Magnetic field free spin torque induced oscillations in magnetic tunnel junction with perpendicular polarizer and planar free layer

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Spin torque nano-oscillators (STNOs) are non-linear auto-oscillating systems known to produce steady state magnetization precession in the microwave range, which occur when current-induced spin-transfer torque (STT) balances the intrinsic Gilbert damping of a magnetic layer. STNOs based on magnetic tunnel junctions (MTJ) are considered as attractive alternative to the conventional voltage controlled oscillators due to its nanoscale size, large frequency tunability, and simple integration with conventional CMOS technology. To improve the microwave performances recent studies concentrate on STNOs where either polarizer or free layer has strong interfacial perpendicular anisotropy which may lead to enhanced output power and eventual zero-field operation [1,2].

Here we report on the observation of the room-temperature zero-magnetic-field STT-induced microwave generation in the MTJ with perpendicular polarizer and planar free layer (Figure 1(a)). Above the critical current I_C ~ -0.6 mA, the excitations are steady state auto-oscillations with frequencies up to 3 GHz and emitted power up to 7 nW. The frequency of the signal strongly depends on the driving current above the critical value exhibiting the pronounced “redshifting” behavior, with the value of the frequency-current tuning ratio *df/dI* ~ 5.7 GHz/mA (Figure 1(b)), several times larger than reported up to now [3]. This opens a possibility of current-induced wide-range frequency modulation in such devices.

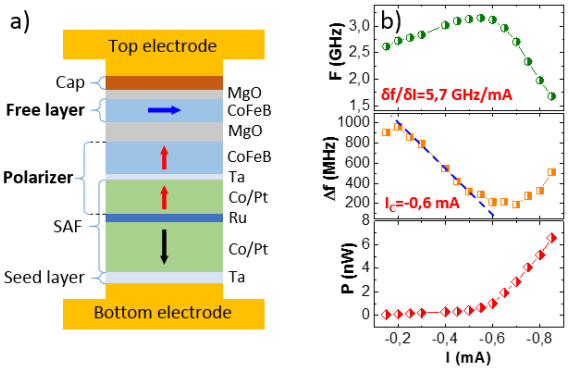

Figure 1 : (a) Schematics of the MTJ stack. Arrows denote the magnetization orientations at zero field. (b) Center frequency, FWHM linewidth and peak power of the generated signal at zero magnetic field

[1] D. Houssameddine, et al, Spin-torque oscillator using a perpendicular polarizer and a planar free layer *Nat. Mater.* **6** 447–53 (2007)
[2] H. Kubota, et al, Spin-Torque Oscillator Based on Magnetic Tunnel Junction with a Perpendicularly Magnetized Free Layer and In-Plane Magnetized Polarizer *Appl. Phys. Express* **6** 103003 (2013)
[3] B. Fang, et al, Zero-field spin transfer oscillators based on magnetic tunnel junction having perpendicular polarizer and planar free layer *AIP Adv.* **6** 125305 (2016)