MAGNETIC VORTEX DYNAMICS IN MULTI-POINT-CONTACT SYSTEMS

A. Ruotolo, B. Georges, V. Cros, J. Grollier, A. Dussaux, C. Deranlot, S. Fusil, K. Bouzenouane, A. Fert
Unité Mixte de Physique CNRS/Thales, Route départementale 128, 91767 Palaiseau, France

Spin-torque driven precession of a magnetic vortex has been demonstrated to be a mean to generate, through the Giant Magnetoresistance effect, microwave signals [1]. As compared to the excitation of uniform modes, vortex precession modes are significantly more powerful and narrow-banded. Moreover, much smaller applied external fields are required to keep the precession stable. Still, even narrower linewidths and larger emitted powers are needed if practical applications want to be envisaged. Synchronization of two, or more than two, oscillators remains at the moment the only reasonable way to increase the power and, at the same time, reduce the linewidth of the emission.

We have studied the emission response of single and multi-contact systems. The devices were fabricated by a real-time controlled nano-indentation technique. Contact size in the range of 20 – 50 nm could reliable be achieved. In single contact devices sub-GHz oscillations were detected in magnetic field applied out of the sample plane. The emitted signals are characterized by a large power (up to 1 $nW/mA^2/GHz$) and narrow linewidth (< 10 MHz), suggesting vortex precession as the origin. This assumption was confirmed by macromagnetic simulations and theoretical models. A single fundamental mode was always detected in single-contact devices, along with harmonics of several orders.

In closely-spaced multi-contact systems more than one modes, along with their harmonics, could be detected simultaneously at fixed d.c. current and applied field. By changing the injected current, multi-modes could be merged in single modes whose power and linewidth were, respectively, larger and narrower than those of the original modes. This behavior is indicative of coherent synchronization of oscillators [2]. The range of applied fields (< 10 mT) and the characteristic features of both the single and the merged modes suggest phase-locking between vortex modes.

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[2] S. Kaka, M.R. Pufall, W.H. Rippard, T.J. Silva, S.E. Russek and J.A. Katine, Nature **437** 389 (2005)