

PhD fellow in 2D Quantum Materials and Superconductive Electronics.

IIT invites excellent candidates to apply to its PhD program organized in collaboration with the Open University; this international PhD program confers Doctorates in *Health, Sustainable and Human Technologies*.

In order to be admitted into the ARC program, the minimum requirements are

- i. a Masters-level degree, which broadly corresponds to a 4/5-year undergraduate MSc/MChem/Meng-style degree or to a postgraduate Masters in the British system, or to a second level University degree in Italy;
- ii. a grade corresponding to an upper second class (2.1) or a merit in the UK system or 100/110 in the Italian system. Candidates with lower grades but redeeming features (publications, specific expertise) are requested to contact the potential supervisors before applying;
- iii. where English is not the applicant's first language, a valid IELTS (International English Language Testing System) certificate. The minimum acceptable score is an overall 6.5, with no less than 6.0 in any of the four categories

One PhD fellow position **will be available from April 1st 2025** in the [2D Materials Engineering](#) Group led by Dr. [Camilla Coletti](#).

Title of the project: 2D Quantum Materials and Superconductive Electronics.

Description: The focus of the research is on Nb-based 2D materials, specifically Niobium disulfide (NbS₂) and Niobium diselenide (NbSe₂), and their application in superconducting field-effect transistors (FETs). These materials are at the forefront of materials science due to their unique properties, including superconductivity at the monolayer level[1].

Superconductivity, characterized by zero electrical resistance and the exclusion of magnetic fields, is a foundational principle in modern materials science. While numerous devices utilizing superconductivity have been theorized and implemented, challenges remain in creating scalable, high-quality materials and devices[2-4]. Traditional fabrication methods, such as sputtering, often lead to sub-optimal material quality, particularly for applications requiring precise control over thickness and purity[5]. This project aims to address these limitations by leveraging the exceptional properties of 2D transition metal dichalcogenides (TMDCs), which allow for precise control over material thickness and crystal purity.

In this research, the candidate will focus on synthesizing Nb-based 2D materials and integrating them into device architectures to create superconducting FETs. These devices will utilize electric fields to modulate superconductivity, enabling novel functionality and paving the way for potential breakthroughs in superconductive electronics. The work will involve advanced material synthesis, extensive characterization, and device fabrication in a cleanroom environment, as well as transport measurements to study the behavior of the devices under various conditions.

The project offers the opportunity to contribute to a transformative area of materials science with the potential for substantial technological impact. The successful candidate will join a dynamic, interdisciplinary research team equipped with state-of-the-art facilities, benefiting from mentorship and collaboration with leading researchers in the field.

External Reference:

- [1] Xi et al., *Nature Physics*, 12(2):139–143 (2016)
- [2] Puglia et al., *Applied Physics Letters*, 116(25) (2020).
- [3] De Simoni et al., *Nature Nanotechnology*, 13(9):802–805 (2018)
- [4] Paolucci et al., *Nano letters*, 19(9):6263–6269 (2019)
- [5] Durrell et al., *Reports on Progress in Physics*, 74(12):124511 (2011).

Main Supervisor: [Camilla Coletti](#) ([2D Materials Engineering](#))

Other Supervisor: [Antonio Rossi](#) ([2D Materials Engineering](#))

Essential expertise:

- i. Master's degree in Physics, Materials Science, or related fields, with a minimum grade of 100/110.

- ii. Experience in the growth of quantum or 2D materials.
- iii. Familiarity with cleanroom environments and transport measurements.
- iv. Strong coding skills (e.g., Python, MATLAB) are a plus. Excellent communication skills and ability to work in a collaborative, multidisciplinary team.
- v. Excellent communication skills and ability to work in a collaborative, multidisciplinary team.
- vi. Fluency in English, both written and spoken.

Desirable expertise:

- i. Synthesize Nb-based 2D materials (NbSe₂, NbS₂) using advanced techniques.
- ii. Perform detailed characterization of the synthesized materials, focusing on their superconducting properties. Develop and fabricate devices integrating these materials into superconductive FET architectures.
- iii. Develop and fabricate devices integrating these materials into superconductive FET architectures.
- iv. Conduct transport measurements and analyze device behavior under gating conditions.
- v. Collaborate with team members, contributing to the overall progress of the project.
- vi. Present findings in conferences and prepare high-impact scientific publications.

How to apply. Prospective students must submit using [the online form](#) the following documents

- 1) 2-page CV, which includes studies, expertise and achievements.
- 2) 1-page research statement, which includes the choice of a project from the list above and a justification of the choice. Only if robustly justified, the student may signal their interest also for a second project, but there is no guarantee that this will be taken into account by the selection panel.
- 3) A transcript of undergraduate and postgraduate studies.
- 4) A valid IELTS certificate, obtained no more than two years before the proposed registration date.
- 5) Contact details of two referees.

Deadline for application: January 29th 2025.

Istituto Italiano di Tecnologia, with its headquarters in Genoa, Italy, is a non-profit institution with the primary goal of creating and disseminating scientific knowledge and strengthening Italy's technological competitiveness. IIT's research endeavour focuses on high-tech and innovation, representing the forefront of technology with possible application from medicine to industry, computer science, robotics, life sciences and nanobiotechnologies.

Istituto Italiano di Tecnologia is an Equal Opportunity Employer that actively seeks diversity in the workforce.

Please note that the data that you provide will be used exclusively for the purpose of professional profiles' evaluation and selection, and in order to meet the requirements of Istituto Italiano di Tecnologia. Your data will be processed by Istituto Italiano di Tecnologia, based in Genoa, Via Morego 30, acting as Data Controller, in compliance with the rules on protection of personal data, including those related to data security.