Materials Science

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XMCD Study on Co/Ir Multilayers with Perpendicular Magnetic Anisotropy

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Introduction

It is known that Co/Ir and Co/Rh multilayers have strong interlayer magnetic coupling. In a previous study, we reported that Co/Ir(111) multilayer epitaxially grown on Ir(111) has a strong perpendicular magnetic anisotropy. In this study, we performed XMCD(X-ray magnetic circular dichroism) measurements for samples with different Co layer thickness in order to separate the orbital magnetic moment from spin magnetic moment and to discuss the influence of strain on magnetic anisotropy through the orbital magnetic moment.

Experimental Procedure

Samples were prepared with a molecular beam epitaxy (MBE) system. Substrates were sapphire single crystals with (1102) surface, on which Pt of 20 Å and Ir of 500 Å were deposited as buffer layers. The Ir layer thickness was fixed at 11.1 Å. The Co layer has a wedge shape whose thickness varies from 3A to 22 Å with thickness gradient of 0.4 Å /mm. The deposition was carried out alternatively for 30 periods. Magnetization was measured by a SQUID magnetometer in magnetic fields of ±5T applied perpendicular and parallel to the film surface. XMCD measurements were carried out at AR-NE1B beam line installed in KEK, in which both magnetic field and incident beam were perpendicular to the film surface.

Result and Discussion

Figure 1 shows the XMCD spectra for Co thickness of 3. 9 Å and 21.5 Å. From these results, it found that intensity of XMCD spectra decreased less than 6 Å. The magnetization measurements showed that all samples have ferromagnetic like hysteresis curves, and which have perpendicular magnetic anisotropy. It was found that the thickness of 1.5 Å (= δ) Co layer dose not contribute to magnetization. Figure 2 shows the dependence of $t_{co}K_{eff}$ calculated from the magnetization curve on the Co layer thickness. The $t_{co}K_{eff}$ could be separated into an interfacial component and a volume component which depends on t_{Co}.

Figure 3 shows the orbital angular moment m_{orb} and effective spin magnetic moment $m_{spin\ eff}$ as a function of Co layer thickness. These moments were calculated from the spectra in Fig.1 according to the angular momentum sum role and were modified by effective Co thickness t_{Co}-δ. The thickness dependence of $t_{co}K_{eff}$ shows that the interfacial component becomes dominant as the decrease of Co layer thickness. The tendency that the m_{orb} increases with the decrease of Co layer thickness is seen in Fig.3. From these results, it is considered that strain at the interface, which arises from the lattice mismatch, is responsible for the increase of z component of orbital angular moment and, hence, the increase of perpendicular magnetic anisotropy.

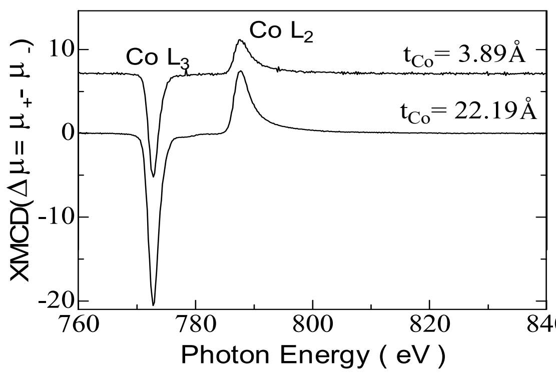

Fig1. XMCD spectra of Co/Ir(111) multilayers

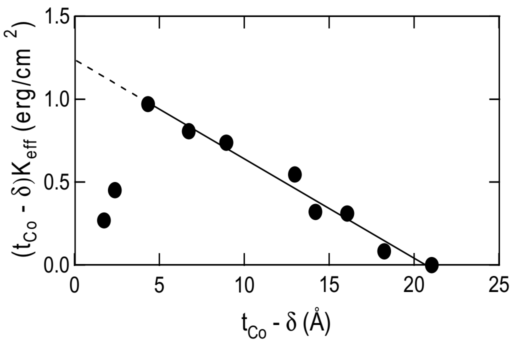

Fig2. Dependence of perpendicular magnetic anisotropy on Co thickness

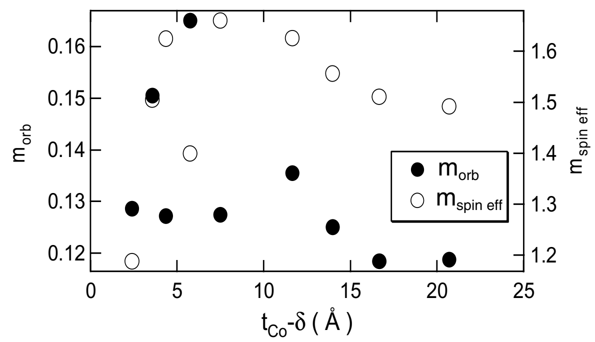

Fig3. Dependence of m_{orb} and $m_{spin\ eff}$ on Co thickness

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