Elastic and piezoelectric properties of nanowires

Sorbonne Université

NICOLAS BAUDIN
INTERNSHIPS IN FRANCE INITIATIVE

Name of the hosting institution in France	Sorbonne Université
Name of the host laboratory / research team	Institut des NanoSciences de Paris
Address	4, place Jussieu 75252 PARIS CEDEX 05
Web site	http://www.insp.jussieu.fr/?lang=en
Name of the supervisor	Olga BOYKO
Function	assistant professor
Email	olga.boyko@insp.jussieu.fr
Phone number	01 44 27 45 33

Internship offer

Topic of the internship (title)	Elastic and piezoelectric properties of nanowires			
Proposed dates of the internship	**Start:**	2019-09-08	**End**	2020-03-08

Scientific and academic objectives of the internship (detailed description of the internship content, work expected from the intern and expected outcomes):

Objective: investigate the elastic and piezoelectric properties of Nitride Nanowires
Nanophononics is a quite novel field defined as the control of elastic wave propagation in the nanoscale. The technological aspects of nanophononics are very promising. Control of nano-scale elastic energy would improve existing electronic devices, as well as lead to completely new applications in the fields of nano machines, electronics, energy transport, energy generation and energy harvesting. It has been suggested that similar devices as those used for electronics can be developed for the control of phonon flows. The research in our group 'Acoustics for Nanosciences' focuses on the elastic behaviour of advanced materials that are realized through clean room technology. We have both an experimental and numerical approach to investigate the generation of high-frequency elastic waves, the interaction between wave and matter, and the control of wave propagation at the nanoscale. The engineered materials we design are generally composed of inclusions in solid matrix. Such materials exhibit exotic and unique propagation properties. The internship project is to study the elastic and electronic properties of structures based on Gallium Nitride (GaN) nanowires. GaN nanowires have attracted extensive research interest for their enhanced piezo-electric properties and their exceptional flexibility. Although many applications require knowledge and ability to control the mechanical behaviour of NW based nanostructures, the elastic properties of such structures remain relatively unexplored. These are great candidates for future nano-generators. In collaboration with the Center for Nanosciences and Nanotechnology (C2N) we made several samples containing nanowires. Depending on the density of nanowires we observe a change in their morphology. In the low density samples, the nanowires have a pyramidal shape (*see annex*). In order to perform elasticity experiments, the nanowires were placed in a polymer and then metallized with a 50 nm layer of platinum. During this stage, the nanowires will be observed under an electron microscope to characterize their state of the surface and the thicknesses. The samples will then be studied on an optical measurement set-up using the Transient Grating method. The Transient Grating method is a non-destructive technique where the source of the elastic waves and the detection are all optical. Thanks to the surface elastic waves thus measured, it is possible to obtain the elastic constants of the nanowires. On the other hand, the nanowires will also be characterized from an electronic point of view. The candidate will work in the clean room at the INSP and will deposit interdigital comb transducers in order to analyse the piezoelectric properties. In summary, we propose to analyse the subsequent deformation of nanowires, using the Transient Grating method, which is based on four-wave mixing both to optically generate high-frequency elastic waves and to detect them. This will lead to an accurate understanding of the vibrations of nanowires properties allowing thereby for the prediction of the piezoelectric behaviour, the enhancement of the energy conversion and in return to an improved design of the nanowires.
See annex for more details

Does the project involve a French industry partner?	No
Targeted Australian university	Any

Expected profile of applicant

Level of study	Master or doctoral level
Discipline	Physics, Mechanics, Nanotechnology
Required qualities, knowledge and skills	The internship involves an important experimental investment (sample fabrication, optical and acoustic measurements). The offer is addressed to the candidate having a good knowledge of solid state physics

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Annex 1

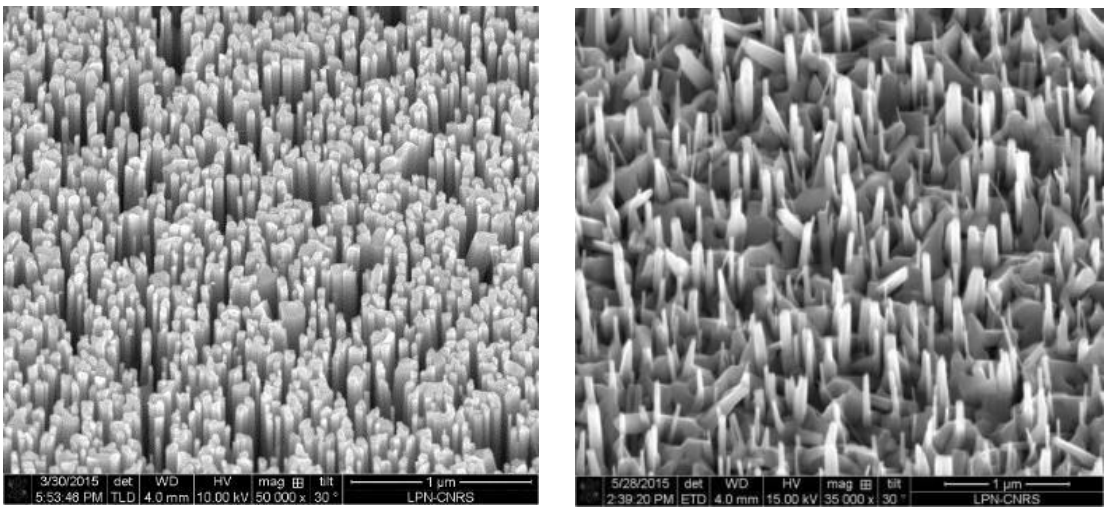

Fig. 1. Images obtained by scanning electron microscope of two samples of different morphology (dense nanowires on the left, thin nanowires on the right)