of fundamental physics as well as of technological applications[1,2]. Moreover, Co/Ru system exhibits perpendicular magnetic anisotropy (PMA) and is very interesting from the viewpoint of magnetic anisotropy. However, there are few studies about the origin of PMA and it is still an open question. In this study, magnetism and structure of Co thin films on the Ru(0001) single crystal were investigated by x-ray magnetic circular dichroism (XMCD) and x-ray absorption fine structure (XAFS), and the correlation of them is discussed.

Experimental

All the experiments were performed in a UHV condition. Co was evaporated by the electron-beam evaporation method with a substrate temperature of 363 K. Thickness of the films was controlled by the oscillatory intensity of the RHEED spot.

Co *K*-edge EXAFS spectra were taken at BL-7C with a double-crystal Si(111) monochromator detuned by ~40% at normal (90°) and grazing (30°) x-ray incidence. The incident x-rays were detected by an ionization chamber filled with N_2 and fluorescent x-rays by a single element SSD. Co $L_{III,II}$-edge XMCD spectra were taken at BL-7A and obtained by reversing the magnetization of the films. The remanent magnetization was examined. For the detection of magnetization, XMCD measurements were performed at GI and NI.

Results

From the XMCD measurements, we found that as-deposited Co films show only surface parallel magnetization in the whole thickness range of the observation (1-15 ML), while a Ru capping on 1-5 ML Co/Ru(0001) causes a spin reorientation transition from surface parallel to perpendicular magnetization. No significant change of surface parallel magnetic orbital moment was observed by the Ru capping, indicating that the observed spin reorientation transition should be attributed to the increase of surface perpendicular magnetic orbital moment.

From the analysis of polarization dependence of EXAFS spectra, in-plane and out-of-plane Co-Co bond lengths for each Co thickness were obtained (Figure 1). The strain induced by the substrate and the release of the strain can be confirmed. For 3 ML Co thin films, the effect of Ru capping was also investigated (Figure 2). The Ru capping relaxes the strain in Co thin films as the Ru coverage increases. This change of the structure corresponds to the behaviour of the spin reorientation transition. The correlation between the origin of PMA and the stain in Co thin films is thus indicated.

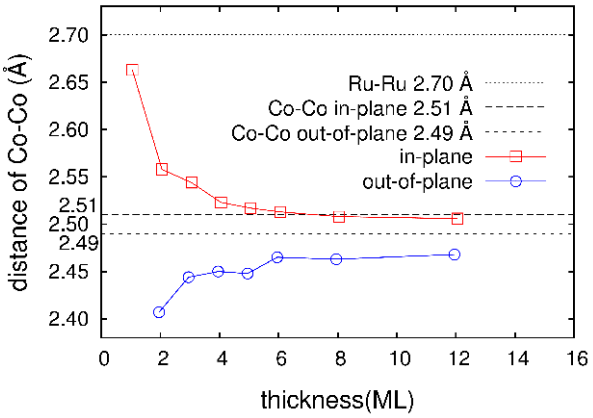

Figure 1: In-plane and out-of-plane Co-Co bond lengths for each Co thickness.

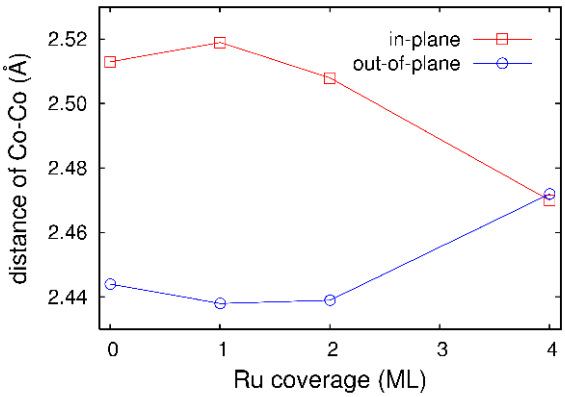

Figure 2: In-plane and out-of-plane Co-Co bond length for Ru(x ML)/Co(3 ML)/Ru(0001).

References

[1] Y. Huang et al., J. Magn. Magn. Mater. 99 L31 (1991).
[2] S. Hamada et al., J. Magn. Magn. Mater. 240, 539 (2002).

* ohta@fc.ritsumei.ac.jp