FABRICATION AND CHARACTERIZATION OF JOSEPHSON JUNCTIONS FOR PROCESS-AWARE COMPACT MODELS

Record number : OPR-1039

Overview

RESEARCH DIRECTION

Dominique Drouin, Professeur - Department of Electrical and Computer Engineering

INFORMATION

dominique.drouin@usherbrooke.ca

RESEARCH CO-DIRECTION

Max Hofheinz, Professeur - Department of Electrical and Computer Engineering

INFORMATION

max.hofheinz@usherbrooke.ca

ADMINISTRATIVE UNIT(S)

Faculté de génie
Département de génie électrique et de génie informatique
Institut quantique

LEVEL(S)

3e cycle

LOCATION(S)

Campus de Sherbrooke

Project Description

Context: Superconducting circuits are one of the leading candidates for the implementation of practical quantum computers. In this context, Canada's first semi-industrial fabrication facility for superconducting circuits will soon be established at the Institut interdisciplinaire d'innovation technologique (3IT) at Université de Sherbrooke. This will involve the elaboration of a Process Design Kit (PDK) for academic and industrial users of the facility wishing to fabricate chips according to certain specifications. An important aspect in the success of this fabrication is the capability to predict device performance before fabrication using numerical simulations to avoid excessive trial and error. While classical components like capacitors, inductors, and resonators may be modeled efficiently with commercially available finite-element codes, properties of the Josephson junction are determined by quantum transport physics at the atomistic scale.

Research project: The aim of this thesis project is to develop a compact model of Josephson junctions, including the impact of atomic defects specific to the 3IT fabrication processes. Supported by the expertise of 3IT, IQ and Nanoacademic Technologies Inc. in the fields of fabrication, finite-element and atomistic simulation for superconducting circuits, the student will have to (i) fabricate junctions in the 3IT cleanroom and measure their room-temperature and cryogenic current-voltage characteristics at the IQ Quantum FabLab, (ii) characterize the physical properties of junctions using analytical tools (atomic-force and scanning electron microscopy and more advance analytical tool (transmission electron microscopy, atom-probe tomography), (iii) collaborate with team members to fit current-voltage characteristics derived from analytic or numerical ab initio calculations, (iv) provide the experimental insights and support the integration of the Josephson junction's models into the 3IT PDK and combine it with Nanoacademic's QTCAD® software, leading to more predictive design and fabrication workflows.

Supervision & work environment: Under the supervision of Profs. Dominique Drouin and Max Hofheinz, the work will be carried out mainly at the Interdisciplinary Institute for Technological Innovation (3IT) and at the Quantum Institute (IQ) of UdeS, in close collaboration with the company Nanoacademic Technologies Inc. 3IT is a unique institute in Canada, specializing in the research and development of innovative technologies for energy, electronics, robotics and health. The IQ is a state-of-the-art institute whose mission is to invent the quantum technologies of tomorrow and transfer them to the industry. Nanoacademic Technologies Inc. is a small scientific software company based

in Montréal. Founded in 2008 as a spin-out of research done by the group of Prof. Hong Guo at the McGill Physics Department, Nanoacademic develops and distributes atomistic and quantum modeling software for material science and nanodevice engineering applications. Nanoacademic is currently leveraging its finite-element and atomistic simulation backends to develop new design tools for superconducting circuits. The student will thus benefit from an exceptional research environment that combines students, professionals, professors, and industrialists working hand-in-hand to develop the future technologies.

Researched profile:
• Masters in micro-nanofabrication, electrical or quantum engineering, or materials science.
• Strengths: knowledge of superconductivity and Josephson juctions, superconducting qubits or other superconducting devices.
• Experience with semiconductor characterization.
• Excellent adaptability, autonomy, teamwork and problem-solving skills.
• Strong taste for design, experimental cleanroom work and interdisciplinary research and development.
Contacts: jobnano@usherbrooke.ca
Documents to provide: CV, all post-secondary transcripts and references.

Discipline(s) by sector

Sciences naturelles et génie

Génie électrique et génie électronique

Funding offered

To be discussed

Partner(s)

Nanoacademic Technologies inc.

The last update was on 29 April 2024. The University reserves the right to modify its projects without notice.