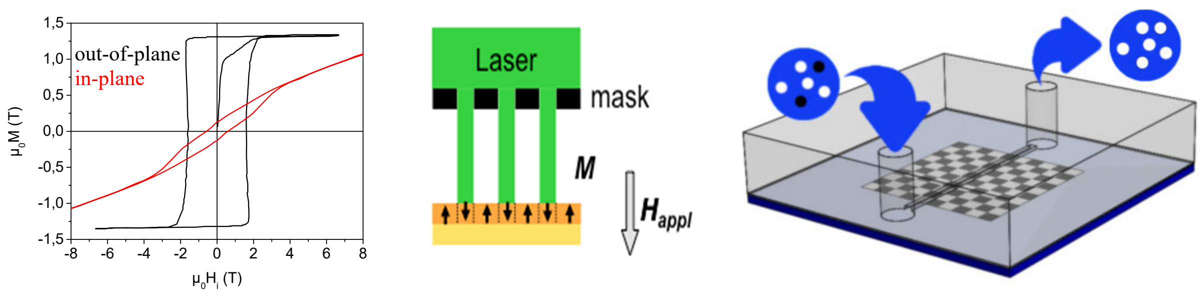
TP60 - Fabrication of a micro-fluidic device with integrated micro-magnets to manipulate magnetic nanoparticles

Thibaut Devillers and Nora Dempsey, Institut Néel, CNRS/UGA

Magnetophoresis refers to the motion of an object under the influence of an inhomogeneous magnetic field and is exploited for the manipulation (trapping, separation, mixing. transportation…) of biological species [1]. As a source of magnetic flux, hard magnetic materials have the advantage to be autonomous, meaning they are active without a power supply (unlike coils) and without an externally applied magnetic field (unlike soft magnets). The magnetophoretic force acting on an object, given by $F_m = M.V.\nabla B$, (V being the volume M the magnetization of the object and B the magnetic induction), can be maximized by increasing the field gradient (∇B), through a reduction in the size of the flux source. Therefore, micro-magnets are an exceptionally powerful driving force for magnetophoresis at microscale.

- The first part (4h) of the practical is dedicated to the fabrication of hard micromagnets through the following process : thick hard magnetic NdFeB film growth by high rate triode sputtering [2], micro-patterning using the Thermo-Magnetic-Patterning (TMP) technique [3], and magnetic characterization.
- The second part (4h) of the practical is dedicated to the fabrication of polymer-based micro-fluidic chips embedding micromagnets into a microfluidic channel, and their use for trapping and manipulation of magnetic micro/nanoparticles in a fluid [4].



Left: Magnetic hysteresis loops of a 5 µm thick NdFeB film; **centre:** local patterning of a hard magnetic film using the TMP technique; **right**: PDMS µ-fluidic device with integrated µ-magnets for particle manipulation.

[1] M.A.M. Gijs, F Lacharme, and U. Lehmann, *Chem. Rev*. 2010**,** **110**, 1518
[2] N.M. Dempsey, A. Walther, F. May et al., *Appl. Phys. Lett.* 2007, **90** 092509
[3] F. Dumas-Bouchiat, L.F. Zanini, M. Kustov, et al., *Appl. Phys. Lett.*, 2010, **96**, 102511
[4] L.F. Zanini, N.M. Dempsey, D. Givord, et al., *Appl. Phys. Lett.,* 2011, **99**, 232504