

DE LA RECHERCHE À L'INDUSTRIE

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Projet
Valorisation

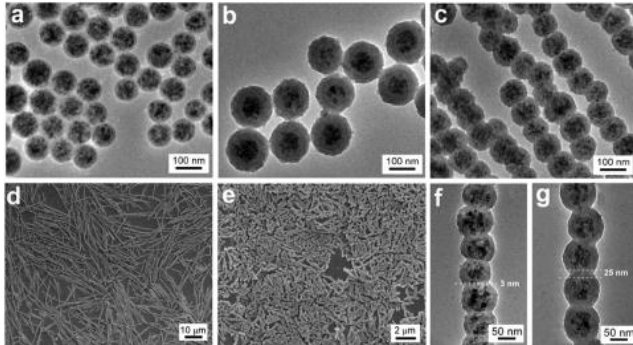
CARTOGRAPHIE LOCALE DE LA SUSCEPTIBILITÉ MAGNÉTIQUE (CALM)

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Fermon¹

¹ SPEC - CEA Saclay – CNRS UMR3680, 91191 Gif-sur-Yvette, France

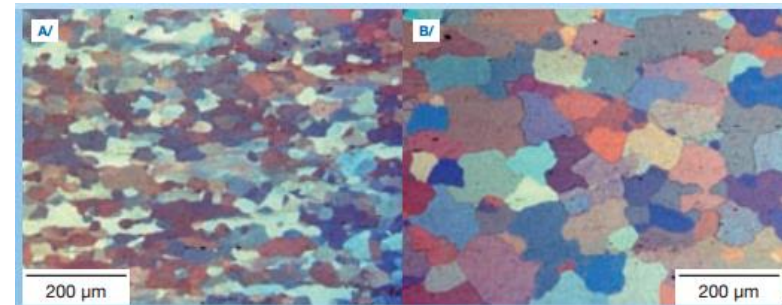
² CEA LIST, 91191 Gif-sur-Yvette, France

Magnetic nanoparticles



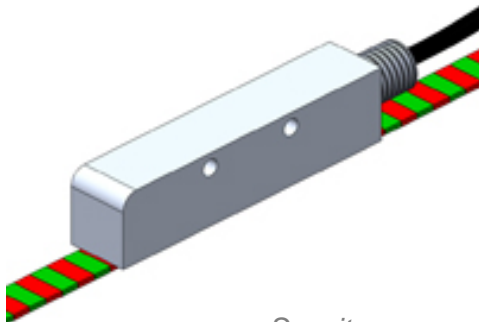
Chemistry of Materials 27(8):3071 (2015)

Material science (ex: steel)



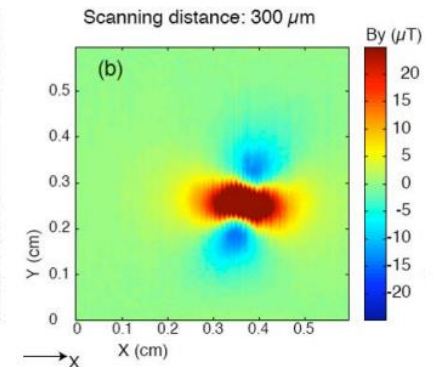
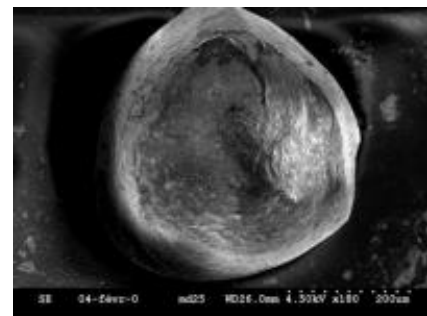
**Ugitech*

Magnetic encoders



*Sensitec
EMPIR*

Geology - paleomagnetism

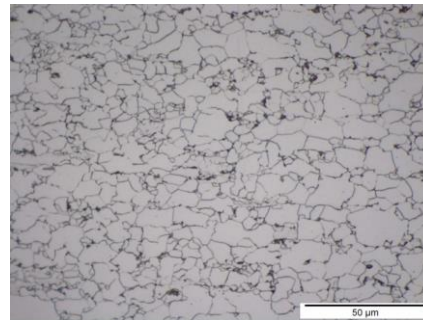


Meteorite (450μm)

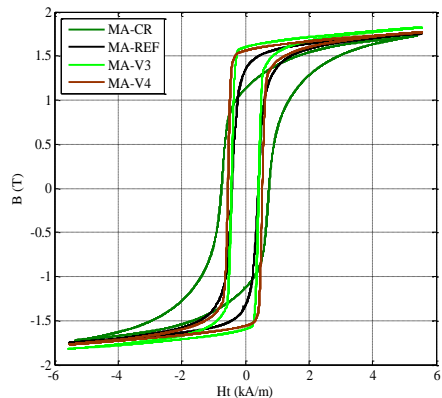
NON-DESTRUCTIVE CHARACTERIZATION OF MATERIALS

Chemical composition, heat treatment, mechanical treatment, density of dislocations., ...

Microstructure



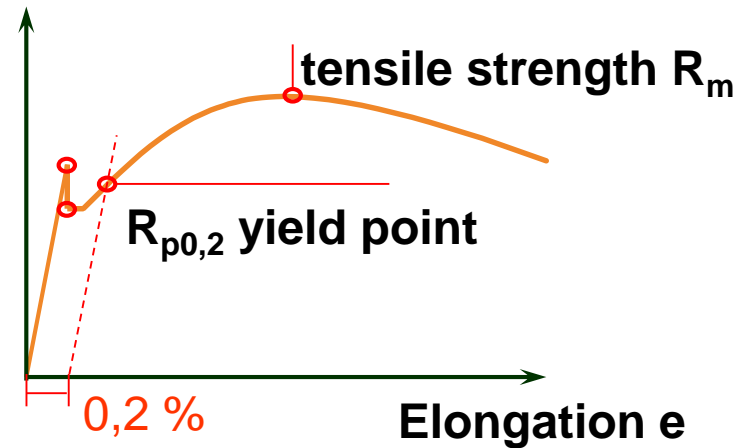
EM properties



$B(H)$, μ_{inc} , BN ,

...

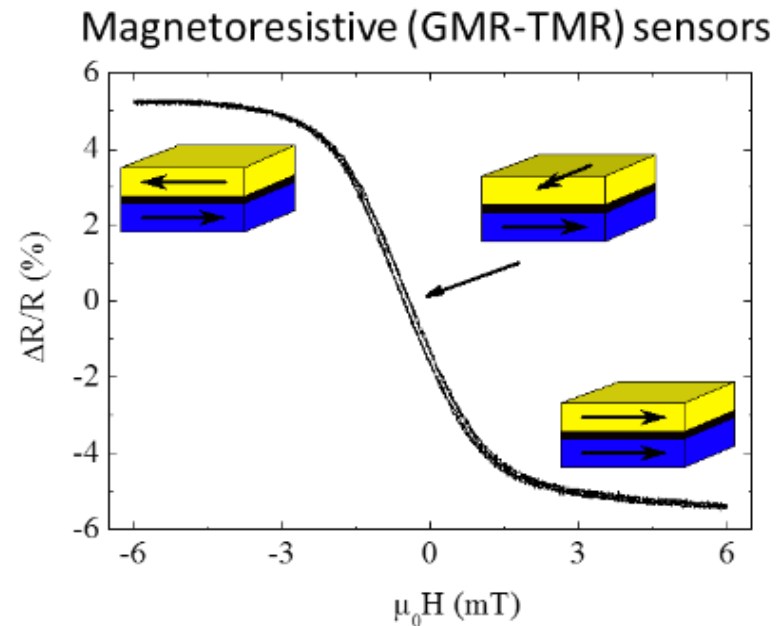
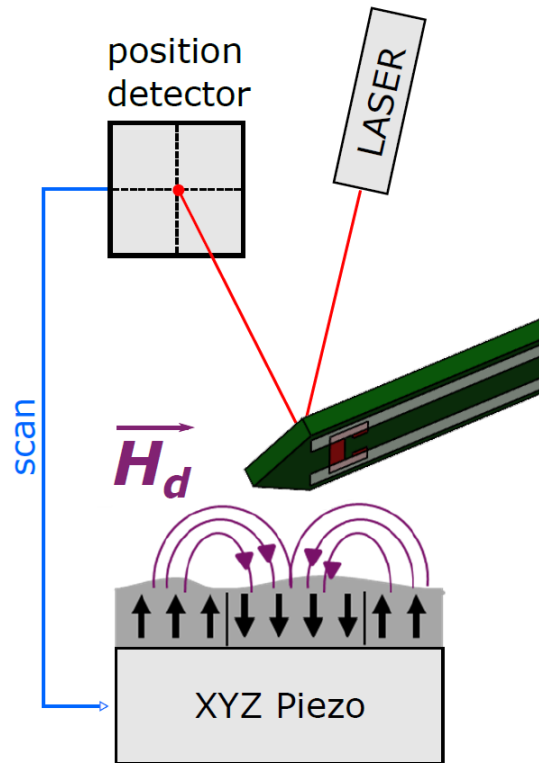
Strain



Shear force, hardness, ...

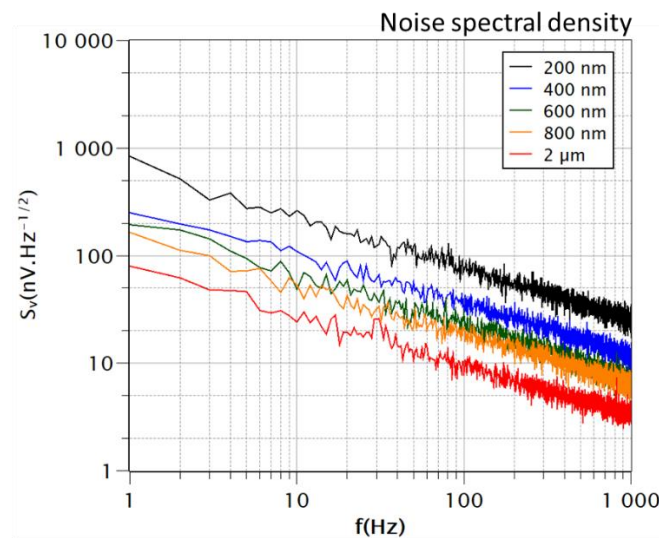
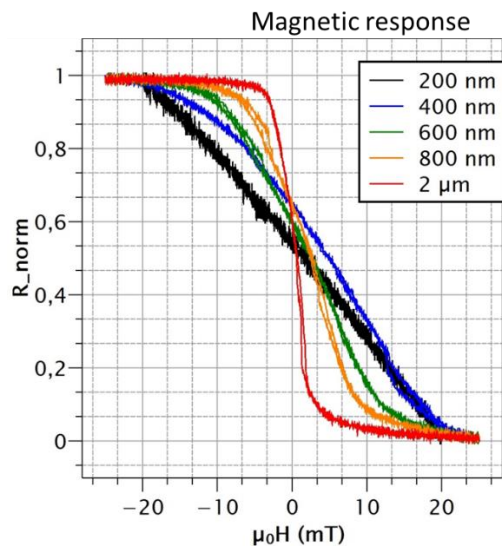
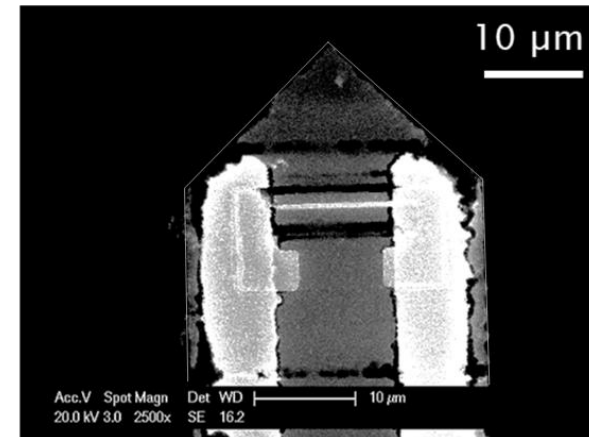
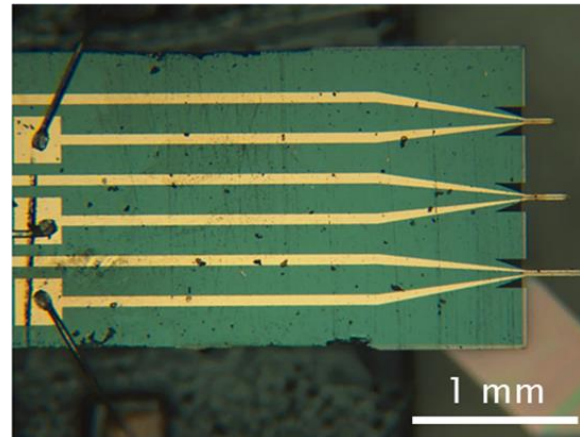
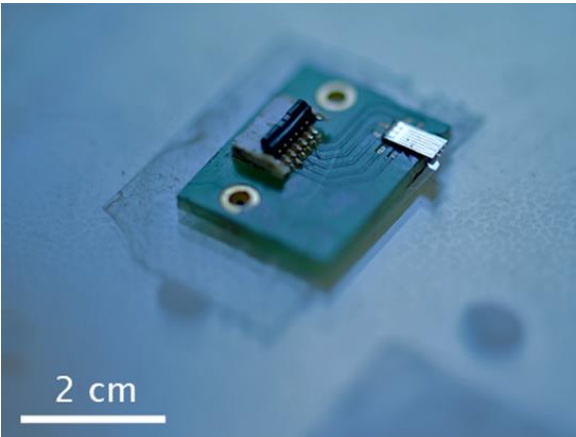
SMALL SCALE IMAGING – LOCAL PROBE MICROSCOPE

Magnetoresistive sensor (MR) + scanning probe microscope (SPM)



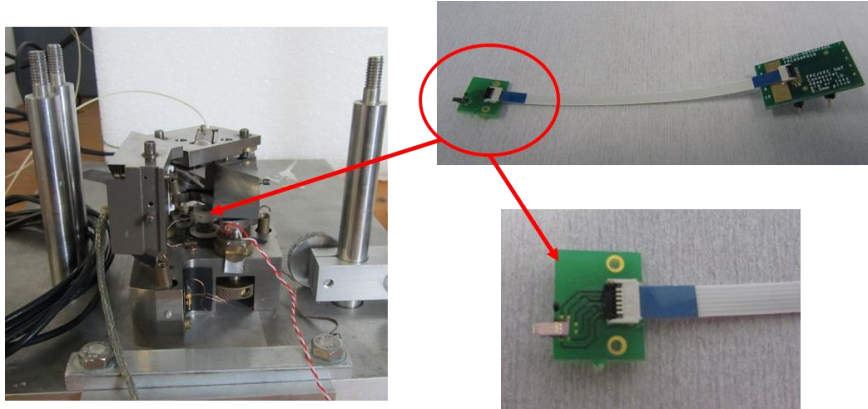
AIM : image the leakage fields emitted by the sample
With a submicrometric resolution
In AC – susceptibility up to MHz
=> Prototype

FABRICATION OF NANOGMRS INTEGRATED IN FLEXIBLE CANTILEVERS

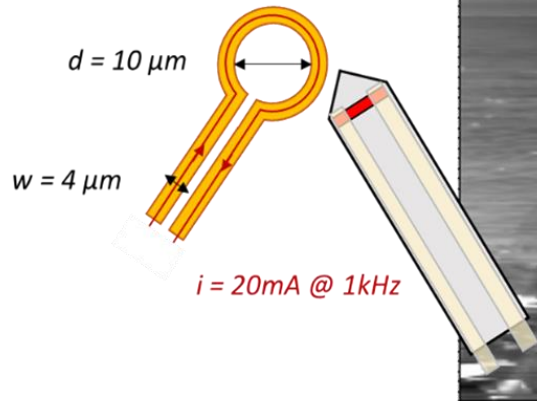


Detectivity of the
500nm GMR:
1 μ T à 10Hz

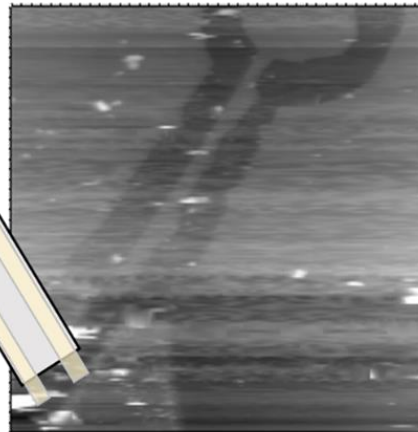
MR-SCANNING PROBE MICROSCOPE – RESOLUTION < 1MM



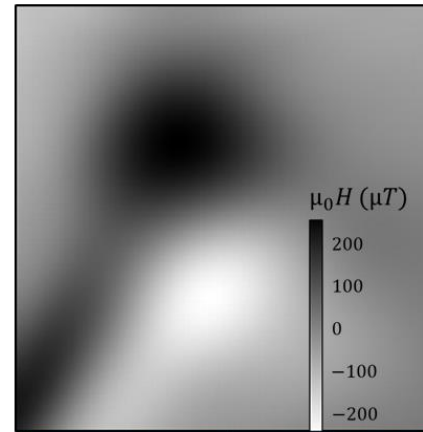
gold coil ($t_{Au} = 50nm$)



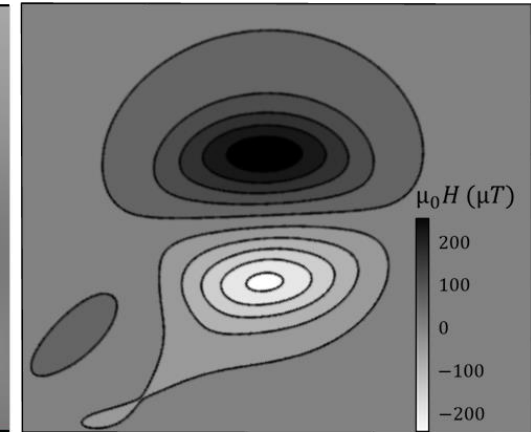
Topography



GMR signal (width 500 nm)



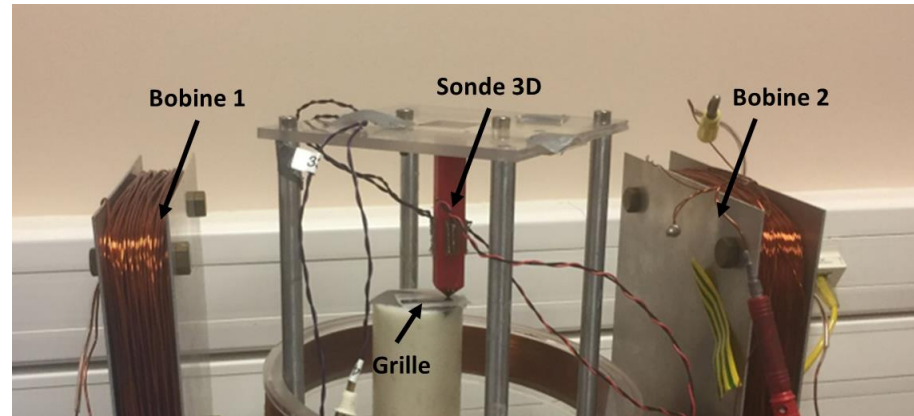
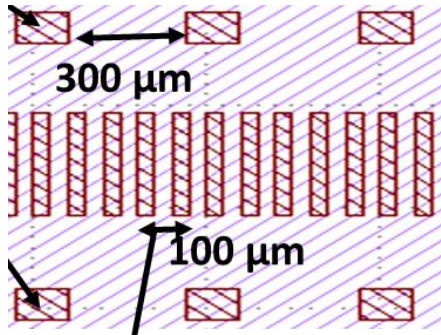
simulations



Next: higher frequency susceptibility measurement

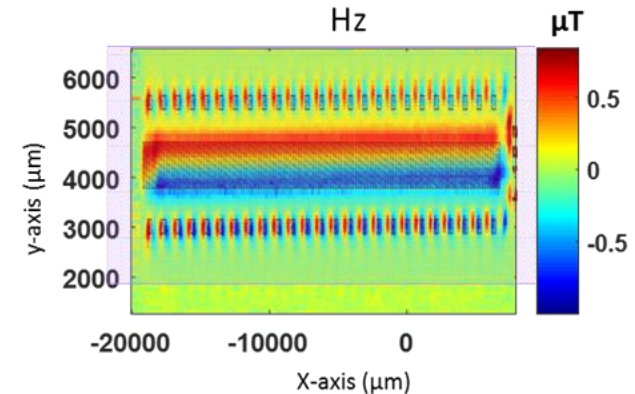
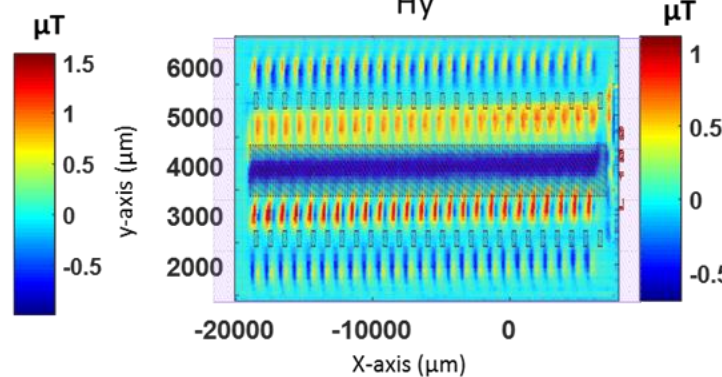
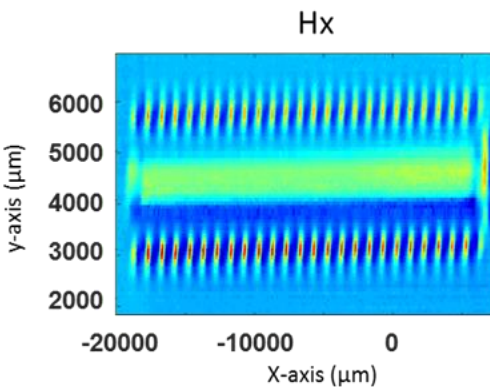
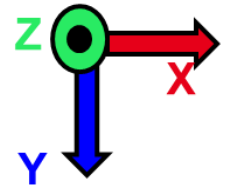
CARTOGRAPHY AT LARGER SCALE AND LARGER FREQUENCY – 3D SCANNER

NiFe squared grid



$$\vec{M} = \chi_m \cdot \vec{H}$$

Susceptibility



**Next: higher frequency (MHz)
GMR – sample distance control**



CARTE project

Lateral resolution

- sensors of the order of 100nm
- TMR sensors

The generation of an AC field in a frequency regime ranging from DC to 100 MHz

The detection system in the same frequency regime

=> Aim to make a prototype

- **Distribution of the instrument to a distributor.** We are trying to start a collaboration with Bruker.
- **Contact with Dassault** for CND and material analysis
- **Manufacture of sensors.** A transfer with Crivasense Technologies on sensor manufacturing can be considered.
- **Simulation and image analysis software.** An implementation in the CIVA software and a potential diffusion by the partner EXTEND, distributor of the software, can be considered. Collaboration with the LIST.
- **Patent "** Magneto-resistive stack without radiated field, sensor and magnetic mapping system including such a stack " filed (BD19517)

Valorisation:



CALM 2018-2019



CALM 2018-2019



Nanomag 2016-2019



CARAMEL 2018



Andrin Doll- project 165238



PhD « Phare
amont-aval »

Thank you for your attention