7A, 11A/2004G326

X-ray photoelectron diffraction study for structural determination of cobalt thin films on the Pd(111) surface

Daiju MATSUMURA, Kenta AMEMIYA, Toru SHIMADA, Jun MIYAWAKI, Hitoshi ABE, Takumi OTSUKI, Enju SAKAI, Toshiaki OHTA*
Department of Chemistry, Graduate School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

Introduction

The structural determination of ultrathin magnetic films deposited on a non-magnetic substrate is of a fundamental importance for understanding the magnetic properties of such systems. Some magnetic thin films such as Fe on the Cu(001) substrate have been widely investigated to reveal the relation between the structure and the magnetic property. Co thin films prepared on the Pd(111) substrate are known to have a perpendicular magnetic easy axis at a thickness of under 4 monolayer (ML). Recently, we found that the molecular adsorption enhances the perpendicular magnetic anisotropy under a certain condition [1]. There are some other parameters of the thin films that affect the magnetic anisotropy. Especially the anisotropy in the structure might strongly affect the magnetic anisotropy due to the magnetostriction although the precise structure is not well understood in this system. X-ray photoelectron diffraction (XPD) is a powerful tool to determine the surface structures. In this study, we have applied this method for the magnetic thin film structures in order to clarify the relation between the structure and the magnetic anisotropy in the magnetic thin film of Co/Pd(111).

Experiments

Sample preparation and all the spectral measurements were carried out under an ultrahigh vacuum condition. A Pd(111) substrate was cleaned by the repeated cycles of Ar^+ sputtering and successive annealing. The Co thin films were deposited on the Pd(111) substrate by the electron bombardment method at room temperature. Co 2p photoelectrons were collected with the hemispherical electron analyzer (GAMMADATA-SCIENTA, SES-2002). The intensities of the emitted electrons were measured as functions of polar and azimuthal angles by rotating the sample both in polar and azimuthal directions, while the electron analyzer was set at the fixed position.

Results and discussion

Figure 1 shows the full hemispheric images of Co 2p photoelectron diffraction intensities from the Co 6 ML thin film on the Pd(111) substrate. Photon energy was fixed to 1200 eV in this case. Since the photon energy is sufficiently high, the forward scattering contributes to the intensities dominantly. The photoelectron intensities simply indicate the atomic positions under the condition of the dominant forward scattering and the structures of the thin films can be determined without complicated analysis. Cobalt shows a hcp structure at room temperature and atmospheric pressure, while palladium shows a fcc structure. From the Fig. 1, we can observe a typical threefold symmetry in the Co 2p photoelectron intensities. This indicates that the Co thin films show a fcc structure due to the epitaxial growth on the Pd(111) substrate.

We also took the photoelectron diffraction images at several other photon energies and observed several photon energy dependent oscillations at some electron emission angles. The analyses of those spectra are now in operation.

Reference

[1] D. Matsumura et al., Phys. Rev. B, 66, 024402 (2002).

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

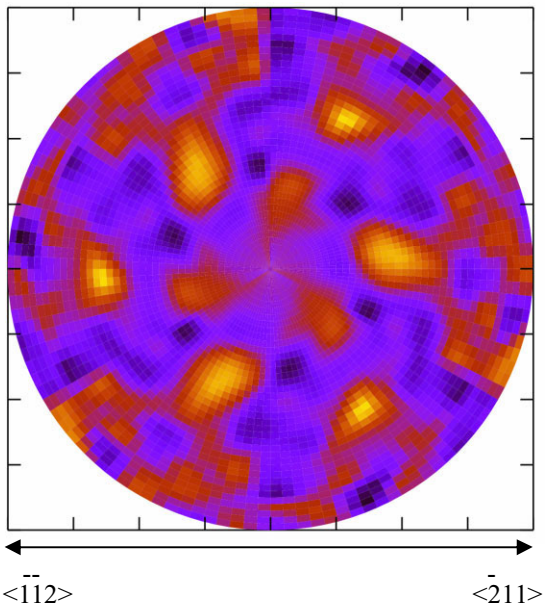

Fig. 1. Full hemispheric Co 2p XPD pattern of the 6 ML Co thin film on the Pd(111) substrate. The XPD intensities are expressed by a color scale in which brighter spots indicate higher intensities. The center of the circle corresponds to the surface normal direction for the emitted electrons.