ED3-2-INV

Topological superconductivity – new materials for novel devices

*Peter Schüffelgen[1], Daniel Rosenbach[1], Tobias W. Schmitt[1], Michael Schleenvoigt[1], Abdur R. Jalil[1], Gregor Mussler[1], Chuan Li[2], Alexander Brinkman[2], Thomas Schäpers[1], Detlev Grützmacher[1]

Peter Grünberg Institute, Forschungszentrum Jülich & JARA Jülich-Aachen Research Alliance, Jülich, Germany[1]
MESA+ Institute, University of Twente, Enschede, The Netherlands[2]

The interplay of induced superconductivity and Dirac physics at the interface of an s-wave superconductor (S) and a 3D topological insulator (TI) turns the surface of the TI into a 2D topological superconductor. Different to conventional superconductors, topological superconductors host exotic subgap states – so-called Majorana modes – at zero energy. In order to employ Majorana modes in future fault-tolerant topological quantum computers, high quality S–TI hybrid devices are required. For achieving pristine interface quality we exploit stencil lithography for full *in situ* fabrication of S–TI hybrid devices via molecular-beam epitaxy. As-prepared Josephson junctions show highly transparent S-TI interfaces and Shapiro response measurements indicate the presence of gapless Andreev bound states, so-called Majorana bound states. To move from single junctions towards complex circuitry for future topological quantum computation architectures, we monolithically integrate two aligned hard masks to the substrate prior to molecular-beam epitaxy. The so-called Jülich process allows to fabricate complex networks of topological insulators and superconductors *in situ* with nm precision.

[1] Schüffelgen P., et al. "Selective area growth and stencil lithography for in situ fabricated quantum devices." *Nature nanotechnology* (2019).

Keywords: Topological superconductivity, Majorana, Topological insulator, Molecular-beam epitaxy