

2. Self-assemblies and new hybrid architectures

Anisotropic nanoparticle networks for permanent magnets

During the period 2014-2019, in collaboration with F. Ott (CEA-LLB), J.-Y. Piquemal (ITODYS) and O. Gutfleisch (Darmstadt, Germany), in the framework of the European project [REFREEPERMAG](#) (2012-2015) we continued working on the synthesis of anisotropic magnetic particles and their dense assemblies which are characterized by permanent magnetic properties. We have (a) optimized the growth of cobalt nanorods to precisely control their shape and diameter and consequently their magnetic anisotropy ([Nanoresearch 2015](#)), (b) extended the synthesis to 5g batches for consolidation experiments at Darmstadt, and (c) modified their surface to make them compatible with consolidation processes ([Chem Mater 2016](#)). We have shown that the energy product (figure of merit of a permanent magnet) of cobalt nanorod assemblies could reach 160 kJ.m^{-3} , a value much higher than that of hexaferrites and AlNiCo alloys ([Nanoscale 2016](#)). We have also shown that the pre-aligned cobalt nanorods were adapted for very high pressure consolidation experiments (up to 1 GPa) but limiting the temperature, to obtain dense and nanostructured materials in which the magnetic volume fraction could reach and exceed 50% ([Acta Mater 2018](#)) (Fig. 1). This activity has been continued during a PhD thesis co-directed with T. Leichlé (LAAS) and defended in October 2019, for the production of milli- and sub-millimetric magnets integrable in MEMS devices. This work has led to the filing of a patent in December 2018. It will continue with a valorization of the patent, through a new PhD thesis started in 2019 in co-direction with T. Ondarçuhu (IMFT) and in the framework of the ANR project POMADE bringing together the LAAS, the IMFT and the team of N. Dempsey of the Néel Institute.

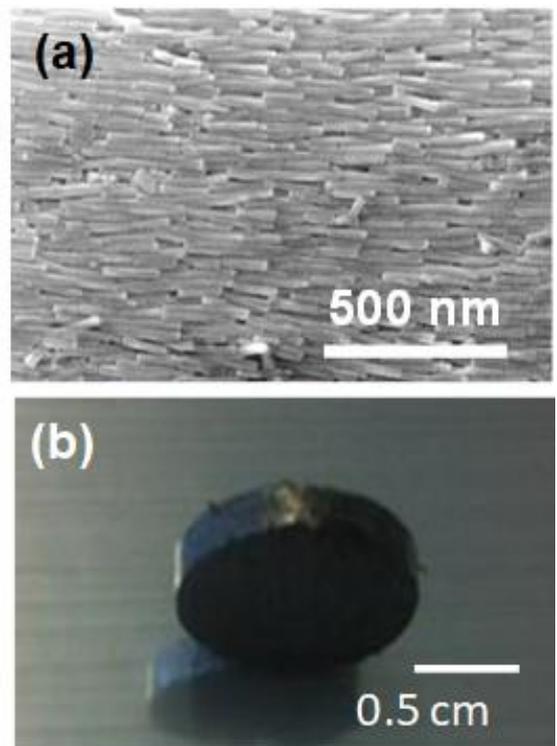


Fig. 1 : (a) MEB image of a dense assembly of Co NRs; (b) example of a permanent macroscopic magnet obtained by compacting the NRs.