Domain wall dynamics and creep phenomena in CoFeB/MgO structures

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Perpendicular magnetised CoFeB/MgO is widely considered one of the best material for various application in spintronics devices, such as magnetic memories and spin-torque nano-oscillators, to name a few. In fact, the high interfacial perpendicular magnetic anisotropy (PMA), accompagned by a low density of patterning-induced defects and a very low damping compared to Co/Pt, FePt, make it an ideal material for the spintronics applications. Thanks to the large PMA, the domain walls (DWs) are extremely narrow (10-30 nm) and rigid, make it also a perfect system to study the dynamics properties of a 1D elastic interface propagating in 2D media with weak disorder.

To this end, we have studies the DW dynamics at low magnetic fields in the so called creep regime, both in films and wires. The arrays of wires are produced by micropatterning using optical lithography with widths spanning from 200 μm down to 1 μm. The wires with largest widths and the films show a creep law, expressed by an average DW velocity v given by $v \sim \exp(-(H_{dep}/H)^{\mu})$, characterised by the universal exponent μ=1/4, as in Co/Pt and many other materials [1]. Remarkably, we found that these systems show a ultraslow creep regime characterized by a reorganization of the dynamics in independent clusters that follow the predictions of critical depinning avalanches [2].

The microwires, on the other hand, breaks the universal creep law above, showing an effective exponent μ^* which increases for narrower wires. This nonuniversal behaviour is originated by the strong pinning of the wires edges due to the micropatterning. As a consequence, the DW highly bends, and the overall velocity decreases. This edge pinning turned out to be much larger than the typical pinning strenght found in the center of the wires, and in the films. This explains why a similar non-universal behaviour is not found in Co/Pt wires, for instance, where the pinning at the edges does not introduce a significant change in the DW dynamics.

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