Materials Science

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Applied field dependence of Compton profiles in Fe/MgO multilayers

Hiroshi SAKURAI[1], Takuro TAMURA[1], Toshitaka KURACHI[1], Satoshi HOMMA[1], Hiromi OIKE[1], Akane AGUI[2], Hiromichi ADACHI[3] and Hiroshi KAWATA[3]
[1]Gunma University, 1-5-1 Tenjin-cho, Kiryu, Gunma, 376-8515, Japan
[2]JAERI, SPring-8, 1-1-1Kouto, Sayou-gun, Hyogo, 679-5148, Japan
[3]KEK-PF, 1-1 Oho, Tsukuba, Ibaraki, 305-0801, Japan

Introduction

Recently magnetoresistive devices have been widely studied because of their importance in data storage technology. These devices are driven by controlling magnetic states which control electronic states. In this paper we discuss the electronic states, which are controlled by applied magnetic field, by measuring magnetic Compton profiles (MCPs).

Experimental

Fe(100nm)/MgO(2.5nm)/Fe(10nm) multilayes were fabricated by R.F. sputtering on Si(111) substrates for X-ray diffraction (XRD) measurements, and on Al foil substrates for magnetization measurements and MCP measurements. Total thickness was adjusted to about 1000nm. The XRD measurement indicates poly crystal Fe, which comes from the Fe (100nm) layers. MgO(2.5nm) layers and Fe(10nm) layers will prefer MgO (200) and Fe (200) texture, respectively. Actually an Fe(10nm)/MgO(1nm) multilayer prefer MgO (200) and Fe (200) texture. Thickness of 1nm FeO at the interface, which could be FeO (200) texture, was confirmed by magnetization measurement. The MCP measurements were carried out at KEK-PF-ARNE1A1.

Results and Discussion

Figure 1 shows magnetization measurement under applied field perpendicular to the multilayer film plane. Positions denoted "A" and "D" indicate magnetic saturation which overcome shape magnetic anisotropy under enough magnetic fields. Positions denoted "B" and "E" have steps, which can indicate perpendicular magnetic anisotropy. Actually magnetic easy axis of Fe is <100> and the present sample will have Fe (200) texture at Fe the (10nm) layer. Thus Positions denoted "B" and "E" extract magnetization at the Fe (10nm) layer. When the magnetic field is zero, the sample has zero magnetization. This can be due to magnetic close circuits which are constituted by in-plane magnetic anisotropic Fe (100nm) layers and perpendicular magnetic anisotropic Fe (10nm) layers. Then positions denoted "C" and "F" correspond to deviation from magnetic close circuits.

Figure 2 shows the MCPs measured under the specified magnetic filed shown in Fig. 1. Grey closed circles denote the MCP under the magnetic field of 2T (positions denoted "A" and "D"). This MCP comes from polycrystalline Fe of Fe (100nm). Black closed circles denote the MCP under the magnetic field of 0.25 T (positions denoted "B" and "E"). This MCP comes from Fe (200) texture of Fe (10nm). A gray solid line shows a theoretical MCP of Fe (100) [1], which agrees with the experimental MCP of Fe (200) texture (black closed circles). Open circles denote the MCPs under the magnetic field of 0.25 T (positions denoted "C" and "F"). This MCP is different from the MCP at the positions denoted "B" and "E", although the applied magnetic field is the same. It reflects magnetic close circuit states, which is a disorder state magnetically. This state may enhance the s-d interaction and give the enhanced negative polarization of conduction electrons.

In conclusion, we have succeeded to measure the electronic states, which are induced by applied magnetic field, by measuring the MCPs.

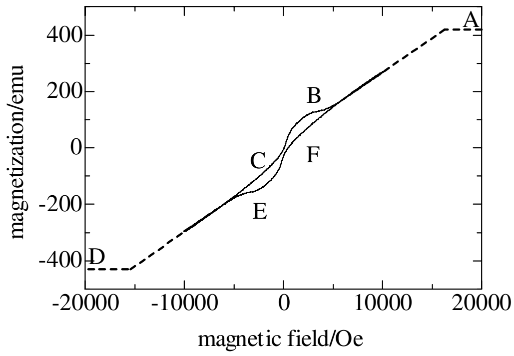

Figure 1

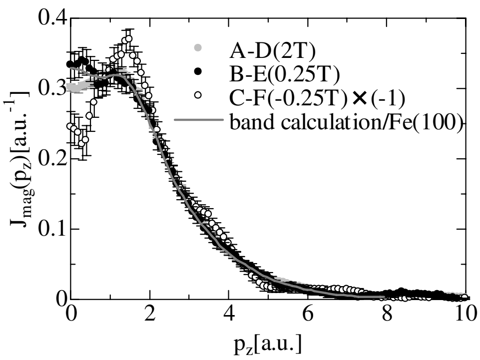

Figure 2

References

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