

Structures of Co ultrathin films on Pd(111) studied by Surface XAFS

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Introduction

The perpendicular magnetic anisotropy (PMA) of ultrathin films has been investigated widely because of its potentiality in dense memory storages. Co ultrathin films on Pd(111) is one of the systems showing large PMA and recently it is reported that CO surface chemisorption stabilizes PMA of Co/Pd(111) [1]. One of the origins of PMA is magnetoelastic anisotropy, which is influenced by small displacements from the bulk structure. The structure of the Co ultrathin films, however, is not revealed because of its island growth mode and alloy-like environment at interfaces. The structural studies of the Co films have exclusively been done for the multilayers [2], but not for ultrathin films yet. Thus, we performed surface XAFS study on the Co ultrathin films on Pd(111) and examined the effect of CO adsorption.

Experimental

All the experiments were performed in a UHV condition. A single crystal of Pd(111) was cleaned by the cycles of Ar⁺ sputtering (2 kV) and subsequent annealing at 1100K. Co was evaporated by the electron-beam evaporation method. Thickness of the films was calibrated by Auger intensity ratio, Co LMM/ Pd MNN.

XAFS spectra were taken at BL-7C with a double-crystal Si(111) monochromator detuned by ~40% at normal incidence (NI, 90°) and grazing incidence (GI, 30°). The incident x-rays were detected by an ionization chamber filled with N₂ and fluorescent x-rays by a single element SSD.

Results

Fig. 1 shows Fourier transforms of the Co-K EXAFS spectra for 2, 6 and 12 ML Co films on Pd(111) measured at 110K and the curve fitting results of the nearest neighbor (NN) Co-Co distance are listed in Table 1. Basically we can get in-plane information from the NI EXAFS spectra and out-of-plane information from the GI ones. For all the thicknesses, the in-plane NN distance is the same as in bulk cobalt (2.50±0.01 Å). From this we can conclude that the cobalt does not grow coherently on the Pd substrate. The Co in-plane NN distance is too much shorter than that of the bulk Pd (2.75 Å). The lattice distortion in Co films is very slight.

Fig. 2 shows Co-K edge XANES spectra for 2, 4 and 6 ML Co films before and after CO adsorption. For all cases, a peak at the shoulder decreases after CO adsorption. Especially for 2 ML Co films where the effect of CO adsorption is largest, the clear decrease can be seen in the GI spectra. The stabilization of PMA by CO chemisorption is possibly explained by the electron donation from CO to Co films.

References

- [1] D. Matsumura et al, Phys. Rev. B 66, 024402 (2002).
 [2] S. K. Kim, et al, Phys. Rev. 53, 11114 (1996).

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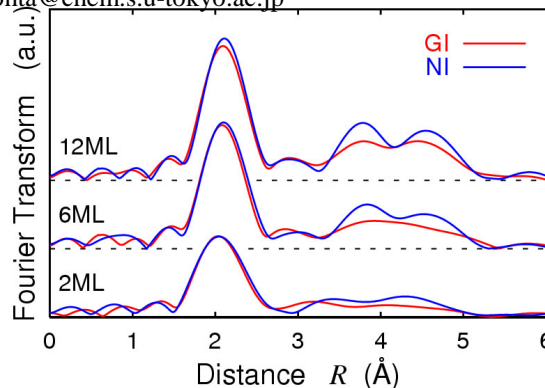


Fig. 1. Fourier transforms of the Co-K EXAFS spectra for the Co films on Pd(111) at 110 K.

Table 1. Curve fitting results of the nearest neighbour Co-Co distance. Values in parentheses are estimated errors.

	GI (Å)	NI (Å)
2 ML	2.482(0.010)	2.498(0.011)
6 ML	2.487(0.008)	2.496(0.007)
12 ML	2.490(0.005)	2.493(0.006)

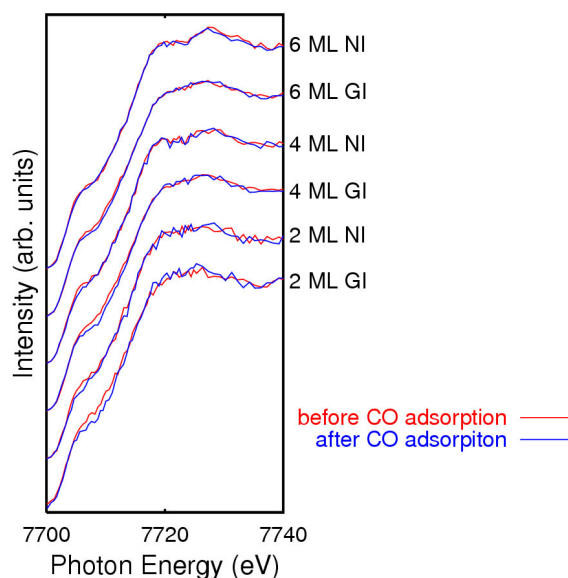


Fig. 2. Co-K edge XANES spectra recorded at 110 K before and after CO adsorption.