Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 25/10/2016

Responsable du stage / *internship supervisor*:

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Code d'identification : UPR 2940 — Organisme : CNRS

Site Internet / *web site*: http://neel.cnrs.fr/

Adresse / *address:* 2, avenue des Martyrs, Grenoble

Lieu du stage / *internship place*: Grenoble

Titre du stage / *internship title*: E-beam electromechanics for quantum nanomechanical engineering

Micro-electromechanical systems have dramatically developed over the past 40 years to become indispensable in modern technology. This success prominently relies on the reduced dimensions of these devices, enabling both high level of integration and ultra-high sensitivity in a variety of applications such as navigation, communication and connected objects.

The recent progress in nanotechnology have raised the perspective to further push this approach to nanomechanical systems, with a corresponding size reduction of more than 3 orders of magnitude. However this challenge has so far remained unsuccessful: While being their main strength, the extremely reduced dimensions of nanomechanical systems also represent their Achilles' heel, making them both extremely difficult to detect and overly sensitive towards external perturbations.

The hosts of the proposed project have recently started developing a novel generation of all-integrated hybrid optomechanical components which appear as very promising candidates for tackling the above stated obstacles[1]. The principle of these devices relies on suspended semiconducting photonic nanowires[2] incorporating their own motion readout system, consisting in a quantum dot implanted near their basis. The main ambition is to scale down this concept to nanowires with dimensions in the 10 nm range. Because of its disruptive nature, this research requires to reconsider the whole scientific and technological methodology in order to validate and optimize the proposed approach. In particular, efficient nanomechanical motion readout methods at these scales have been so far missing.

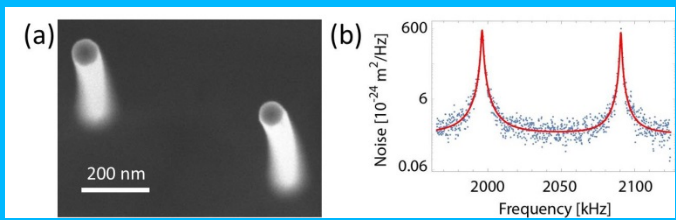

Fig. *(a) SEM micrograph of InAs nanomechanical wires. (b) Brownian motion spectrum of an InAs nanomechanical wire as obtain using the e-beam nano-elecromechanical measurement technique.*

Project:

The present project proposes to investigate a newly introduced readout scheme enabling ultra-sensitive nanomechanical detection of objects with dimensions down to the nanometer level. The method relies on detecting the fluctuations of the scattered electrons current inside a scanning electron microscope[3]. The hosts of the project have started to successfully implement this approach for detecting the thermal motion of semiconducting InAs nanowires (cf. Fig. (a)) with a very high sensitivity (see Fig. (b)).

This M2 internship will investigate this electromechanical interaction over various semiconducting and conducting materials (GaAs, Si, Carbon nanotubes…) both at ambient and cryogenic temperatures, with the perspective to characterize and stabilize the measurement backaction effects. Possibilities to couple this scheme to cathodoluminescence measurement can be envisioned in a PhD work.

References

[1] I. Yeo, et al, Nature Nanotechnology **9**, 106 (2014)
[2] J. Claudon et al. Nature Photonics **4** (3) 174-177 (2010)
[3] A. Niguès et al. Nature communications **6**, 9104 (2015)

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : Yes**

Si oui, financement de thèse envisagé/ *financial support for the PhD***: Allocation région**

Lumière, Matière, Interactions	**x**	Lasers, Optique, Matière	**x**