90度磁気結合膜の偏極中性子線反射率による微細磁気構造解析

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The fine magnetic structure of magnetic multilayer with 90 degrees magnetic coupling layer by using Polarized Neutron Reflectivity analysis

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Recently antiferromagnetic (AFM) spintronics are drawing attention owing to the high resonance frequencies and zero stray fields. It has been theoretically reported that spin transfer torques (STT) in AFM materials can be obtained [1]. However, it is hard to directly observe spin torque oscillation (STO). Comparing to this, we fabricated the novel quasi-AFM layer which has multiple domains with alternatively antiparallel magnetization by using biquadratic magnetic coupling between two ferromagnetic (FM) layers through Fe-O layer. The magnetic property of the quasi-AFM layer is expected to have properties that are intermediate between AFM and FM. The macroscopic result of its magnetic property is shown in ref. [3], and the crystal structure was also be reported in ref. [4]. And to analyze the magnetic structure, we carried out polarized neutron reflectivity (PNR) analysis by BL17 SHARAKU in MLF, J-PARC.

The Ta/Ru/IrMn/CoFe(A)/Fe-O/CoFe(B)/Cu/CoFe(C)/Cu/Ta films were sputtered on thermal oxidized Si wafers and annealed in a field to fix the magnetization of CoFe(A) in x direction by IrMn. We measured the polarized neutron reflectivity of this film and used the software named GenX to fit the data, from which we can find out the magnetization direction and magnetic moment of the film.

Fig.1 (a) shows the M-H curve of the film, which means the magnetization of CoFe(A) and CoFe(B) were coupled with angles of about ±90 degrees through Fe-O and the CoFe(B) had become the quasi-AFM. The schematic magnetization images and fitting result is shown in Fig.1 (b). We can see that the magnetization of CoFe(A) was fixed in x direction and the magnetization of CoFe(C) had reversed in low field. The CoFe(B) is expected to be quasi-AFM and the x component of magnetization should be zero. However, the result indicates the CoFe(B) had magnetization of 1.35μ_B in x direction, which means the biquadratic coupling was not strong enough and the magnetization of it was not completely antiparallel. The average angle between the magnetization of CoFe(A) and CoFe(B) was estimated as ± 42 degrees from $\cos^{-1}(1.35\mu_B/1.82\mu_B)$. In presentation, we will show the process how we fitted it and explain the result in detail.

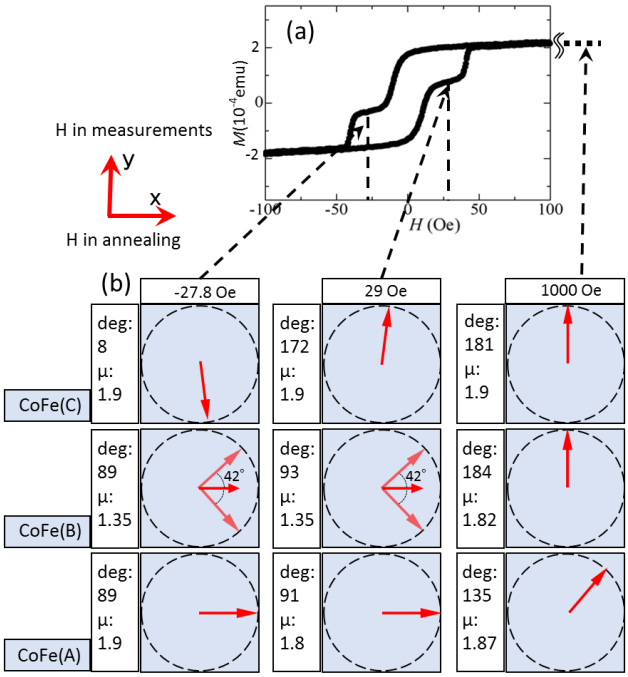

Fig. 1 (a) M-H curve, (b) schematic magnetization images in field of -27.8 Oe, 29 Oe and 1000 Oe.

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