AB07

Domain Wall Pinning by Alternating Materials in Current-induced Domain Wall Motion

W. J. Kim[1], T. D. Lee[1], and K. J. Lee*[2]
[1]Department of Materials Science and Engineering, KAIST, Daejeon, 305-701, Korea
[2]Department of Materials Science and Engineering, Korea University, Seoul, 136-713, Korea
*Corresponding author: kj_lee@korea.ac.kr, Phone: +82 2 3290 3289, Fax: +82 2 928 3584

Recently, current induced domain wall motion by spin transfer torque is of great interest. For its applicationfor a high-density storage device [1], a sufficiently high velocity of domain wall (DW) is essential. It is also important to make well-defined pinning positions of DWin the nanostrip with an adequate depinning current density. The notch at the edge of nanostrip was suggested as the pinning scheme[1], and has been studied in the experiments [2].

Here we investigate another scheme to pin DW by inserting adifferent material in the nanostrip. We investigated on the DW *motion in the Permalloy nanostrip of which width and thickness are 60nm and 4nm, respectively. Two identical segments of* different material were inserted into the nanostrip, as illustrated in the inset of Fig. 1. The segments have length of D, and separated by 160nm. The transverse DW was placed at the middle of the segments. We carried out micromagnetic simulation solving the Landau-Lifshitz-Gilbert equation including the adiabatic (N_{adia}) and the local nonadiabatic spin torque ($N_{nonadia}$) terms [3]. The ratio of $N_{nonadia}$ to N_{adia} was assumed to be the same as the damping constant.

When the saturation magnetization (Ms) of the segment is larger than that of Permalloy, the residual magnetostatic fields from the segments make the magnetic potential in the separation of the segments. Thus, DW is confined in the middle of the segments. The potential is deeper for the larger Ms and the longer Δ of the segments. The variations of threshold current density (Jc) for depinning as a function of Δ for various Ms' of the segments are shown in Fig. 1. Jc's are mostly the same for the different Δ, for Ms of 1200emu/cm3 and 1400emu/cm^3. The large difference of Ms disturbs the motion of DW in the segment because the amplitude of spin torque is inversely proportional to Ms, so that it is reduced in the segment of a larger Ms. For Ms of 1000emu/cm^3, Jc varies with the variation of Δ, that is, the depth of the potential. The segments with a different Ms from that of nanostrip play roles as confinements of DW. Jc can be tuned by changing Ms and Δ of the segments. More details of the study will be discussed in the presentation.

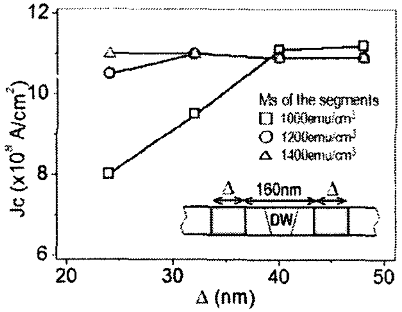

Fig. 1. Jc as a function of Δ for va-rious Ms'of the segment. The segments in the nanostrip are marked with dark region *in the schematic illustration in the inset.*

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AB08

Spin-Transfer Dynamics in Planar Magnetic Structures

Ya. B. Bazaliy*
Instituut Lorentz, Leiden University, Niels Bohrweg 2, Leiden, 2333 CA, The Netherlands and
Department of Physics and Astronomy, University of South Carolina, 712 Main St., Columbia, SC 29208, USA
*e-mail: yar@mailaps.org, Phone: +31-6-21-90-26-29, Fax: +31-71-527-5511

We consider magnetization dynamics in nanostructures in the presence of a dominating easy-plane anisotropy. Such an anisotropy quite naturally leads to a motion of the magnetization with small out-of-plane deviation. Mathematically, the system of Landau-Lifshitz-Gilbert equations describing the evolution of the two polar angles of the magnetization is reduced to a single equation for the azimuth angle [1]. In the present work this equation is derived in the presence of spin-transfer torques produced by electric current flowing through a nano-device [2]. The obtained equation is equivalent to the one describing a massive particle in an external potential with a viscous friction force damping the motion. The current producing the spin-transfer torque changes the effective damping term from its zero value set by the Gilbert constant. As expected from the conventional approach to spin-transfer devices, interesting process happen when the damping coefficient becomes negative. However, in contrast to the usual description, the effective planar equation allows for a straightforward intuitive understanding of both static and precession states of the device. It also provides an analytic method for finding boundaries between different precession modes, a task previously performed only numerically. We analyze the switching and the precession states of the collinear and of the 90-degree (also called a spin-flip transistor [3]) devices. In the collinear case we calclate the boundary for between the "in-plane" and "out-of-plane" precession modes [4,5]. For the spin-flip transistor we find a counter-intuitive stabilization of the antiparallel direction which in this case is destabilized by either anisotropy or spin-transfer torques when acting alone. Such a stabilization arises due to a peculiar interplay between the two torques and enhanced damping. Overall, the planar approximation is shown to be a useful tool for the studies of the spin-transfer devices.

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