7A, 11A/2008G651

Effect of NO adsorption on the magnetism and structure of Ni/Cu(001) thin film

Shogo Kouzai[1], Hitoshi Abe [2], Masako Sakamaki[2], Kenta Amemiya[2], Hiroshi Kondoh[1]
[1]Keio Univ., Yokohama, Kanagawa 223-8522, Japan
[2]Institute of Materials Structure Science, Tsukuba, Ibaraki, 305-0801, Japan

Introduction

Magnetic anisotropy of Ni/Cu(001) has been extensively studied since the Ni films exhibit extraordinary spin reorientation transitions(SRT); the in-plane magnetization below 7-11 ML, perpendicular one up to 40 ML, and then again in-plane one[1]. The effect of surface chemisorptions on the magnetic easy axis has been investigated quite intensely since the early days. In the present study, NO-adsorbed Ni/Cu(001) films was investigated with the depth-resolved X-ray magnetic circular dichroism (XMCD) technique[2] and revealed that NO adsorption reduced the surface magnetization.

Experimental

All the experimental was performed in an ultrahigh vacuum chamber at the soft x-ray station, BL-7A and BL-11A. A Cu(001) single crystal was cleaned by repeated cycles of Ar^+ bombardment(1.5 kV) and annealing to ~900 K. Ni films were evaporated at room temperature by an electron beam evaporation. The film thickness was monitored *in-situ* reflection high energy electron diffraction (RHEED) and 4, 6, 8, 10, 12 ML Ni film ware prepared. XMCD measurements were carried out at 100 K. The direction of magnetization was examined using spectra taken at normal (90°) and grazing (30°) x-ray incidence. Depth-resolve XMCD measurements were performed by an imaging-type microchannel plate detector with the partial electron yield mode.

Result and discussion

Ni *L*-edge XMCD spectra of Ni(10 ML)/Cu(001) are shown in Figure 1. XMCD intensities for GI spectra was weaker than those for the NI spectra by a factor of cos60°=1 / 2, indicating that they have perpendicular magnetization. The spectra were analyzed to obtain a spin magnetic moment (m_s) by applying the sum rules, leading to m_s= 0.79 μ_B for Ni(10 ML)/Cu(001) and m_s= 0.60 μ_B for NO/Ni(10 ML)/Cu(001). It is thus ambiguously revealed that NO adsorption reduces the magnetization. The probing dependence of the obtained spin magnetic moment of NO adsorption at 10 ML Ni is shown Figure 2. We analyzed depth-resolved XMCD data with a simple model, which is composed of top nonmagnetic one layer and bottom magnetic nine layers as shown in Figure 3. Simulated results shown in Figure 2 reproduce the observed depth profile of magnetic moment, which indicate that the magnetization of NO/Ni(10 ML)/Cu(001) locates in the bottom nine layers, while the top one layer is almost nonmagnetic.

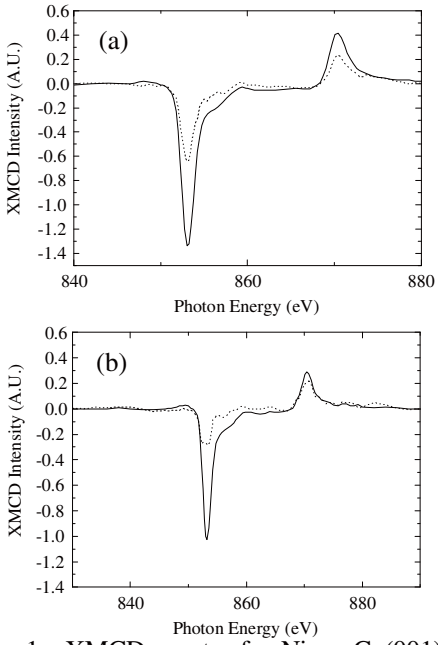

Figure 1: XMCD spectra for Ni on Cu(001) before and after NO adsorption.(a)NI and GI geometries Ni/Cu(001).(b)Ni and GI geometries NO/Ni/Cu(001).

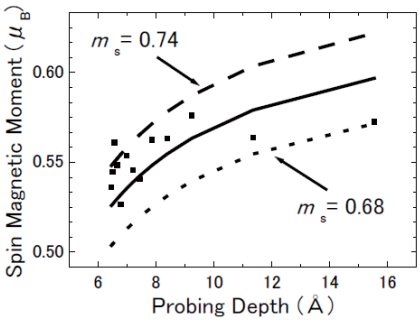

Figure 2: The probing depth of dependence of Ni magnetic moment m_s of NO/Ni(10 ML)/Cu(001).Solid line is simulated curves with (m_{top} ,m_{bot}) =(0.0, 7.1)μ_B.

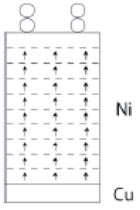

Figure 3: A schematic model for the simulations and fittings.

References

[1] W.L. O'Brien et al., Phys. Rev. B **54**, 9297 (1996).
[2] K. Amemiya et al., Phys. Rev. B **71**, 214420 (2005).

*kouzai@chem.keio.ac.jp