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XMCD study of spin reorientation transitions of Co/Pt(111) induced by CO adsorption

Hirokazu WATANABE[1], Kenta AMEMIYA[2], Daiju MATSUMURA[2], Soichiro KITAGAWA[2], Hitoshi ABE[2], Toshihiko YOKOYAMA[1], Toshiaki OHTA[2]
[1] Institute for Molecular Science, Myodaiji-cho, Okazaki, Aichi, 444-8585
[2] Department of Chemistry, Grad. School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033

Introduction

Magnetic ultrathin metal films have attracted much interest due to their unusual magnetic properties, such as a perpendicular magnetic anisotropy (PMA). Some experiments have shown that surface plays important roles in the appearance of the PMA. For instance, CO chemisorption on Co films grown on Pd (111) or Pt(111) stabilizes the PMA, resulting in a spin reorientation transition (SRT) [1,2] from the parallel to perpendicular magnetization. In the present study, we have observed the SRT of the Co/Pt(111) films induced by CO adsorption, by means of the x-ray magnetic circular dichroism (XMCD). The temperature dependence of the SRT has also been investigated.

Experiments

All the operations were performed in an UHV chamber. A Pt(111) single crystal was cleaned by cycles of Ar^+ sputtering and annealing at 1000K. Co was evaporated by an electron bombardment heating of a cobalt rod.

XMCD experiments were performed at BL-11A using circularly polarized x-rays, which were obtained by collecting the light emitted upwards from the electron orbit of the storage ring by 0.4mrad. The circular polarization factor was about 80 %. The XMCD spectra were obtained by changing the sample magnetization direction, remaining the polarization of x-rays unchanged.

Results and Discussion

Co *L*-edge XMCD spectra were recorded at normal (90º; NI) and grazing (30º; GI) x-ray incidence for the Co films of which thickness were 2 to 13 ML. Fig.1 clearly shows that CO adsorption induces the SRT from the parallel to perpendicular magnetization.

Fig.2 shows the spin magnetic moments determined from the XMCD spectra by using the sum rules. It is clearly seen that CO adsorption induces the SRT for the Co films of which thickness is 3 to 6 ML. In other words, the perpendicular magnetization region is broadened by 3 ML. This might be explained by the reason that CO adsorption reduces the magnetic moment of the film surface, which originally prefers the parallel direction.

By contrast, no SRT induced by CO adsorption was observed at room temperature for the 4 ML Co film. On the other hand, below 130K, CO adsorption causes the SRT even for the 10ML Co film, suggesting that the perpendicular magnetization region is wider than that at 210 K. This temperature dependence may be attributed to the changes in the CO adsorption sites, which is also suggested in the case of CO/Co/Pd(111) [1].

References

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* amemiya@chem.s.u-tokyo.ac.jp

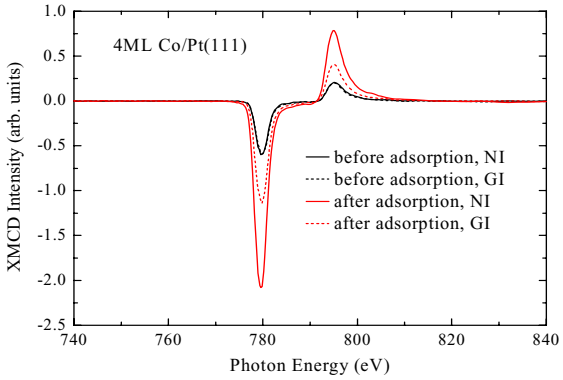

Fig1. Co *L*-edge XMCD spectra before and after CO adsorption at 210 K.

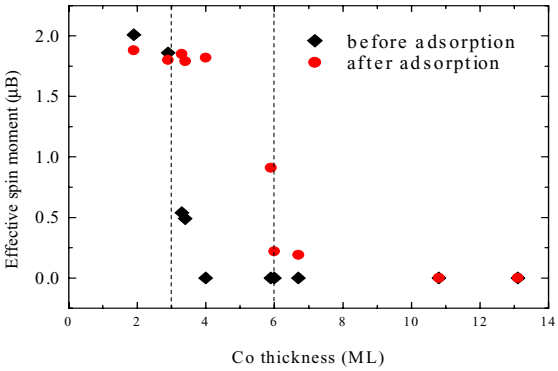

Fig2. Spin magnetic moments before and after CO adsorption at 210 K. Dotted lines show critical thicknesses of the SRT.