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Magnetic Compton profiles of Pd/Fe multilayers

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Recent nano-structured magnetic materials, such as multilayers, granules, nano-particles, are expected to show interesting properties due to modifications of wave functions. Magnetic Compton profiles (MCP) have been known as the probe of wavefunctions.

Recently we have suggested a novel and convenient technique to reduce the strong background scattering from the substrates, of which the film sample is deposited on a thin substrate, such as a PET (Polyethylene Terephthalate), and have succeeded the first observation of anisotropy of magnetic Compton profiles in Pd/Co multilayers [1,2]. In this paper we report on anisotropies of MCP's in Fe/Pd multilayers and discuss on the anisotropy of the wavefunctions and electronic structures.

Three kinds of multilayers, [Pd(1.6nm)/Fe(0.8nm)], [Pd(1.6nm)/Fe(1.6nm)] and [Pd(1.6nm)/Fe(4.0nm)], were fabricated by the R.F. sputtering method. A film thickness of multilayers was 1μm. The multilayers were grown on the PET (Polyethylene Terephthalate) substrate with a thickness of 4μm.

The θ-2θ X-ray diffraction measurements show that the Pd(1.6nm)/Fe(0.8nm) multilayer and the Pd(1.6nm)/Fe(1.6nm) multilayer have strained fcc Pd and fcc Fe, which are (111) textured. While, the Pd(1.6nm)/Fe(4.0nm) multilayer has rather complicated phases, such as the mixed phase of the fcc phase at the interface and the bcc phase inside of the Fe layer.

The monochromatized X-ray energy was 59.8keV. A sample was set in a superconducting magnet with a magnetic field of 2T. The applied field was the in-plane configuration and the out-of-plane configuration. The incidence X-ray was tilted by 10 degree against the applied field direction.

Figures 1 shows the anisotropy of the MCP's. The anisotropies of the MCP's in the Pd/Fe multilayers are less than 3% of the peak value of the MCP's. The reduced anisotropies of the MCP's in the Pd/Fe multilayers has a contrast to the Pd/Co multilayers, in which the anisotropies are 30% of the peak value of the MCP's [1,2]. The theoretical calculation [3] shows the majority bands are below the Fermi energy, and the minority bands have the Fermi energy at the lower energy tail of the DOS peak. The former deduce the spherical distribution of the majority wavefunctions. The later also can deduce the spherical distribution of the minority wavefunction because the minority electrons occupy the DOS peak tail, which has a rather flat shape.

A model MCP is calculated using an atomic Fe3*d* wavefunction under a uniaxial (cylindrical) crystal field symmetry. The model anisotropic MCP's are shown in Fig. 1 by thin solid lines. The model calculation reproduces the experimental anisotropies. Then the anisotropy of wavefunctions can be dominated by the anisotropy of the Fe 3*d* minority wavefunctions.

References

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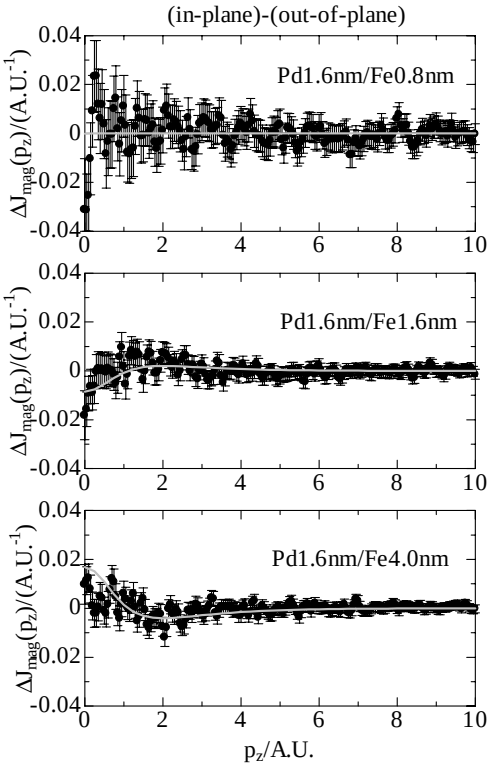

Figure 1

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