# Current-induced domain wall motion for a narrow wall

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An electrical current flowing through a domain wall generates a spin torque [1]. Two spin torque terms, adiabatic and nonadiabatic torque, were proposed to describe the current-induced domain wall motion (CIDWM). The adiabatic torque is caused by the fact that the spin of incoming electrons exactly follows the local magnetization. When the spin does not perfectly follow the local magnetization by any reason, a nonzero nonadiabatic torque appears [2-6]. It was claimed that the nonzero nonadiabatic torque acts like a local magnetic field and is responsible for a finite terminal velocity of domain wall [3, 4]. The finite velocity at an acceptable current density is essential for the application of the CIDWM. Two possible origins of the nonzero nonadiabatic torques were proposed; the local torque due to the magnetic scattering and the nonlocal torque due to the quantum mechanical oscillation of spin density around local magnetizations.

In this work, we investigated the effect of the nonlocal torque provided by a narrow wall on the wall velocity. Following the semi-classical model proposed by Xiao et al. [6], the spin density and corresponding spin torque oscillates on both sides of domain wall in contrast to the recent work reported by Ohe and Kramer where it appears on only one side of domain wall [7]. We found the "force" acting on the domain wall is significantly reduced when the spin torque oscillates on both sides of domain wall in a measoscopic nanowire with a single conducting channel. In this case, the terminal velocity is nearly zero [8]. For a nanostripe with multi-conducting channels, however, the oscillation is still large at the domain wall but significantly decreases at the outside of domain wall due to the integration over the Fermi surface. As a result, "force" is remained to be finite and the velocity is finite [9]. We observed a creep of domain wall even at a very low current density as experimentally observed by Yamanouchi et al. [10].

In the presentation, we show details of spin-wave excitation and domain wall motion.

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