CURRENT-INDUCED DOMAIN WALL OSCILLATION AND PROPAGATION

June-Seo Kim, O. Boulle, D. Bedau, P. Möhrke, T. Moore, M. Kläui, U. Rüdiger
Fachbereich Physik, Universität Konstanz, Universitätsstr. 10, D-78457 Konstanz, Germany

The recent discovery that a spin-polarized current can induce domain wall dynamics (DW) without any external magnetic field has opened a new path to manipulating magnetization. It is now the subject of extensive research motivated not only by its fundamental interest but also by promising applications for memory and spintronic devices. Up to now, most studies investigated the average dynamical response of a DW to a DC current or quasi-static current pulses. Such studies have shown that the DW dynamics on such time scale (depinning/propagation) occurred for high critical current density (~10^{12} A/m²) and was characterized by a large stochasticity (displacement poorly reproducible) and a low average velocity [1].
Recently, much attraction was given to the DW dynamics on shorter time scale where higher velocities as well as lower critical current density were reported [2,3]. In particular, it was recently shown that a domain wall in a nanowire pinned at an artificial notch can be driven into large amplitude oscillation by a high frequency AC current for very low current density (~10^{9}A/m²) [3]. Here, we investigated the resonance by a high frequency AC current of a single vortex core in a permalloy disk with diameter varying between 1 and 4 µm, which allows a better control of the energy landscape felt by the vortex core. We observe variations of the dc voltage (homodyne detection) for some peculiar frequencies that clearly indicate the resonant excitation of the vortex. The shape of the DC voltage vs frequency curve is determined by the relative orientation (up or down) of the vortex. This is a first step toward the study of the recently predicted and observed switching of the vortex core orientation induced by current pulse/ AC current [4].
In addition, we investigated the propagation of a DW in a nanowire induced by current pulses by using time-resolved MOKE measurements. Contrary to standard static imaging or averaging techniques, the measurement were made in "single shot" which allows the probing of the stochastic component of the propagation. The dependence of the DW velocity with the current and field conditions will be presented and discussed.

[1] M. Kläui et al., Phys. Rev. Lett. **94**, 106601 (2005), Phys. Rev. Lett. **95**, 26601 (2005)
[2] Hayashi *et al.*, Phys. Rev. Lett. **98**, 037204 (2007), Thomas *et al.*, Science, 315, 1553, (2007) [3] D. Bedau, M. Kläui et al., Phys. Rev. Lett. **99**, 146601 (2007)
[4] Yamada *et al.*,, Nature Materials, **6**, 269 (2007)