3D NANOARCHITECTURES
FOR FLUXONIC AND MAGNONIC FUNCTIONALITIES

Oleksandr V. Dobrovolskiy

Superconductivity and Spintronics Laboratory,
Nanomagnetism and Magnonics, Faculty of Physics, University of Vienna, Austria
e-mail: Oleksandr.Dobrovolskiy@univie.ac.at

Extending 2D structures into the third dimension has become a general trend in various areas, including photonics, plasmonics and nanomagnetism. This approach provides a means to modify conventional and to launch novel functionalities by tailoring vector potentials inducing anisotropic and chiral effects. In magnetism [1,2], curvilinear geometry brings about two exchange driven interactions - effective anisotropy and antisymmetric vector exchange, i.e. an effective Dzyaloshinskii-Moriya interaction. In the case of superconducting nanostructures [3,4], the combination of low-dimensionality with a curvilinear geometry allows in principle for the observation of topology-driven effects, such as unconventional phase slips, reversible and irreversible switching, fractional flux-flow instabilities, and the Berezinskii-Kosterlitz-Thouless transition.

In my talk, I will introduce focused ion and electron beam-induced deposition, FIBID and FEBID, respectively, as direct-write techniques suitable for the fabrication of free-standing 3D nanoarchitectures with a resolution in the sub-nm range vertically and 10-20 nm laterally [5]. In particular, I will outline selected proof-of-concept experiments, technological limitations, and future prospects of using 3D hybrid ferromagnet / superconductor structures with pre-defined shape and curvature in microwave engineering [6] and such research areas as magnon fluxonics [7] and superconducting spintronics [8,9].

Research leading to this results has received funding from the DFG in the framework of the Collaborative Research Center SFB/TRR-173 Spin+X (Project B04) and Personal Grant 374052683 (DO1511/3-1). Furthermore, support from the European Commission within the framework of the MSCA-RISE program under Grant Agreement No. 644348 (MagIC) and COST Action CA16218 (NANOCOHYBRI) of the European Cooperation in Science and Technology is acknowledged.

[1] Fernández-Pacheco et al. Nat. Comm. **8** (2017) 15756.
[2] Streubel et al., Nat. Commun. **6**, 7612 (2015).
[3] Lösch et al. ACS Nano **13**, (2019) 2948.
[4] Cordoba et al. Nano Lett. (2019) 10.1021/acs.nanolett.9b03153
[5] Huth et al., Microelectron. Engin. **185-186** (2018) 9.
[6] Dobrovolskiy et al., Nat. Comm. **9** (2018) 4927.
[7] Dobrovolskiy et al., Nat. Phys. **15** (2019) 477.
[8] Jeon et al., Nat. Mater. **17** (2018) 499.
[9] Chumak et al., Nat. Phys. **11** (2015) 453.