Institut de Recherche
Interdisciplinaire de Grenoble

Pheliqs
Quantum Physics & Engineering

Université Grenoble Alpes

Master 2 internship

Hybrid nanomechanics with a semiconductor quantum dot

Background. Thanks to recent progress in nanotechnology, it is now possible to couple a two-level, atomic-like system to a mechanical oscillator. Such hybrid systems are currently attracting a lot of interest, as they enable to realize new sensors with quantum-enhanced readout and constitute a powerful platform for quantum information technologies. Our team has made pioneering contributions to the field, by coupling a semiconductor quantum dot – an optically-active artificial atom – to a vibrating microwire [1-5].

However, experiments focused so far on the fundamental vibration mode of the microwire, whose frequency is too small (~1 MHz) to reach the so-called “resolved-sidebands regime”. The latter enables an optical control of the mechanical oscillator, unlocking many intriguing possibilities including optical cooling, phonon lasing or coherent mechanical control.

Project. This Master 2 internship will explore two parallel tracks to achieve the resolved-sidebands regime. The first track will investigate experimentally the mechanical properties of the overtones of a vibrating microwire. To this end, the candidate will exploit a recently developed on-chip actuation strategy combined with an optical readout of the quantum dot emission spectrum. The device for this study is available at the lab and functional (see figure). The second track is theoretical and aims at preparing future experiments with a new kind of acoustic cavity. A nanowire acoustic heterostructure will be designed by combining analytical calculations with finite-element simulations.

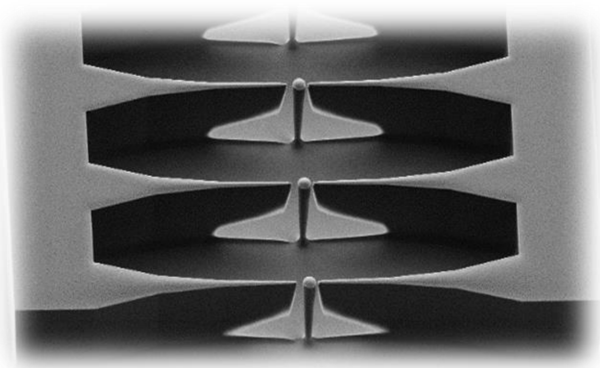

Figure: Scanning electron microscope image of 20-µm-high microwires with pairs of electrodes for on-chip actuation.

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Host team. The host team at CEA/IRIG/PHELIQS (contact: Julien Claudon, CEA Research Director, [Google Scholar profile]) is equipped with numerical simulation softwares. We also develop state-of-the-art fabrication processes to realize unique semiconductor nanostructures. We finally operate two cryogenic optical spectroscopy setups dedicated to single-QD experiments. We are currently involved in several national and European research projects. The candidate will thus benefit from an established network of collaborators, both at the national and European levels.

Applicant profile. The proposed project mixes experiments and theoretical investigations. We are looking for a highly motivated candidate with an interest in condensed matter physics and optics. She/he will have completed an undergraduate program in Physics, Optics or Engineering.

This Master 2 internship could be prolonged by a PhD thesis.

References

[1] Yeo *et al.*, Nature Nanotechnology **9**, 106 (2014) | ↗NPG

[2] Stepanov *et al.*, Nano Lett. **16**, 3215 (2016) | ↗ACS

[3] Munsch *et al.*, Nat. Communications **8**, 76 (2017) | ↗ NPG

[4] Artioli *et al.*, Phys. Rev. Lett. **123**, 247403 (2019) | ↗APS

[5] Kettler *et al.*, Nat. Nanotechnology **16**, 283 (2021) | ↗NPG

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To apply for this position, send your application (including CV) by e-mail to: julien.claudon@cea.fr

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