NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2019-2020

p-n junction nanowires for solar cells

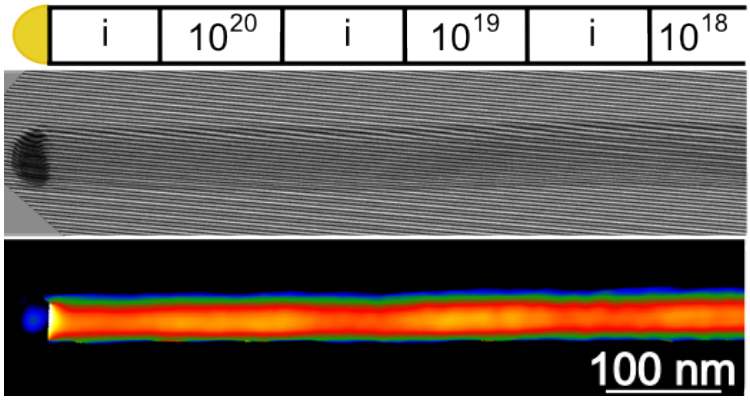
General scope:

The properties of nanowires (NWs) can be tuned carefully using optimized growth conditions or top down fabrication using lithography on a suitably designed substrate. Moreover, it is possible to tune the electrical properties by doping, and p-n junctions can be fabricated in NWs. These structures are interesting, for example for application as NW solar cells. Among others, NWs present one major advantage for such applications: they act as antennae and therefore can absorb the light more efficiently using less material. However, challenges remain to control and measure the doping levels in such nano-objects with nm precision. Furthermore, the role of the NW surface on their electrical properties requires further investigation.

Research topic and available facilities:

The aim of this internship is to contribute to the study of p-n junction semiconducting NWs regarding their opto-electrical properties. The student will integrate a multi-institute, multi-disciplinary research group. His/her role will be the fabrication of electrically contacted NWs containing a p-n junction on TEM compatible membrane chips, and their electro-optical characterization. This includes first the current-voltage analysis, and then their complete characterization as a photodetectors (responsivity, linearity, spectral selectivity, time response). These results will be correlated to detailed characterization by transmission electron microscopy, performed on exactly the same single NW. Moreover, combining in-situ biasing with TEM techniques sensitive to the electric field or electrostatic potential (electron holography, as shown in the figure), we may obtain a quantitative description of the electrical properties of this object at the nm scale. Using this combination of techniques, we will improve our understanding of NW solar cells.

The student's work will involve:
- Sample preparation by cleanroom fabrication techniques, including optical and electron beam lithography.
- Current-voltage measurements and electro-optical characterization.
- Performing the electrical part of in-situ TEM experiments (TEM will be performed by the supervisor), data treatment, and correlation of electrical and imaging results.



From top to bottom: schematics of the nanowire doping, hologram, phase image showing doping contrast.

Possible collaboration and networking: The internship will be in collaboration with IRIC (Eva Monroy). Potential collaborations with CEMES Toulouse, Vienna University of Technology and Technical University of Eindhoven.
Possible extension as a PhD: Not granted in advance, but we are open to support applications for a PhD grant.
Required skills: Interest in solid-state physics, electrical and optical properties and characterization techniques and transmission electron microscopy.
Starting date: Jan/Feb 2020 or earlier.

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