SEVENTH FRAMEWORK
PROGRAMME

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Collaborative Project

CNTQC

Project title:	**Curved Nanomembranes for Topological Quantum Computation**
Project number:	**618083**
Project coordinator:	**Leibniz-Institut für Festkörper- und Werkstoff-forschung Dresden e.V., Germany**
Project homepage :	http://www.nano2qc.eu/
HZDR participant:	**Institute of Ion Beam Physics and Materials Research**
Starting date:	**01.06.2014**
Duration (months):	**36**

Summary

Topological quantum computation, based on the encoding of quantum information in non-local degrees of freedom, provides a promising route for a working quantum computer not affected by quantum decoherence. A possible way of realizing this non-locality is to encode qubits into so-called Majorana fermions - quantum particles that are their own antiparticles. As an elementary particle, Majorana fermion is a hyphotetical object. However in condensed matter it can be built out of what nature offers us: electron and hole excitations.

Recently a number of experimental setups have been proposed to support Majorana zero modes, among which are planar superconductor-semiconductor heterostructures and superconductor-topological insulator hybrids. Despite the fact that such solid-state-devices consist of rather "conventional" building blocks, the actual experimental observation of Majorana fermions is still the biggest challenge in the field. The experimental difficulty stems from a required, very delicate fine-tuning of intrinsic materials parameters, e.g. strength of the Rashba spin-orbit coupling, and external physical quantities, e.g. strength of externally applied magnetic fields.

The aim of CNTQC is to overcome these hurdles by designing, fabricating and testing novel platforms where strong curvature-induced quantum effects can generate the requirements of the Majorana fermion's cocktail in a controlled manner. The pursued approach will exploit modern nanostructuring technology to transform very thin nanomembranes into three-dimensional nanoarchitectures with a strongly curved geometry.

The combined experimental and theoretical understanding of the geometrically-induced topological superconducting state aims to pave the way towards a direct demonstration of the existence of Majorana fermions in these curved solid-state devices. This concept sets a stage for the generation of versatile platforms for topological quantum computation.