

## Nanostructured magnets : a bottom-up approach combining liquid-phase synthesis and magnetophoresis-assisted capillary assembly

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The fabrication of micrometric magnetic materials and their integration into portable devices reveal great interests for telecommunications, automotive, biomedical and space applications, but still remain highly challenging.

The bottom-up approach for nanostructured magnets is an interesting alternative route to the classical rare earth metallurgy or thin film deposition. Indeed, the recent progresses in the magnetic nanoparticle synthesis allow a good control of the particle size, shape and chemical composition. For instance : - single-crystalline Co nanorods (NRs), which combine a high magnetization and a large magnetic anisotropy could be prepared by the polyol process [1]. These anisotropic particles constitute building blocks of primary choice for permanent magnet applications. [2]

- spherical and fairly air-stable iron-based nanoparticles (Fe<sub>2</sub>C NPs) were prepared by organometallic approach and display soft magnetic properties (high magnetization and low anisotropy), ideal for inductors. [3]

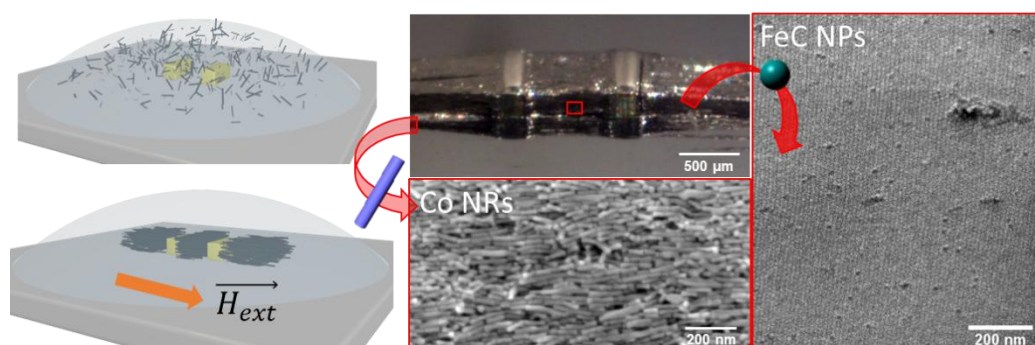
We reported recently a versatile approach for the fabrication and direct integration of nanostructured magnetic materials of controlled shaped at specific locations onto silicon substrates [4]. The magnetophoresis-assisted capillary assembly of magnetic nanoparticles, either spherical or anisotropic, leads to the fabrication of high-performance Co-based permanent magnets and Fe-based supercrystals. Integrated submillimeter magnets as well as millimetric self-standing magnets exhibiting magnetic properties were obtained [4]. In-situ characterizations are presently conducted in order to understand the physical mechanisms at play : self-assembly, magnetophoresis and drying.

[1] E. Anagnostopoulou et al., *Nanoscale* **8**, 4020 (2016)

[2] S. Ener et al., *Acta. Mater.* **145**, 290 (2018)

[3] J. M. Asensio et al., *Nanoscale* **11**, 5402 (2019)

[4] P. Moritz et al., *ACS Nano* **15**, 5096 (2021)



**Figure 1.** Schematic view of the magnetophoresis-driven assembly process. Optical and Scanning Electron Microscopy (SEM) images of nanostructured magnets prepared from Co NRs or Fe-based NPs. electron