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Spin Pumping and Magnetization Relaxation in Structured NiFe Films

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The generation and the detection of spin currents in a solid are the main subjects in the field of spintronics. The spin pumping is a crucial phenomenon which allows the spin-current generation in a wide range of materials[1], but its mechanism is yet to be elucidated. We have investigated the spin-pumping effect in nanostructured metallic systems in terms of the spectral shape of the ferromagnetic resonance (FMR) absorption.

The $Ni_{81}Fe_{19}$ composite nanostructured samples used in the present study were fabricated by means of electron beam lithography and lift-off technique. $Ni_{81}Fe_{19}$ was deposited by electron beam evaporation in a high vacuum on a thermally *oxidized Si substrate. Figure 1 shows ascanning electron microscope* (SEM) image of the fabricated sample. These nanostructures were covered with Pt films, which were sputtered in an Ar atmosphere.

The magnetization-precession damping affected by the spin-pumping effect in the present systems were investigated using the FMR signals in the Pt/$Ni_{81}Fe_{19}$ nanostructures, spin currents should be injected from the $Ni_{81}Fe_{19}$ layer into the Pt layer via the spin-pumping effect operated by FMR. Recent studies have revealed that the magnetization-precessiondamping is partly due to the transfer of angular momentum from the precessing local spins to the conduction electrons. This transfered angular momentum, when a paramagnetic metal is connected to the ferromagnet, may dessipate by propagating into the metal as a spin current[2]. Therefore, the spin-pumping effect in the Pt/$Ni_{81}Fe_{19}$ nanostructures is detected by monitoring thechange in the FMR-spectral width and by comparing it with that in the $Ni_{81}Fe_{19}$ nanostructures. We investigated the spectral-width modulations in the nano wire and a plane layer. These modulations depend on paramagnetic metals as well as the shapes of structures, implying an important role of the interface spin interaction in the spin-pumping process.

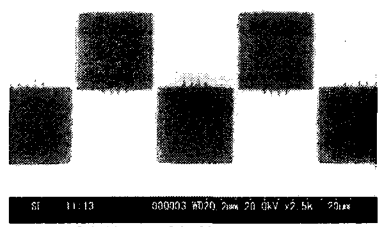

Fig. 1. A SEM image of the $Ni_{81}Fe_{19}$ nanostructures

REFERENCES
[1] Y. Tserkovnyak, A. Brataas, and G. E. W. Bauer, Phys. Rev. Lett. **88**, 117601 (2002).
[2] E. Saitoh, M. Ueda, H. Miyajima, and G. Tatara, Appl. Phys. Lett. **88**, 182509 (2006).

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Magnetic Domains of Permalloy Rings with a Straight Line

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The magnetic domains of patterned permalloy films were widely investigated by the researchers because of its low crystal- and stress-induced magnetic anisotropy [1]. Therefore, the domain structures of patterned permalloy films were dominated by their geometry. Considering the spintronic applications, the permalloy with elliptic shape, ring structure, rectangle and straight line was widely studied [2, 3, 4, 5]. For the ring-shaped permalloy, the flux-closure vortex and onion are the stable remanent states. The domain manipulation plays an important role in the spintronic applications.

In this presentation, we try to use a straight line to influence the domain structure of a permalloy ring. By utilizing the anodic oxidation technique of atomic force microscope, the pattern structure was first drawn on a metal mask. After etching processes, permalloy films deposition and permalloy films lift-off procedures, a 40nm thick permalloy ring with a straight line was obtained, as shown in Fig. 1(a). As a reference, a single ring structure was also fabricated, as shown in Fig. 1(b).

As the figure shown, the ring was 2 um in diameter and 0.4 um wide. The straight line was 2 um long and 0.4 um wide. The magnetic domain of permalloy structures was investigated by magnetic force microscope equipped with an external magnetic field. *In the as grown state, we found complex* domain structures in both cases. After saturating the samples then releasing the field, a vortex-like structure was only found in the ring structure. The permalloy straight line act as a key factor on the vortex formation in the ring structure. The detail MFM images and discussion will be given.

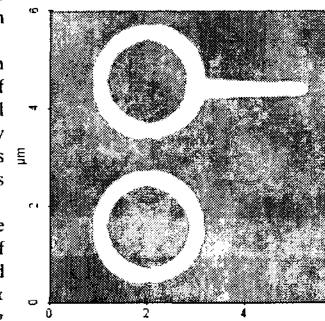

Fig. 1. AFM images of permalloy rings (a) with or (b) without a straight line.

REFERENCES
[1] D. Craik, magnetism -- principles and applications (John Wiley & Sons, England, 1995).
[2] Schneider, H. Hoffmann, and J. Zweck, Appl. Phys. Lett., **79**, 3113 (2001).
[3] K. Shigeto, T. Okuno, K. Mibu, and T. Shinjo, T. Ono, Appl. Phys. Lett., **80**, 4190 (2002).
[4] M. Kla¨ui, C. A. F. Vaz, and J. A. C. Bland, W. Wernsdorfer, G. Faini and E. Cambril, L. J. Heyderman, Appl. Phys. Lett., **83**, 105 (2003).
[5] Xiaobin Zhu, Dan A. Allwood, Gang Xiong and Russell P. Cowburn, Peter Grütter, Appl. Phys. Lett., **87**, 062503 (2005).