7A, 11A, 16A/2008G172

Magnetization Depth Profile in Ultrathin Mo/Co/Au and Au/Co/Au Trilayers

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Introduction

Magnetic multilayers show a wide variety of magnetic properties not available in bulk materials due to important contribution of surface effects originating from a large number of atoms located at interfaces. In this study, we focus on the overlayer effect on magnetic anisotropy of ultrathin Co film. Mo overlayer on Co thin film induces spin reorientation transition (SRT) at the Co thickness, which is lower than for Ag overlayer [1, 2]. This means that Mo overlayer shifts SRT to lower Co thickness values more effectively than Ag. Therefore, we have studied independently magnetism of Mo/Co and Au/Co interfaces by means of depth-resolved X-ray magnetic circular dichroism (XMCD) technique [3] at Co $L_{2,3}$ absorption edge.

Experiments

The samples were MBE-grown on sapphire(11-20) substrate covered with 20 nm Mo buffer layer. Then we deposited subsequently Mo/Co/Au and Au/Co/Au films. Co layers have wedged shape in the range of 0 - 2.5 nm. At the thinner region of the Co thickness perpendicular magnetic anisotropy was observed for both samples and that area is wider for the Au/Co/Au film. The SRT from perpendicular to in-plane magnetization orientation takes place at the Co thickness of ~2 nm for Au/Co/Au and ~1.5 nm for Mo/Co/Au. We have performed detailed X-ray absorption spectroscopy (XAS) and XMCD measurements at the region of SRT. We recorded a series of spectra at once, each of which has different probing depth by separately detecting the Auger electrons at different detecting angles using 2D detector. Samples were magnetized by pulse magnetic field (~700 Oe) before each measurement at room temperature.

Results

We observed decrease of XMCD intensity at the upper Mo/Co interface, which can be seen from probing depth dependent XMCD spectra shown in Fig. 1. The XMCD intensity of the Mo/Co/Au film was smaller than that of the Au/Co/Au film. The Mo/Co/Au film shows decrease of the XMCD intensity at smaller probing depth, as well as larger asymmetry between the XMCD intensities at the L_2 and L_3 edges. From the analysis of the depth-resolved XAS and XMCD spectra, it can be inferred that the upper interface and lower interface shows different electronic and magnetic states for the Mo/Co/Au film. The XAS spectra indicate a charge transfer from the Co layer to the Mo overlayer.

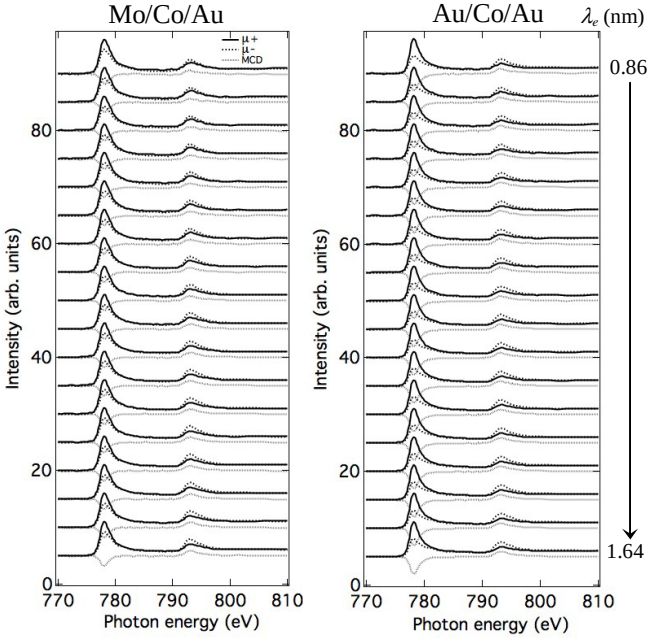

Figure 1: Co *L*-edge XAS and XMCD spectra for the Mo/Co/Au and Au/Co/Au films for different probing depth at normal incidence. These spectra are taken at the position of the sample where the Co thickness ~0.9 nm where perpendicular magnetic anisotropy was observed in the both samples. The probing depth, λ_e, was varied in the range from 0.86 nm to 1.64 nm.

References

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