Co/Pd 多層構造の元素別軌道磁気モーメントの異方性

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Anisotropic Orbital magnetic moments in Co/Pd multilayers

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Introduction

CoPd is a candidate for the spintronics materials possessing perpendicular magnetic anisotropy (PMA) which can be utilized for the high-density recording technology [1]. The 4*d* transition metal (TM) system of Pd is well recognized as the sustainable elements of 5*d* TM system in Pt toward the PMA materials combined with the magnetic 3*d* TMs. In order to understand the mechanism of PMA in CoPd, the contributions of orbital magnetic moments of each element have to be clarified explicitly. Bruno theoretically proposed the orbital moment anisotropy in TM multilayers as a second perturbation of spin-orbit interaction [2]. However, even in the strong spin-orbit coupled cases using 4*d* or 5*d* TMs, the applicability of this formula has been still debated [3]. Our aim in this study is to discuss both orbital and spin moments of Co and Pd for PMA and in-plane anisotropy samples by using angular-dependent X-ray magnetic circular dichroism (XMCD) in Co *L*-edge and Pd *M*-edges.

Experimental

We prepared two kinds of samples of Co/Pd multilayered structures: Co (0.69 nm)/Pd (1.62 nm) for PMA and Co (1.03 nm)/Pd (1.62 nm) for in-plane anisotropy with stacking five periods on the Si substrates [4]. Sample surfaces were sputtered by Ar ions before the XMCD measurements in order to remove the oxygen contamination. We performed XMCD experiments at BL4B, UVSOR, Institute of Molecular Science. Total electron yield mode was adopted. A magnetic field of ±5 T was applied along the direction of the incident polarized soft x-ray.

Results

We observed XMCD signals in Pd *M*-edges after the removal of surface contamination as shown in Fig. 1. Although the X-ray absorption spectroscopy (XAS) line shapes overlap with those of O *K*-edge absorption, clear XMCD signals induced by the proximity with Co layers are observed. The Pd *M*-edge XMCD line shapes in both PMA and in-plane samples almost remain unchanged. Magneto-optical sum rule analysis, which is defined in the TM *L*-edge absorption, cannot be applicable for *M*-edge XMCD. Precise XAS line shapes in Pd *M*-edges are necessary for the determination of absolute values of spin and orbital moments. On the other hand, clear Co *L*-edge XAS and XMCD with angular dependence reveal the enhancement of orbital moments in the surface normal direction because of PMA.

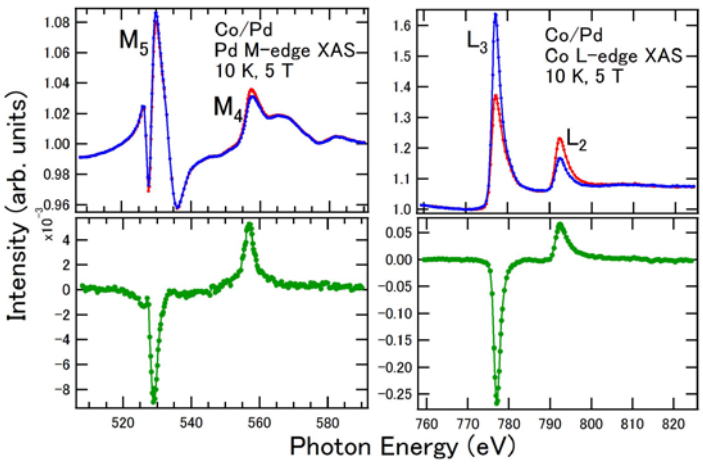

Fig. 1, XAS and XMCD of Pd *M*-edge and Co *L*-edge in perpendicularly magnetized Co (0.69 nm)/Pd (1.62 nm) multilayer.

References

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