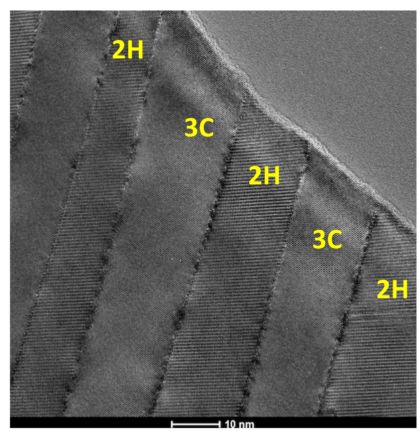
**PhD research proposal 2021**

# *Shear induced phase transformation in SiGe nanowires for the synthesis and integration of SiGe-2H crystal phase on SOI*

**General framework**

SEEDs team has a long standing know-how in synthesis and characterisation of group-IV semiconductor. At the moment we are especially investigating different ways to synthesized the very promising hexagonal Ge-2H phase (an allotrope of the standard diamond cubic 3C structure) which exhibits a direct band gap and an excellent light emission capabilities [1] with a tuneable emission wavelength in the mid infrared between 1.8-4.2 µm by a concentration range of 0-40% of Si. This material may therefore provide additional photonic functionality to the silicon technology and fill the gap between electronics and photonics industry. We aim at integrating SiGe-2H light sources on silicon on insulator in a CMOS compatible way.

Recently, we have pioneered an original method to achieve a shear induced phase transformation in Ge and Si nanowires NWs resulting in unprecedented heterostructures with quasi periodic embedded 2H domains distributed all along the <111>-oriented nanowire (fig). The process is described in refs [2,3]. Our studies show the influence of temperature, diameter and crystallographic direction on the phase transformation.



Heterostructured Si Nanowire obtained by strain induced phase

We propose to combine this shear strain-induced process with selective epitaxial growth on the transformed SiGe-2H seed. To make this approach fully compatible with CMOS one purpose is to optimize the process to enable phase transformation along <100>-oriented SiGe nanostructures (nanofins or nanowires). The second challenge is to develop a highly selective etching method to remove the 3C top part and uncover the 2H transformed domain which is expected to serve as seed in order to subsequently increase the volume of the 2H segment.

This project is part of Opto-silicon project funded by the EU H2020 FET-OPEN.

[1] E.M.T. Fadaly et al. *Nature* **580**, 205–209 (2020).
[2] L. Vincent et al. Nanoletters 14 (2014) p.4828
[3] L. Vincent et al. Nanotechnology 29 n°12 (2018)

**Objectives and work plan**

The PhD student is expected to contribute to :

- technological developments for integration of SiGe-2H on SOI (achieve phase transformation in <100> nanofins, feasibility of selective etching)
- modelling strain field inducing phase transformation in nanostructures and exploring the influence of the system geometry (influence of crystal orientation, aspect ratio, density of nanofins…)
- understanding phase transformation mechanisms in SiGe nanostructures
- optimisation of epitaxial regrowth on SiGe-2H seeds and characterisation of structural and physical properties of the synthesized structures.

**Profile and skills required**

We are looking for applicants with a Masters degree in Physics, Physical Chemistry, materials science or related areas with an interest in nanotechnologies. Experience with microfabrication in cleanroom would be a clear advantage.

The candidate should have :

- strong knowledge in crystallography, crystal growth and plasticity of materials
- ability to work in cleanroom environment
- ability to work in a team and good communication skills
- upper intermediate level in English

**Application**

Applicants must provide by email the following documents :

- Curriculum vitae
- Details of grades obtained at university from the 1st year to present
- Motivation letter from the applicant
- Short description of the master internship
- Two recommendation letters

Deadline application 05/28/2021

**Funded offer**

Fully funded PhD by EU H2020 FETOPEN

Employer : University of Paris Saclay

Duration 3 years starting on 09/01/21

**Contact**

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