

# Spin transfer torque on domain wall state in nanopillar magnetic tunnel junction with perpendicular magnetic anisotropy

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It has been demonstrated that the magnetic state of nanoscale magnetic tunnel junction (MTJ) can be switched by a spin-polarized tunnel current via the so-called spin transfer torque (STT) effect. This is a promising mechanism for the write operation memory elements and for driving microwave nano-oscillators. Particularly MgO-based MTJ with perpendicular magnetic anisotropy (PMA) [1] has recently generated great interest due to its potential application in information storage, such as STT-MRAM (magnetic access memory).

The MTJ studied here were grown by magnetron sputtering: substrate/RuCoFe(50)/Ta(20)/Co<sub>60</sub>Fe<sub>20</sub>B<sub>20</sub>(8)/MgO(9)/Fe(5)/Co<sub>60</sub>Fe<sub>20</sub>B<sub>20</sub>(8)/Ta(3)/Co(2.5)/Pt(8)/[Co(2.5)/Pd(8)]x4/Co(3)/Ru(9)/[Co(2.5)/Pd(8)]x13/Ru(200), where thicknesses are in Angström. Then, various sizes ~70 to 300nm in diameters of nanopillars were patterned. More details about the growth and the magnetic parameters can be found in Ref. [2, 3].

We have studied the magneto-transport properties of these devices using a standard four probe-probe method. For the biggest (octagon ~250nm) structures only, an intermediate state, between parallel (P) and anti-parallel (AP) state, appears in the resistance versus applied magnetic field R-H loops and even exists at zero voltage (see FIG. 1). This intermediate resistance value is attributed to a domain wall (DW) state. The influence of the dc voltage (or current) on the DW state is shown on the state diagram in the FIG.1. We notice an asymmetric behaviour according to the sign of the applied voltage (or current) due to STT: for V>0, the DW state is stabilized, in the opposite for V<0, this state disappears. The stabilization of the DW state will be discussed in this presentation.

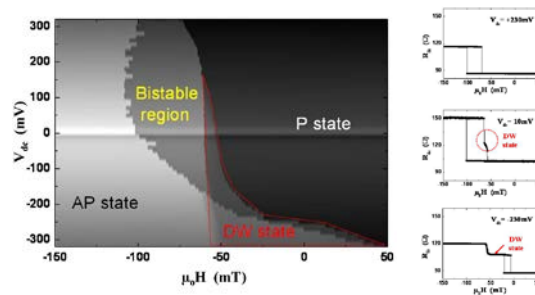


Figure 1: State diagram in (H, V) space of an octagon nanopillar of 250nm of diameter. We can distinguish the AP, P and bistable region while the red area focus on the DW state. On the right is shown the R-H loops for various voltage V=+250mV, +10mV and -250mV.

[1] S. Ikeda *et al.*, Nature Mater. **9**, 721 (2010)

[2] D. C. Worledge *et al.*, Appl. Phys. Lett. **98**, 022501 (2011)

[3] J. Z. Sun *et al.*, J. Appl. Phys. **111**, 07C711 (2012)