DRF: Thesis SL-DRF-17-0356

RESEARCH FIELD

Mesoscopic physics / Physique de l'état condensé, chimie et nanosciences

TITLE

Superconducting Circuits in Silicon Technology

ABSTRACT

A big advantage of the Silicon technology is its maturity and reliability. Incidentally, some materials used or useful in silicon based devices are superconducting at low temperature. The objective of this project is then to realize a new kind of MOSFET transistor-like devices for which the drain and sources electrodes will be superconducting. Once realized, these new quantum circuits will allow developing quantum architectures in a scalable technology.

At low temperature, a Silicon nano-MOSFET transistor behaves as a single electron transistor due to the electrostatic confinement and Coulomb interaction. This situation appears when the charging energy becomes larger than the thermal energy. On the other hand, the superconductivity is described by the condensation of a very large number of electrons pairs in a macroscopic quantum state. On a purely scientific level, the goal of this study is to understand better how antagonist properties can coexist in such hybrid devices. The objective will then be to fabricate devices like Josephson junction controlled by a gate and in which current can flow with no dissipation. These components, coupled to a capacitor, allow fabricating superconducting qubit for which the energy levels separation can be controlled by the gate. This point is important to adjust the coupling of the qubit with a superconducting cavity whose resonant frequency is fixed by the design. In many experimental situations, it is this coupling that allows reading or transferring the quantum information carried by the qubit.

From a technological point of view, the electrodes will be fabricated from superconducting silicides such as the platinum mono-silicide (PtSi) or Boron doped Silicon (Si:B) that can be superconducting using laser doping/annealing. In the case of silicides, the goal is to control the metal/semiconductor solid state reaction in order to obtain the good superconducting phase as close as possible to the transistor channel. For Si:B, the issue is to control the laser doping/annealing first on Silicon on insulator (SOI) and then on pre-existing devices without damaging them. The technological objective is to reduce the access resistances which are an important source of dissipation in commercial sub-micron transistors. It is a major issue in the micro-nano electronics industry where the energy consumption is a limiting factor for development.

In practice, the student will be part of the INAC/PHELIQS/LaTEQS laboratory and will join the DTSI/SDEP group at the CEA/LETI for the realization of simplified test structures and devices in a clean room. The low temperature measurements will be performed at the LATEQS at the CEA/INAC.

LOCATION

Institut nanosciences et cryogénie
Photonique, Electronique et Ingénierie Quantiques
Laboratoire de Transport Electronique Quantique et Supraconductivité
Place: Grenoble
Start date of the thesis: 01/10/2016

CONTACT PERSON

François LEFLOCH
CEA
DRF/INAC/PHELIQS/LATEQS
CEA
Institut Nanosciences et Cryogénie PHELIQS- LaTEQS
17 rue des martyrs 38054 Grenoble FRANCE
Phone number: +33 4 38 78 48 22
Email: francois.lefloch@cea.fr

UNIVERSITY / GRADUATE SCHOOL

Université Grenoble Alpes
Ecole Doctorale de Physique de Grenoble

THESIS SUPERVISOR

François LEFLOCH
CEA
DRF/INAC/PHELIQS/LATEQS
CEA
Institut Nanosciences et Cryogénie PHELIQS- LaTEQS
17 rue des martyrs 38054 Grenoble FRANCE