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Magnetic Compton profiles of nano-structured materials

Hiroshi SAKURAI*[1], Fumitake ITOH[1], Hiromi OIKE[1], Katsuyoshi TAKANO[1], Minoru OTA[1], Xiaoxi LIU[2], and Hiroshi KAWATA[3]
[1]Dept. Electronic Eng. Gunma Univ., Kiryu, Gunma 376-8515, Japan
[2]SVBL Gunma Univ., Kiryu, Gunma 376-8515, Japan
[3]KEK-PF, Tsukuba, Ibaraki 305-0801, Japan

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 wave functions. In this study, we have succeeded to develop a system for measuring magnetic Compton profiles of an Fe granular film and an Fe/Pd multilayer by a grazing incident X-ray geometry (GIMCP: Grazing Incident Magnetic Compton Profile).

The incident monochromatized X-ray energy was 46.7keV with the scattering angle 160 degrees. A beam size was 0.05×2mm^2. An Fe thin film (Fe 100nm coated with Ag 8nm), the Fe granular film ([Fe(3.9nm)/MgF_2(4.5nm)]$_{60}$) and the Fe/Pd multiplayer ([Fe(4nm)/Pd(4nm)]$_{50}$) were sputtered on polished glass (BK7) substrates (50ϕ×4t). The Fe plate (10×30×0.1mm^3) was measured as a reference sample with an incident angle of 10 degree. The measurement was carried out under the vacuum at R.T. The applied field on the sample was 0.5T. The background scattering from the window of vacuum chamber was about a several tens cps, which was less than 0.1% of total counts. Table 1 shows count rates at the Compton peak (C), measuring hours (t) and magnetic effects (ME) with the seven active detectors. Figure of merits (FOM) are defined as following, FOM= ME(Ct)$^{1/2}$. Figure 1 shows the MCP's of the Fe thin film and the Fe plate. The agreement of the two profiles is well within statistical error. It suggests that the successful development of the GIMCP system.

Figure 2(a) shows the difference of MCP's of the Fe granular film and the Fe plate. There is no remarkable difference, although a magnetization of Fe layers reduces to 10% of the bulk magnetization. The magnetization curve can be fitted by the Langevin function, suggesting the super-paramagnetism. However electronic structures are almost the same with the bulk Fe.

Figure 2(b) shows the difference of the MCP's of Fe(4nm)/Pd(4nm) and the Fe plate. The difference is not remarkable within the statistical error, although the spin polarization at the Pd site has been reported by x-ray magnetic circular dichroism measurements at the Pd $L_{2,3}$ edges[1]. Anisotropy measurements and theoretical considerations are needed for further discussions.

Tabale 1

	counts/hr	hr	mag_eff	FOM
Fe 0.1mm	3.60E+06	5.5	0.0096	43
Fe film 100nm	8.81E+05	26	0.00546	2.6
Fe/Pd	6.83E+05	58	0.00098	6
Fe/MgF_2	2.77E+06	86	0.001527	24

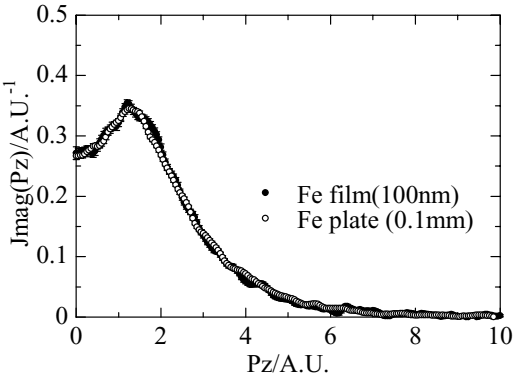

Fig.1

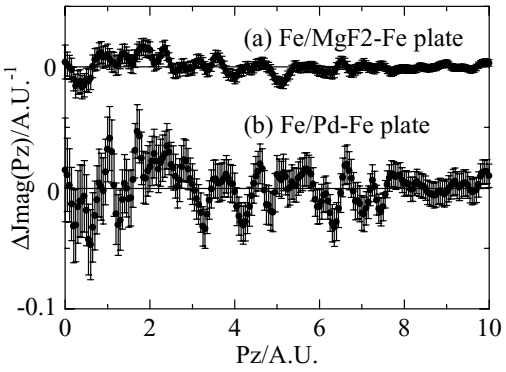

Fig.2

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