

Master internship/PhD

Internship/job title	Trap-mediated transport in semiconductors in the space charge limit
Location :	Laboratoire PMC – Ecole Polytechnique – Route de Saclay – 91128 Palaiseau
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Date of publication	01/11/2018
Observations	Starting date : January – March 2019

TOPIC: Localized defect states in semiconductors have long been used to modify and improve the electrical and optical properties of semiconductors [1], and more recently they have become the focus of applications in quantum information [2]. We have recently provided the first evidence [3] that the unusual electromechanical properties of silicon nanostructures in the so-called space-charge-limit, for example the giant piezoresistance [4], are likely related to mechanical modifications of the charge trapping dynamics at deep electronic traps. The aim of the internship, and a potential subsequent Ph.D. thesis, is to further investigate the details of this novel phenomenon.

The topic is a rich one with a number of potential research directions that could be taken, including studies of photo-quenching of trap-mediated effects with a sub-bandgap light excitation, piezo-impedance spectroscopy measurements of nanoscale silicon membranes into which specific, well-identified defects have been engineered, and defect spectroscopy using a novel scanning tunneling luminescence experiment [5]. The interested student will also have the opportunity to numerically study the coupled equations of motion which describe transport in the space-charge-limited regime in the presence of deep electronic traps [6]. Initially preference will be given to photo-quenching experiments.

The candidate will perform impedance spectroscopy measurements on mechanically stressed nano-devices initially fabricated at the I.E.M.N. in Lille and subsequently defect engineered at the University of Melbourne. To this will be added sub-gap photo-excitation using a tunable Ti:sapphire laser.

The internship and potentially subsequent thesis work is part of a larger ANR-funded effort with partners at the I.E.M.N in Lille, the University of Melbourne in Australia, and the CEA L.E.T.I. in Grenoble.

- [1] H.J. Queisser & E.E. Haller, *Science* **281**, 945 (1998)
- [2] T.D. Ladd et al., *Nature* **464**, 45 (2010); D.R. McCamey et al., *Appl. Phys. Lett.* **89**, 182115 (2006)
- [3] H. Li et al., Li, Heng, et al., arXiv:1801.09494 (2018) ; H. Li et al., arXiv:1810.11219 (2018)
- [4] A.C.H. Rowe, *J. Mater. Res.* **29**, 731 (2014)
- [5] W. Hahn, W., et al. *Phys. Rev. B* **98**, 045305 (2018)
- [6] M.A. Nicolet et al., *Phy. Stat. Sol. b* **70**, 9 (1975)

CANDIDATE & POSITION: Methods to be used include impedance spectroscopy and scanning tunneling luminescence. Funding for a subsequent Ph.D. may be via a ministry Ph.D. scholarship, the ANR or an external funding agency.