SPIN-TRANSFER INDUCED DYNAMIC MODES IN SINGLE-CRYSTALLINE Fe/Ag/Fe NANOPILLARS

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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. We present measurements and simulations of STT effects in nanopillars containing a thin, circular, single-crystalline Fe nanomagnet with four-fold in-plane magnetocrystalline anisotropy as a free layer. The samples are fabricated from epitaxial, MBE-grown Fe/Ag/Fe(001) layered structures by a combination of optical and e-beam lithography [1]. The Fe(001) nanomagnets have diameters down to 70 nm and a thickness of 2 nm. The magnetocrystalline anisotropy inherent to *bcc*-Fe shows up in measurements of the giant magnetoresistance effect in the CPP geometry (CPP-GMR) and gives rise to a novel two-step switching behaviour. The nanomagnet magnetization consecutively switches at two different critical currents I_{c1} and I_{c2} by 90º from parallel to perpendicular and from perpendicular to antiparallel alignment to the fixed layer magnetization [2]. This feature enables us to investigate the angular dependences of CPP-GMR and STT and to compare them to theoretical predictions [3]. Additionally, the anisotropy gives rise to steady-state precession of the free magnetization at low or even zero applied magnetic field when the magnetizations are perpendicularly aligned. This low-field mode is governed by the interplay between the STT and the anisotropy, while the current-driven dynamics in large fields exceeding the coercive field results from the STT acting against the externally applied magnetic field. The two-step switching behaviour as well as the low-field excitations arise from significant asymmetries of the angular dependences of both CPP-GMR and STT, which have been predicted by Slonczewski [3], but have not been observed simultaneously so far. The asymmetries originate from strong spin accumulation at the Fe/Ag(001) interfaces in agreement with Ref. [4].

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