XMCD study on spin reorientation transition of nickel thin films
induced by adsorption of H₂ and CO

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Introduction
It is well known that magnetic thin films show unique properties such as perpendicular magnetic anisotropy (PMA), which is energetically unstable when one takes only classical magnetic dipole-dipole interaction into consideration. Among magnetic films that show PMA, Ni thin films on Cu(100) have extensively been investigated because Ni films exhibit PMA in the wide thickness range of 10-50 monolayer (ML).

Recent experiments have shown that H₂ or CO adsorption on Ni surface stabilizes PMA [1]. The stabilization was attributed to a decrease in the surface anisotropy energy that favours parallel magnetization. In this report we discuss the results of experiments by Ni L-edge x-ray magnetic circular dichroism (XMCD) of Ni/Cu(100) before and after H₂ or CO adsorption in order to more fully understand adsorption effects on surface magnetic anisotropy.

Experiments
The XMCD spectra were performed at Beamline 7A. A Cu(100) single crystal was cleaned by cycles of Ar⁺ sputtering and heating at 900 K. Ni was evaporated by resistively heated wires. Film thickness was controlled with in-situ monitoring oscillation of reflection high-energy electron beams. The samples were magnetized by Helmholtz coil with a pulse current. All the measurements were made with remanent magnetization. In the adsorption experiments, the samples were kept at 200 K for H₂ exposure and at 300 K for CO. Both exposures satisfied the condition of saturation.

Results and discussion
Because of low Curie temperatures of Ni thin films, no XMCD spectra were taken less than 6 ML in our experiments. We observed perpendicular magnetization over 9 ML for clean films. In a range of film thickness of 7-9 ML, the easy axis of films rotates from parallel to perpendicular when covered with H₂ or CO. These results qualitatively agree with the literature [1].

Figure 1 shows the ratio of magnetic orbital and spin moments (ML/MS) before and after adsorption of H₂ or CO. The square data points indicate the value for the clean films. The circle and triangular points correspond to the value for the films covered with CO and H₂, respectively. Closed and open symbols represent perpendicular and parallel moments, respectively.

Reference

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