Departement of Applied Physics, Group Physics of Nanostructures

Technische Universiteit Eindhoven University of Technology

Domain wall dynamics in perpendicularly magnetized Pt/CoFeB/Pt layers.

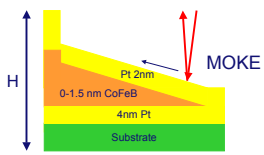
R. Lavrijsen*, G. Malinowksi, H.J.M. Swagten, J.T. Kohlhepp, and B. Koopmans

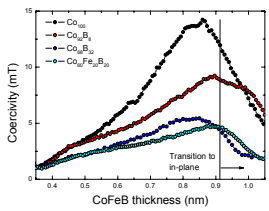
Introduction & Motivation

Domain wall motion in Pt/CoFeB/Pt perpendicularly magnetized nanowires is of particular interest due to the wide tuneability of the critical parameters governing its dynamics.

- By tuning the CoFeB composition and thickness, the coercivity, anisotropy, damping parameter and pinning density can be varied.
- Pt/CoFeB/Pt shows narrow domain walls (~10 nm) [1], particularly interesting for current induced domain wall motion predicted to have a high non-adiabatic spin-torque transfer coefficient [2].

Coercivity

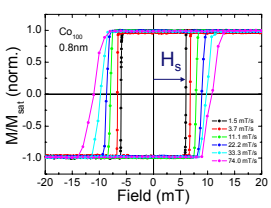


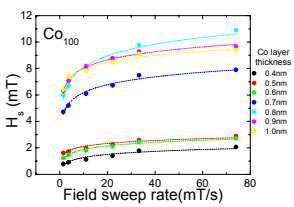


- By scanning a wedge shaped sample with MOKE we are able to obtain the coercivity versus thickness of the CoFeB layer.
- The coercive field increases with thickness, above ~0.9 nm the magnetization turns in plane.

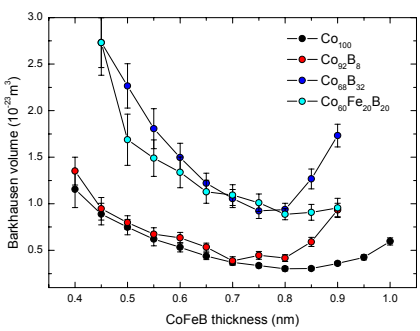
Barkhausen volume

- The Barkhausen volume (V_b) is a direct measure for the pinning site density for magnetization reversal by domain wall motion [3].
- Vb can be determined by measuring the switching field (Hs) while varying the field sweep rate using MOKE and fitting the variation [4].
- For increasing boron content we see an increase of V_b indicating a lower density of pinning sites.



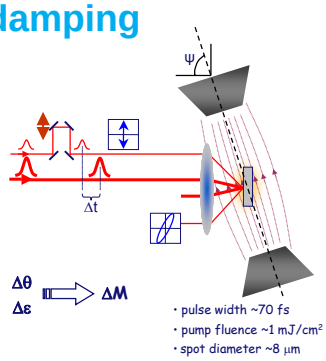


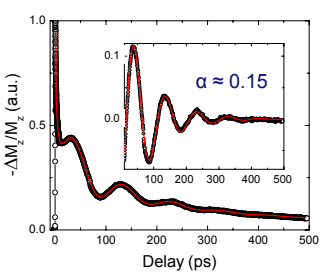
$$\mu_0 H_s = \frac{k_B T}{V_B M_s} \cdot \ln(\mu_0 \frac{dH}{dt}) + H_{s_0}$$



Gilbert damping

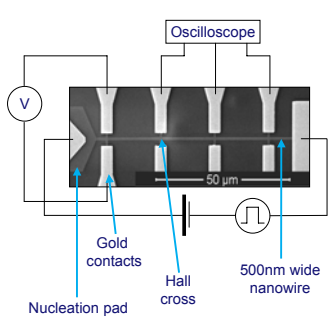
- Using a time resolved MOKE technique the gilbert damping parameter (α) can be determined.
- By applying a field at a certain angle (ψ) to the normal of the sample the magnetization precession after a pump pulse is recorded.
- By fitting the precession with the Landau Lifshitz Gibert equation we are able to determine the gilbert damping.
- A large damping (α≈0.15) is not optimal for "viscous" domain wall motion but might provide valuable insight in the correlation between the domain wall velocity and the damping parameter.

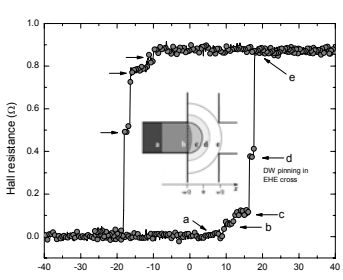




Measurement scheme and outlook

- EBL is used to define 100-500 nm wide nanowires and are contacted by UVL defined gold contacts.
- A large domain wall nucleation pad is used to create a domain wall which can then be pushed in the nanowire.
- By defining crosses in the nanowire the extraordinary hall effect (EHE) be used as a local probe of the perpendicular magnetization direction.
- Steps can be seen in the hall resistance due to geometrical pinning when a domain wall passes through a cross [5].
- Time resolved measurements of the Hall resistance with an oscilloscope at different crosses in the wire is used to measure the average domain wall velocity.





*Contact details: r.lavrijsen@tue.nl

[1] Metaxas *et al.* PRL 99, 217208, (2007)
[2] Tatara *et al.* PRL 92, 086601, (2004)
[3] Mathet *et al.* JMMM 260, 295, (2003)
[4] Raquet *et al.* JMMM 150, L5, (1995)
[5] Ravelosona *et al.* PRL 96, 096601, (2006)