EA03

Spin Transfer Torque Microwave Oscillation Study on Spin-Valve Films with Self-Assembling Nano-Confined Domain Wall Structure

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The magnetoresistance of nano-contacts (NC) has been reported to show a considerably high MR ratio [1]. The origin of the NC-MR is considered to relate on the domain wall (DW) confinement at NC. On the other hand, the microwave oscillation (MO) induced by the spin transfer torque (STT) has been already reported on fabricating a mono-pillar or a point contact of magnetic multilayers[2][3]. We propose to apply our original nano-confined structure formed by the self-assembling nano-oxide layer (NOL) to the microwave oscillator. The peculiar STT-MO was observed in our nano-confined structured films[4]. The point of discussion of our system is that the direct electric current is confined at many numbers of conductive channels with nano-confined DW. From the analysis of the STT microwave characteristics dependence on the direct current and applied magnetic field, the MO of nano-confined DW structure are discussed. The SV is designed as PtMn/CoFe(3.3)/Ru(0.9)/$Fe_{0.5}Co_{0.5}$(2.5)/Al-NOL/$Fe_{0.5}Co_{0.5}$(2.5)(nm). Three types of MO were observed at different magnetization states (MS). One is observed at the MS before the clear anti-parallel alignment (AP) by the applied field. Second is AP state. Another is after reference layer (RL) start to reverse, which means as broken of AP from the RL. The frequency of MO shows discontinuous increases for each MS as shown in Fig.1. This difference may be explained by the difference of spin dynamics in confined DW at each MS.

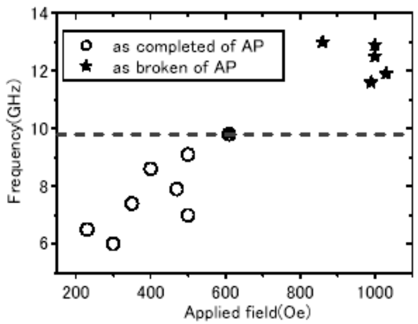

Fig. 1. STT microwave frequency dependence on applied field.

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EA04

Vortex Random Access Memory (VRAM) as New MRAM Scheme

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The magnetic vortex (MV) is a well-known magnetic microstructure typically observed in the ground and/or dynamic states in patterned [1] or continuous soft magnetic thin films [2]. The MV has the in-plane curling magnetizations along with the out-of-plane magnetizations at the core, the so-called vortex core (VC). The VC has either an upward or a downward magnetization orientation, so that it can be used as an information carrier of the binary digits “0” and “1” [3]. Over the past five years, our group has found nontrivial novel dynamic properties of magnetic vortices in geometrically confined magnetic thin-film dots, such as ultrafast vortex-core reversal by oscillating magnetic fields and currents with extremely low power and by circularly rotating fields in the film plane, as well as the detailed mechanism [4], physical origin [5], universal criterion [6], and linear and nonlinear gyrotropic motions of these magnetic vortices [7]. On the basis of these novel static and dynamic vortex properties, we propose a conceptual design of new classes of nonvolatile random access memory using dot arrays of the MV states. In particular, the use of circular rotational fields of frequencies close to the eigenfrequency of a given vortex allows us to select a vortex for its core reversal and to detect its core orientation for information recording and writing, respectively, with low power consumption as small as 10 Oe, and excluding transistors assigned to individual cells for reliable writing and reading operations [3]. Here we suggest new writing and reading schemes for vortex random access memory (VRAM).

The results provide a new as well as more detailed physical understanding of vortex-related dynamics in soft magnetic nanodots, and allow for an effective manipulation of vortex motions and VC switching, as well as its practical application to information storage devices such as VRAM. In the present talk, we discuss the scheme of the proposed VRAM in relation to the feasibility of its realization as a future solid-state information storage device.

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