UHV-NEQ : Chambre Ultra-Vide de dépôts métalliques pour la Nano-Electronique Quantique

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EQUIPMENTS

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The NEQ-UHV equipment has been developed to fabricate several original devices based on high quality superconducting and metal films. For example we optimize superconducting quantum interference devices (SQUID) based on Nb films in terms of sensitivity, ease of fabrication [1] and operation, or operating temperature and magnetic field range through a thorough understanding of their electro-thermal behaviour [2,3]. For the optimization of Nb nanobridge SQUID (Fig. 1), we demonstrated controlled nanoconstrictions using a sequential repetition of customized electro-annealing steps [4,5]. Superconducting vortex dynamics and its dissipation have also been studied in a Nb/insulator/metal multilayer structures [6]. Finally Nb microwave coplanar resonators patterned onto silicon nitride wafers are used as quantum-limited position detectors for the study of a nanomechanical (NEMS) beam at ultra-low temperature (Fig. 2).

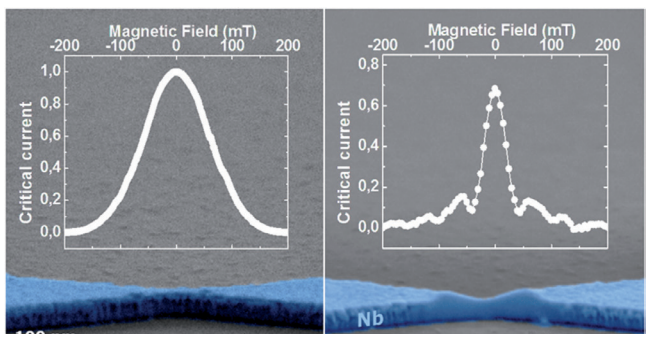

Fig1: Nb constriction before and after sequential electro-annealing [4]. Fraunhofer-like field dependence of the critical current indicates the formation of a weak link.

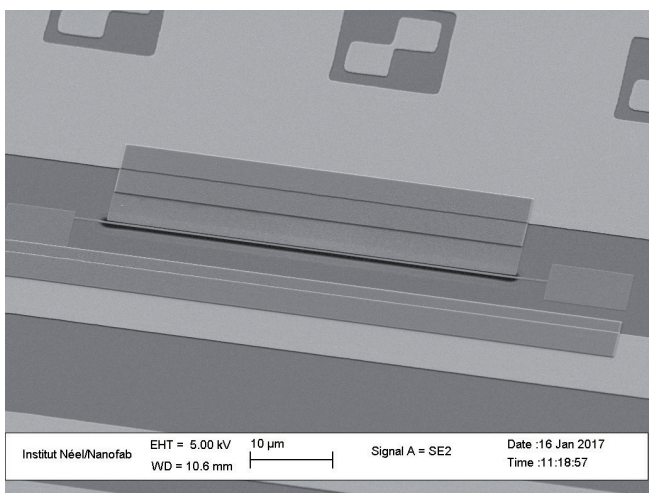

Fig2: Nanobeam NEMS inserted in a coplanar Nb microwave resonator.

We have also implemented the epitaxial growth of rhenium on a sapphire substrate in order to realize quantum circuits and quantum resonators with higher coherence time. Through X-ray diffraction, the Re films show an epitaxial relationship with the substrate and a narrow rocking curve. From these films we realized and studied nanowires down to 50 nm to characterize their superconducting properties and evaluate quantum effects.

OUTCOMES

Publications :

[1] "Niobium-based superconducting nano-device fabrication using all-metal suspended masks", Nanotechnology 24, 375304 (2013).

[2] "Reversibility Of Superconducting Nb Weak Links Driven By The Proximity Effect In A Quantum Interference Device", Phys. Rev. Lett. 114, 157003 (2015).

[3] "Controlling hysteresis in superconducting constrictions with a resistive shunt", Supercond. Sci. Technol. 28, 072003 (2015).

[4] "Healing Effect of Controlled Anti-Electromigration on Conventional and High- T c Superconducting Nanowires," Small, 13, 1700384, (2017).

[5] "In situ tailoring of superconducting junctions via electro-annealing," Nanoscale, 10, 4, (2018).

[6] "Imprinting superconducting vortex footsteps in a magnetic layer," Sci. Rep. 6, 27159 (2016)

[7] "Interplay between electron overheating and ac Josephson effect", Phys. Rev. B 93, 180505(R) (2016).

[8] "Magnetic flux penetration in Nb superconducting films with lithographically defined microindentations," Phys. Rev. B, 93, 054521 (2016).

[9] "Flux penetration in a superconducting film partially capped with a conducting layer," Phys. Rev. B, 95, 1 (2017)

[10] "Quantitative magneto-optical investigation of superconductor/ferromagnet hybrid structures," Review of Scientific Instruments, 89, 023705, (2018)

[11] "Josephson coupling in the dissipative state of a thermally hysteretic µ-SQUID", arXiv:1709.02569.

Leverage :

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