SPIN-TRANSFER TORQUE: THE NEW TURN ON SPINS

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A spin-polarized current entering into a ferromagnetic material exerts a torque on the magnetization by transferring spin angular momentum from the current to the ferromagnet. This so-called spin-transfer torque (STT) gives rise to current-driven magnetization dynamics with unprecedented properties like the switching of the magnetization without applying an external field or the excitation of persistent large-angle precessions of the magnetization with frequencies in the GHz range, which are the basis of the so-called spin-transfer oscillators (STO). In the first part, I give a brief introduction to STT in magnetic multilayers with emphasis on developing a physical picture of the microscopic processes.
The second part focuses on measurements and simulations of STT effects in nanopillars containing a circular, single-crystalline Fe(001) nanomagnet (2 ï 20 nm thick, 70 ï 230 nm in diameter) [1]. The interplay between the cubic magnetocrystalline anisotropy and the STT gives rise to a novel two-step switching behavior [2] and to STO operation without an applied magnetic field [3]. Nanomagnets with a diameter of 230 nm form a magnetic vortex state, which can be excited by the STT to the gyrotropic mode [4]. The locking of this mode to an external HF signal is demonstrated as a first step towards the synchronization of many STOs, which is a prerequisite to achieve sufficient output power for applications, e.g. in communication technology.

References

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