INSTITUT NEEL Grenoble

PhD grant

HYBRID SUPERCONDUCTING NANOWIRES FOR QUANTUM DEVICES

Context :

Progress in quantum technologies goes hand in hand with development of advanced materials and nanostructures. New combinations of superconducting and semiconducting materials are attractive for a range of quantum applications. The objective of the project is to **construct optimal, tunable superconductor semiconductor junctions for electronic quantum devices**. Such junctions will be useful for solid state quantum computers where the tunability of the semiconducting element allows for new types of superconducting quantum bits (qubits). The archetypical device is the gate tunable Josephson junction that has recently been shown to work in different qubit architectures.

As the primary platform for making such devices we will grow hybrid nanowires where the semiconducting core is coated with superconducting layers, exploring hitherto unexploited materials combinations. This project combines **activities on materials growth, electron microscopy, x-ray diffraction and low-temperature transport measurements**, bridging together materials science, solid state physics and quantum technology.

Objectives and means available :

The PhD student will be trained in synthesis and characterization of new nanomaterials and involved in their application in quantum devices. The student will carry out growth of semiconductor nanowires in a III-V molecular beam epitaxy reactor and coat these with superconducting shells such as Al, Ta, and MoGe. New hybrid materials and experimental setups will be developed during the project. Templates for the nanowire growth will be made in the CNRS cleanroom by electron beam lithography. The student will perform initial characterization of the samples by SEM, and combine this with structural characterization by advanced electron microscopy and other techniques (TEM, EDX, XRD). Together with partner labs, the student will in turn take part in device fabrication and low temperature measurement campaigns to probe superconductivity and quantum transport phenomena.

This project is part of the LANEF Chair of Excellence on Hybrid materials for quantum devices lead by Jesper Nygard from Niels Bohr Institute, Copenhagen, DK.

Main activities :

Fabrication of ultrathin superconducting films and nanostructures, Patterning of nanowire arrays by electron beam lithography, Nanowire growth by molecular beam epitaxy, Device fabrication and cryogenic electronic transport measurement, Structural characterizations by transmission electron microscopy

Possible collaboration and networking :
CEA-IRIG-Pheliqs, Niels Bohr Institute (Copenhagen), University of Pittsburgh (USA), University of California in Santa Barbara (USA)

Required profile : Motivated experimentalist, Cleanroom fabrication or electron microscopy, Crystal growth by Molecular Beam Epitaxy, Physics background, e.g. condensed matter

Foreseen start for the grant : 10/2022
Amount : 1680 €/month, including healthcare insurance (income tax to be deduced)
Duration : 36 months

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