NÉEL INSTITUTE Grenoble

Topic for Master 1 internship – Academic year 2022-2023

Quantum transport in superconducting/semiconducting Al/Ge/Al heterostructure

General Scope :

The internship is motivated by our recent investigations of the ultra-scaled hybrid superconducting/semiconducting aluminum/germanium (Al/Ge) devices. By tuning a gate voltage, they reveal a very rich quantum electronic physics ranging from single charge quantum dot, Coulomb diamonds to proximitized superconductivity. These properties were achieved thanks to the unique monolithic monocrystalline Al/Ge/Al nanowire heterostructure with remarkable atomically sharp interfaces between Al and Ge [1]. These promising devices open the way towards quantum technologies in particular superconducting gatemon qubit or the study of Majorana fermions.

[1] Al–Ge–Al nanowire heterostructure: from single -hole quantum dot to Josephson effect,
J. Delaforce, M. Sistani, et al, Advanced Materials, Wiley-VCH Verlag, 2021, 33 (39), 2101989 (2021).

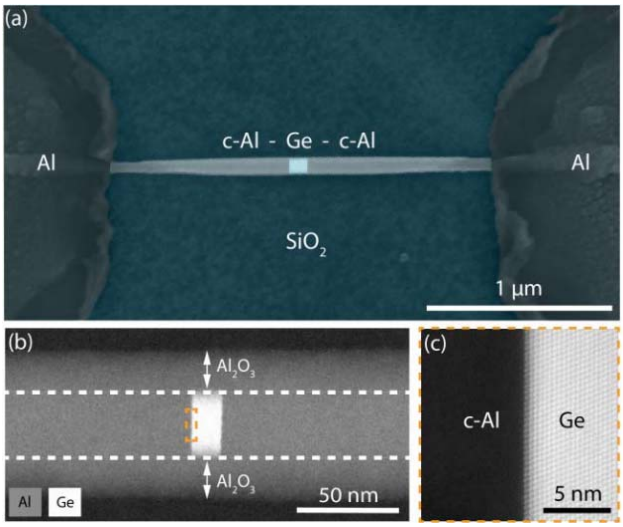

Figure 1: (a) SEM image of the nanowire heterostructure with self-aligned Al leads contacting a Ge segment connected to large aluminum pads deposited on SiO2 layer. (b) TEM image showing a zoom of the Al/Ge/Al heterostructure device. The central white segment is the germanium. (c) TEM image showing the Ge atoms and the atomically sharp interfaces

Research topic and facilities available :

Our research aims at exploring promising superconductor/semiconductor hybrid devices based on ultra-scaled Al/Ge heterostructures. Inside the consortium, we will develop novel quantum devices and their integration in functional quantum circuits to study gatemon superconducting qubit, Andreev qubits, multiterminal junctions. We will measure their electronic transport properties in a homemade He3 cryostat which allows to measure down to 350 mK and their qubit properties in the microwave domain in a dilution fridge.

Possible collaboration and networking : The internship proposal is related to a joint project between the Néel Institute and the Technical University of Vienna (Austria).

Required skills: Skills on solid state physics or quantum transport will be appreciated. Motivation on experimental quantum device is needed.

Starting date : March or April 2022 for internship.

Contact :

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