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Magnetic Compton profiles of Pt/Fe multilayers

Hiroshi Sakurai*[1] Eiji Murayama[1], Minoru Ota[1], Katsuyoshi Takano[1], Fumitake Itoh[2], Hiroshi Kawata[3], Hiromichi Adachi[3], Yoshiharu. Sakurai[4], Msasayoshi Itou[4] and Akihisa Koizumi[5]
[1]Dept. Electronic Enginerring, Gunma Univ., Kiryu, Gunma, 376-8515, Japan
[2] Research Institute of Electromagnetic Devices, Hishi-machi, Kiryu, Gunma, 376-0001, Japan
[3]KEK-PF, Tsukuba, Ibaraki, 305-0801, Japan
[4]JASRI/Spring-8, Sayo-cho, Hyogo, 679-5198, Japan
[5]Dept. Material Science, Univ. of Hyogo, Kamigori-cho, 678-1297, Japan

Pt/Fe multilayers have been reported to show a perpendicular anisotropy [1] and soft magnetic properties [2] with the thin Fe layer thickness. Furthermore it has been reported that Pt/Fe multilayers have an fcc Fe phase with thin Fe layer thickness [2]. The Pt polarization and enhanced Fe magnetic moment are expected from the theoretical calculation in Pt-Fe alloy system [3]. These characteristic Fe are of importance not only for a fundamental science but also industrial applications such as a data storage media and high frequency magnetic devices. However the electronic structures of the Pt/Fe have not been clear.

In this paper we report on MCPs of the Pt/Fe multilayer and separate the contribution into Fe layer and Pt layer and discuss on the anisotropy of the wavefunctions and electronic structures.

Three kinds of multilayers, [Pt(2.0nm)/Fe(0.5nm)], [Pt(2.0nm)/Fe(0.9nm)] and [Pd(2.0nm)/Fe(2.3nm)], were fabricated by the R.F. sputtering method. Crystal structure and multilayered structure were confirmed by θ-2θ X-ray diffraction measurements with the Cu-Kα1 radiation. Texture of (111) of fcc Pt and/or fcc Fe was observed in the each multilayers. Satellite peaks were observed near the fcc (111) diffraction peak. These satellite peaks were consistent with designed multilayer periods.

MCP's were measured at the AR-NE1A1 beamline of KEK-PF. Figures 1 show the MCPs of the Pt/Fe multilayers with in-plane configuration and out-of-plane configuration. Fe layer thickness dependence has been observed with both the in-plane configuration and out-of-plane configuration. The anisotropies of MCPs, $\Delta J_{mag}(p_z)$, depend on the Fe layer thickness. Figures 2 show the MCPs, which are separated into the contribution from the fcc Pt layer and the fcc Fe layer. Both the MCPs of the fcc Pt and the fcc Fe show the anisotropy. However, anisotropies of the MCPs, $\Delta J_{mag}(p_z)$, are prominent in the fcc Fe. This suggests that the anisotropies of the present Pt/Fe multilayers mainly come from the fcc Fe layer. Theoretical MCPs of the fcc Fe by the band calculation (BANDS01) are also shown in Fig. 2. The theoretical calculation cannot reproduce the present MCPs of the fcc Fe. Then the electronic structures of the fcc Fe are modified due to the interface effects such as Pt5*d*-Fe3*d* hybridization at the Fe/Pt interface and/or strain effects due to the difference of lattice constants between the fcc Pt and fcc Fe.

In conclusion, the perpendicular anisotropy of the Pt/Fe multilayer is dominated by the Fe 3*d* electrons with fcc structure.

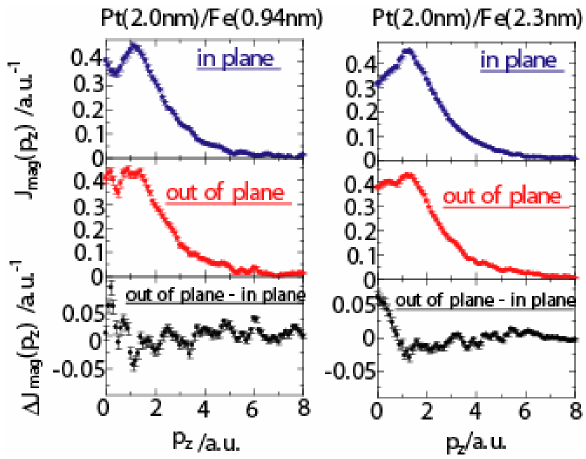

Fig.1 Magnetic Compton profiles of Pt/Fe multilayes.

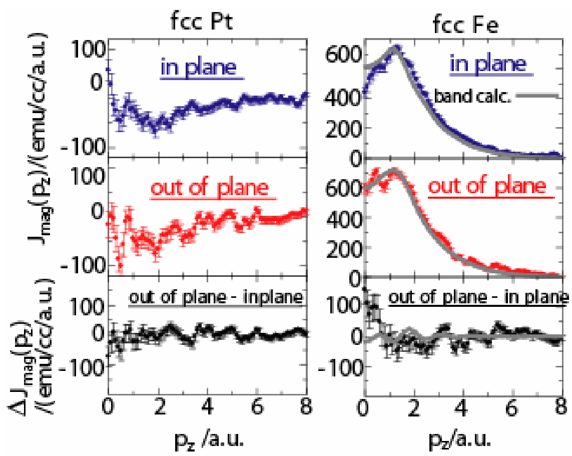

Fig. 2 Magnetic Compton Profiles of fcc Pt and fcc Fe in the Pt/Fe multilayers.

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*sakuraih@el.gunma-u.ac.jp