Spin-Hall-effect-driven domain wall motion in ferromagnetic core-shell nanowires

Principal investigators

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The project is concerned with the exploration of the micromagnetics and field-/current-driven motion of domain walls in ferromagnetic nanotubes. Emphasis is put on the implementation of a spin-Hall geometry, which implies the use of core-shell nanowires, in our case with a ferromagnetic shell (nanotube) and a heavy metal core. While the heart of the project is experimental – synthesis and measurements – it is part of a large effort over NEEL and Spintec combining micromagnetics with spin-polarized effects.

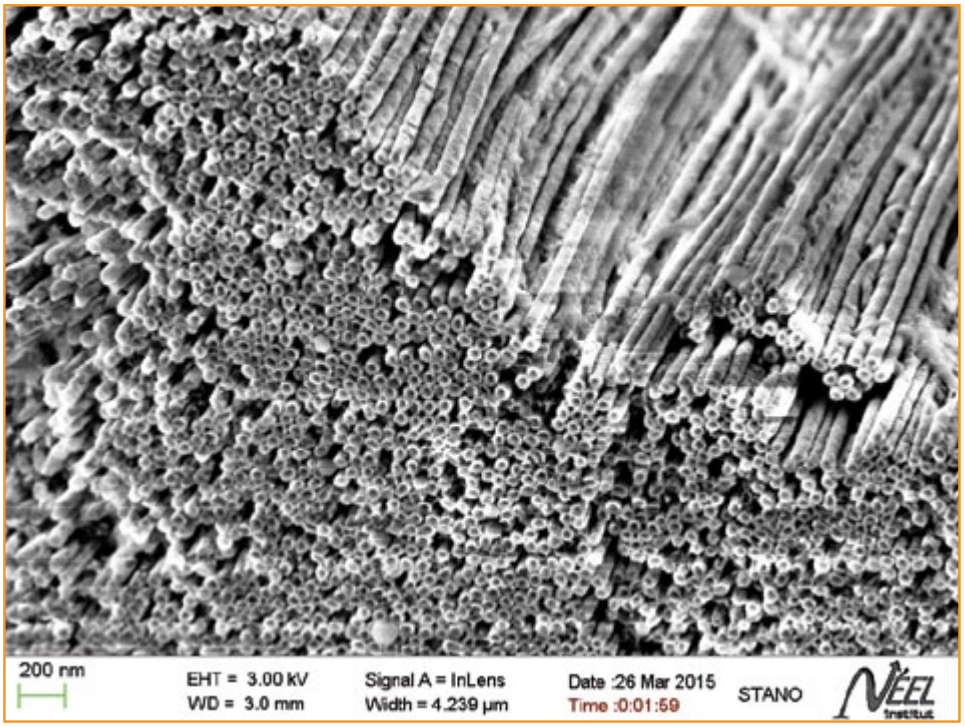
Description

Magnetic nanotubes and nanowires open a way towards enhanced 3D (non-planar) magnetic race-track memories (nonvolatile, fast, high capacity, lower power consumption). These memories are based on moving magnetic domain walls (DWs) with spin-polarized current. In addition, nanotubes can be filled with heavy metal core. Such a core-shell structure can be used for exploitation of spin-polarized effects for domain wall motion which is more efficient than conventional magnetic field-driven motion. Domain wall speed above 1 km/s was predicted in the literature.

We have already succeeded in fabricating nickel nanotubes by electrochemical deposition into nanoporous alumina templates using a porous electrode. Such nanotubes have 50 nm in (outer) diameter and length up to 50 µm.

Only a few reports on such a small and long nanotubes existed in the literature prior to this. Domain walls will be nucleated and studied by magnetic force microscopy and synchrotron techniques (XMCD-PEEM). Later, a heavy metal core (Pt, W) will be added and the motion of domain walls under magnetic field and spin-polarized currents will be explored. Experiments will be supported by simulations combining micromagnetism and spin diffusion.

The goal of the project is to probe domain wall motion in nanotubes as the acquired information (e.g. domain wall speed), which is crucial for potential use of nanotubes in future magnetic memories.



Bundle of fabricated nickel nanotubes

Collaboration: Prof. Julien BACHMANN (University of Erlangen - Germany) : Advanced ERC grant expanding this topic is under writing.

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