Domain-wall pinning at chemical notches in cylindrical nanowires

S. Ruiz-Gómez [a], M. Foerster [b], L. Aballe [b], M. Proenca [c], I. Lucas [d], J. L. Prieto [c], A. Mascaraque [a], A. Quesada [e], J. de la Figuera [f] and L. Pérez [a,g]

[a]*Dept. Fisica de Materiales (UCM)*, [b]*Alba Synchrotron Light Facility, CELLS, Barcelona, Spain*
[c]*Instituto de Sistemas Optoelectrónicos y Microtecnología (UPM)*, [d]*Instituto de Nanociencia de Aragón*,
[e]*Instituto de cerámica y Vidrio (CSIC)*, [f]*Instituto de Química Física Rocasolano (CSIC)*, [g] *IMDEA Nanociencia*

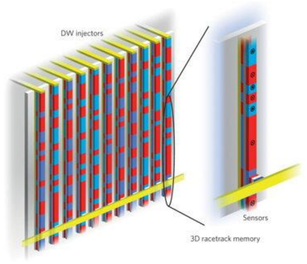
Motivation

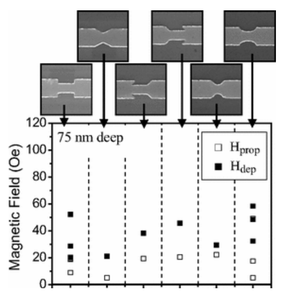
The **movement of magnetic domain walls** (DWs) using **spin-polarized currents** may be the base of next **future magnetic storage technology.**

Racetrack memory, suggested by Stuart Parkin (IBM) : magnetic **DWs** are **pinned** in artificially created **geometrical notches** along the wires [1].

The **depinning** of a DW has an intrinsic **stochastic component**. The **Joule heating** associated to the spin-polarized currents is **more important than thought previously [2,3]**.

Our proposal: introduce **changes in composition** along **cylindrical nanowires** (chemical notches) to use them as local pinning sites.





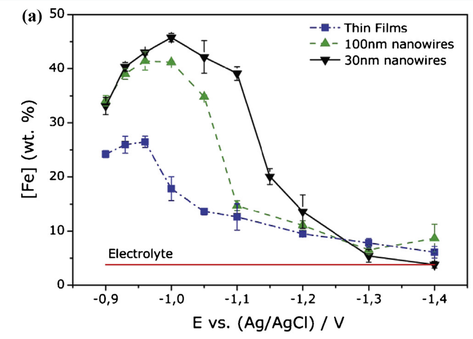
Experimental

Growth conditions:

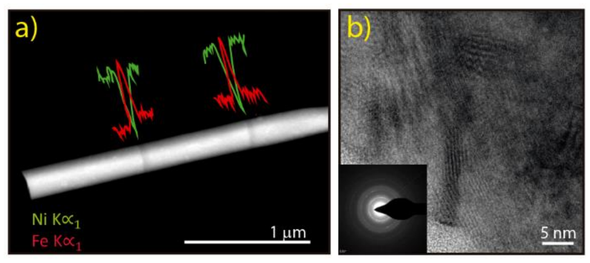
Potentiostatic electrodeposition

Alumina templates: 200nm diameter

Pulsed electrodeposition: V=- 1.5 V 3.5s-15s
V=- 1 V 15s



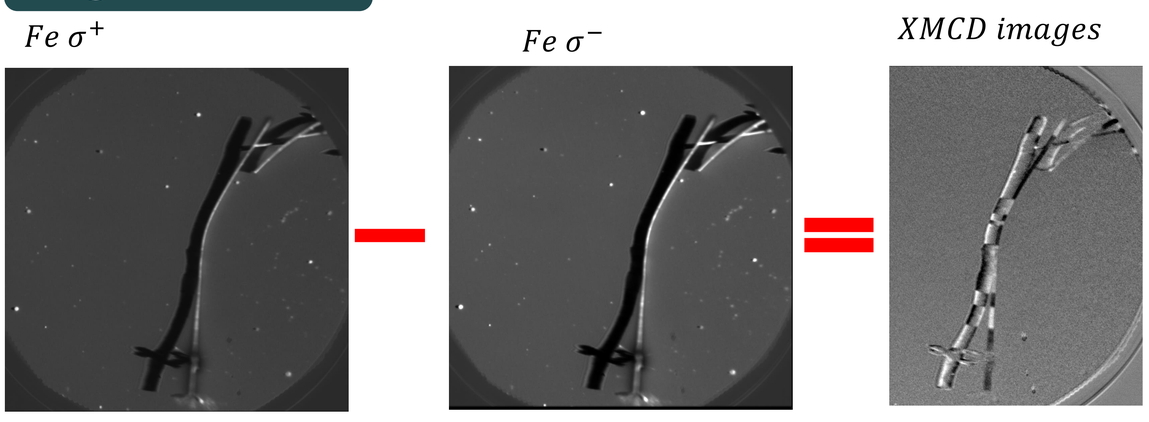
TEM



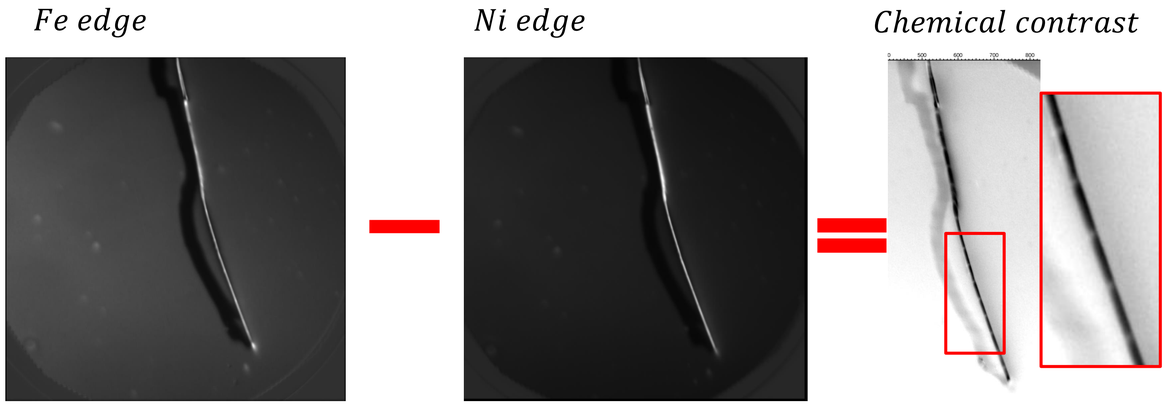
Dark and light segments in the nanowire corresponds to Ni-rich and Fe-rich areas (chemical notches) respectively.

Chemical notches are 20 nm in length and are periodically distributed

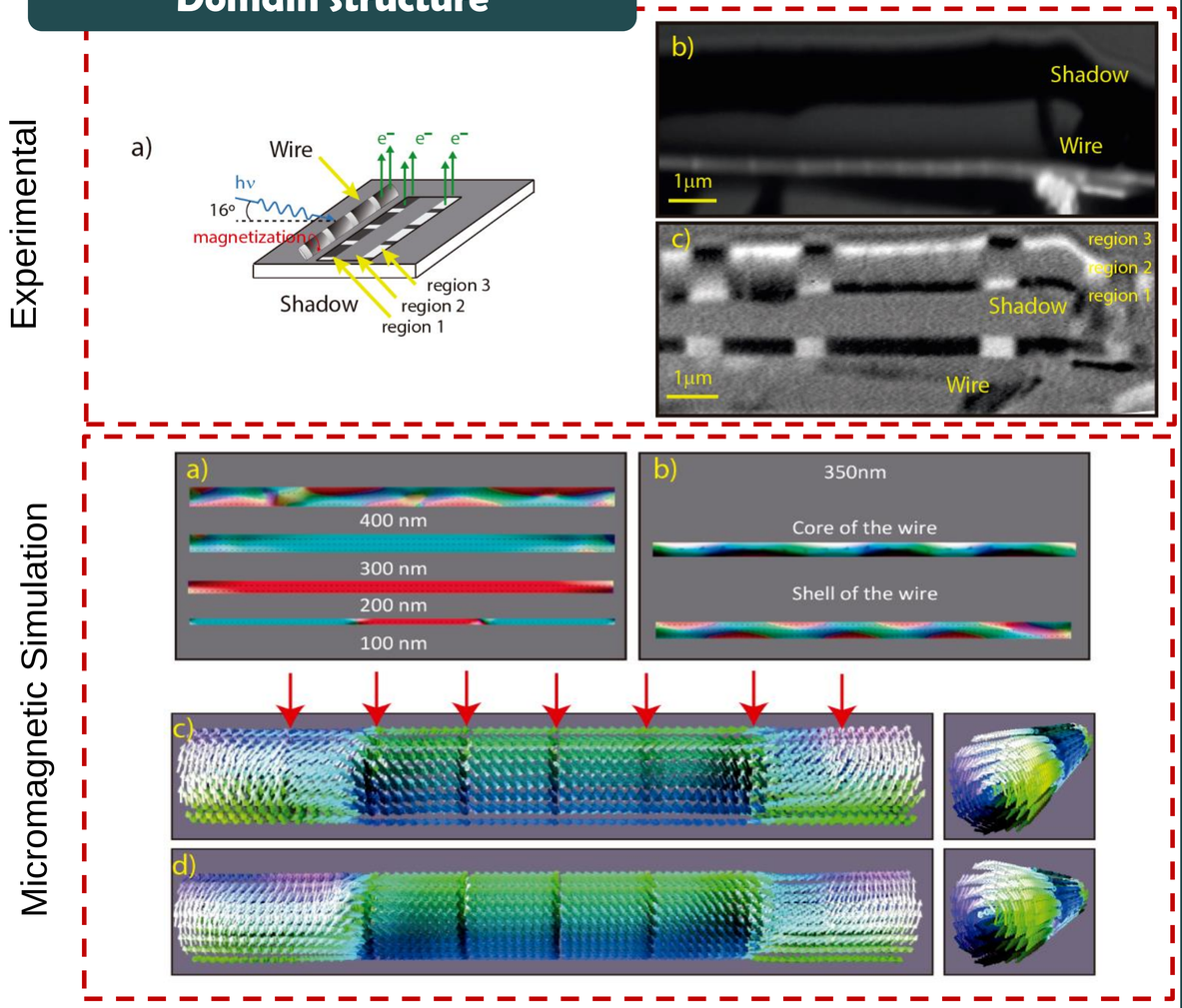
Magnetic contrast



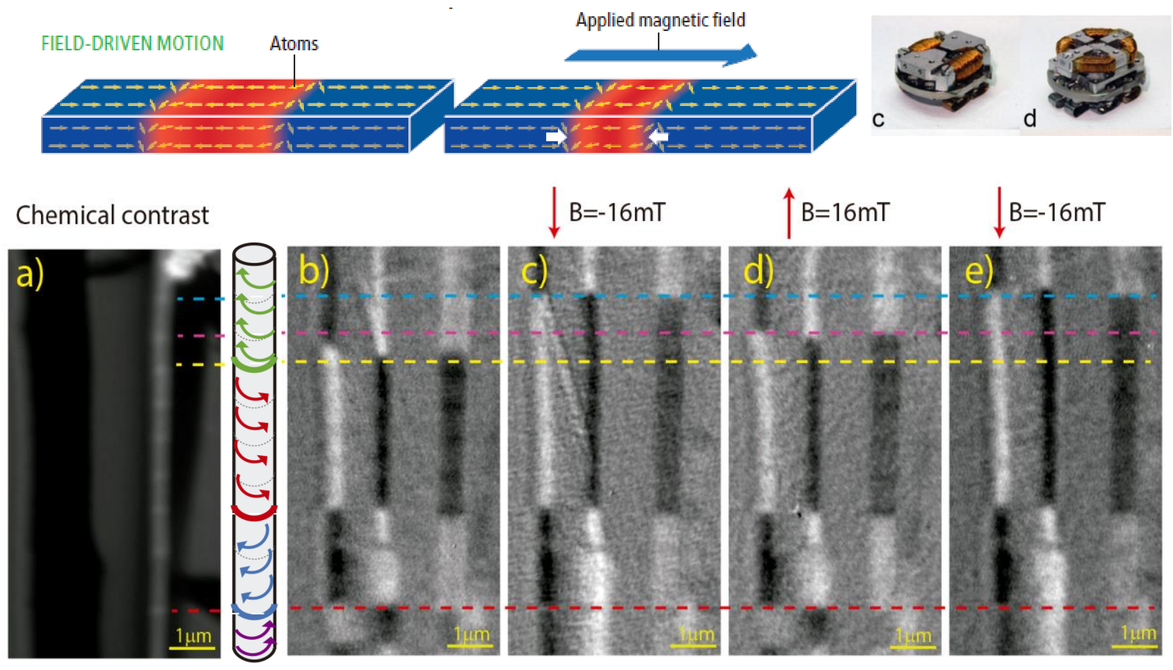
Chemical contrast



Domain structure



Domain Wall motion



Conclusions

Permalloy nanowires with chemical notches have **two different magnetic configurations**: Core/shell for lower diameters and helical configuration for higher diameters.

95% of domain walls are **pinned in notches**

The **depinning field** is **the same** for all studied notches

References

[1] S. S. P. Parkin, et al. Science, 320:194, 2008.
[2] Johanna Akerman, et al. Phys. Rev. B, 82:064426, 2010.
[3]M. Munoz and J. L. Prieto. Nat. Commun.171:63, 2016.
[4] M. Foerster, et al. Ultramicroscopy., 96:082110, 2010

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