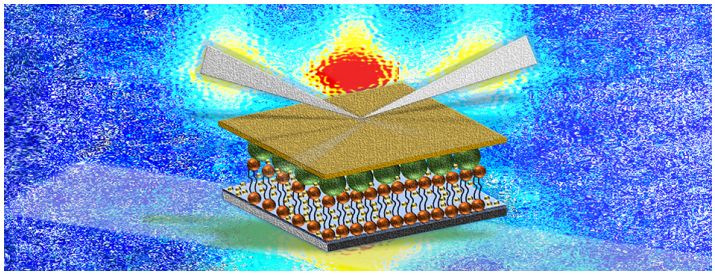

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Magnetic morphology of multishell nanoparticles

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The magnetism exhibited by magnetic nanoparticles (MNPs) is of intense research interest. These nanoscale materials exhibit complex magnetic behaviour, which is essential in the proposed applications, ranging from spintronics and catalysis to biomedicine, where they found their usage as contrast agents in imaging techniques or innovative cancer treatment (hyperthermia) [1]. For these purposes, broadly known iron oxide MNPs were thoroughly investigated in the past. However, we present a novel candidate, the ε-Fe3N, having unprecedented magnetic properties in bulk form, surpassing classical MNPs of iron oxides. In this contribution, we will present an in-depth characterization of passivated ε-Fe3N MNPs with a mean particle diameter of 17.2(2) nm. Unexpectedly, macroscopic magnetization measurements revealed low saturation magnetization (MS ≈ 40 emu/mg) compared to the bulk counterpart [2]. To sufficiently resolve the complex magnetic nature of passivated ε-Fe3N MNPs, the magnetic small-angle scattering with incident beam polarization at the D33 instrument at ILL [3] was employed to probe magnetic scattering fluctuations within MNPs. Finally, we will show the radial distribution of nuclear scattering density, reveal the magnetic morphology of passivated ε-Fe3N MNPs, disentangle magnetization contributions from the magnetic core and shell, and ultimately discuss the resulting magnetic response of the MNPs.

[1] M. L. Bauer, et al., Nanoscale, 24, 12162 –12169 (2016).
[2] I. Dirba et al., J. Phys. D: Appl. Phys, 56, 025001 (2023).
[3] Hricov S., et al., Unmasking the Complex Core-Multishell Morphology of Magnetic Nanoparticles. Institut Laue-Langevin, proposal No. DIR-297 (2023).

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