FP7 Marie Curie Actions- Initial Training Network

Job title: Doctoral Research Fellowship (PhD)
Title: Nucleation and growth mechanisms of III-V semiconductor nanowires
Location: CNRS - Laboratoire de Photonique et de Nanostructures, Marcoussis, France

Duration: 3 years
Closing date: 15 July 2013
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Gross living allowance: 44 118 € per year plus mobility allowance. Salary is subject to deduction of social contributions and to taxes.

PhD Research project
Free-standing nanowires, with diameters of a few tens of nanometers and lengths up to several microns, are nowadays commonly fabricated from a large range of semiconductor materials. These objects have remarkable physical properties and many potential applications, in particular in nanophotonics and nanoelectronics. However, their full potential will only be achieved if their physical properties can be precisely tailored. It is in particular crucial to control the geometry, crystal structure and doping of the nanowires, as well as their position on their substrate. For many applications, it is also essential to combine different materials in a single nanowire and therefore to master the formation of axial and/or radial heterostructures. Despite substantial progress in the recent years, the level at which these properties are controlled is still far from optimal. Most of these properties are determined right at the formation of the nanowires. Applicability of the nanowires thus depends intimately on an understanding and control of the basic growth mechanisms governing their formation.

The PhD student at LPN will be involved in the fabrication of nanowires of III-V semiconductors by molecular beam epitaxy. Gold-seeded and self-seeded growth will be studied. An important aspect of the project is to maintain the intimate coupling between experimental investigations and modeling of the growth phenomena, which is one of the strengths of the LPN team. The candidate will investigate and model the basic nucleation and growth mechanisms governing nanowire formation from a nanosized liquid droplet. The impact of the growth parameters (such as temperature, fluxes of group III and group V atoms and their directions) will be explored, as well as the effects of the droplet geometry and of the mutual dynamical interaction of the nanowires through their density and length. A major aim is to control at will the crystal structure of the nanowires and the formation of heterostructures. The ultimate challenge is to achieve structure and composition control at the level of a single atomic layer. Regarding this objective, a fundamental obstacle (specific to epitaxial growth in nano-sized systems) is the random character of the nucleation instants which determine at which time each new atomic layer starts to form. The PhD student will explore to which extent this limitation can be circumvented.
Context
This PhD research programme will be carried out within the context of the *NanoEmbrace* network, a Marie Curie Actions – *Initial Training Network* (ITN) – project funded by the European Commission, under their Framework programme 7 (FP7). Through the project activities, the PhD students will have the opportunity to come in contact and collaborate with several of the best European research groups. For additional details, see “Further particulars”.

Responsibilities
(1) Perform high quality research in the bespoke research project under the guidance of the supervisory team.
(2) Meet the members of the supervisory team on a regular basis.
(3) Participate in the activities of the Network as specified in the Grant Agreement and/or required by the node coordinator, including secondments in other network nodes and taking part in the network meetings and in the training activities.
(4) Write up the results of the research activity and present research papers and publications at meetings and conferences, as advised by the supervisors.
(5) Widen the personal knowledge in the research area and undertake complementary training.
(6) Keep records of the activities, such as secondments, visits, leave of absence.

Person Specification
The successful candidates *must satisfy the eligibility criteria* (see below) and have:

(1) An excellent academic record in physics, engineering, material sciences or related areas.
(2) A keen interest in pursuing research in nanotechnology, and in particular the science and technology of nanowires.
(3) The ability to work independently, and as a member of a research team.
(4) Excellent interpersonal and communication skills.
(5) A good command of English language, with excellent oral and written skills.

* Note that female candidates are particularly encouraged to apply.

Desirable
Any or combination of the following will be a clear advantage.

- A demonstrable ability or potential to produce research published in peer-reviewed journals.
- A good strategic fit with existing research expertise in the host institution and the *NanoEmbrace* network.
- Knowledge of, or willingness to learn, the language of the host institution (French).
**Eligibility Criteria**

The candidates must meet all the criteria listed below

1. Be, at the time of recruitment by the host organisation, in the first 2 years (full-time equivalent) of their research careers and have not yet been awarded a doctoral degree. This is measured from the date when they obtained the degree which would formally entitle them to embark on a doctorate, either in the country in which the degree was obtained or in the country in which the research training is provided, irrespective of whether or not a doctorate is envisaged. In any case, the ESR’s research experience must not exceed 5 years full time at the end of the 3 years employment period working on the project.

2. At the time of recruitment by the host organisation, must not have resided or carried out their main activity (work, studies, etc) in the country of their host organisation for more than 12 months in the 3 years immediately prior to the reference date. Short stays such as holidays and/or compulsory national service are not taken into account.

3. At the starting time of the positions, the candidates must have completed the courses that would have allowed them to enrol in a doctorate program either in the country where they are studying or in the country offering the position.

4. Gross living allowance is subject to employment laws and employer costs deduction.

**Further particulars**

**The NanoEmbrace project**

One dimensional nanostructures (1DNS) produced from various elemental (Si and Ge) and compound (III-V and II-VI) semiconductors are receiving increasing worldwide attention due to their unique properties and potential for a wide range of applications. They are the building blocks for single photon emitters, third generation solar cells and the monolithic integration of optoelectronic devices. 1DNS can be used to fabricate the smallest light emitting devices and lasers. Despite recent progress, many fundamental and applied challenges still prevent transfer of 1DNS from laboratories to large scale industrial use. The proposed NanoEmbrace assembles eight leading industry partners and ten internationally renowned institutions in materials science, engineering, chemistry, condensed matter physics and nanoscale device fabrication. The original vision of NanoEmbrace is to gain superior control and understanding of 1DNS and to transfer 1DNS from laboratory to industry. It is probably the first organised attempt to put together all the competences and capabilities, experimental and theoretical, necessary for the comprehension of the mechanisms that govern the growth of 1DNS that cannot all be described by existing models. We also aim to provide the highest quality multidisciplinary and cross-sectoral training to early career researchers (ESRs) in nanoscience to create the next generation of research and industry leaders.
The ESRs joining NanoEmbrace will have a unique opportunity to enjoy close personal contact with internationally renowned experts and to put together an unprecedented, complex but unified overall understanding of the growth of 1DNS and to develop the process required to produce practical commercial devices. To deliver the highest quality of training to young talented researchers, NanoEmbrace has identified the key research themes: controlled synthesis, theoretical modelling, characterisation of 1DNS and the integration of 1DNS into device fabrication.

The NanoEmbrace consortium

Coordinator: Durham University, United Kingdom (UK)

Academic Partner institutions: (10 including coordinator)
St Petersburg Academic University (Russia), Ecole Polytechnique Fédérale de Lausanne (Switzerland); Université Paris-Sud XI (France); Consiglio Nazionale delle Ricerche (Istituto per La Microelettronica e i Microsistemi, Rome, Italy); Centre National de la Recherche Scientifique (Laboratoire de Photonique et de Nanostructures, France); Institut Supérieur d’Electronique et du Numérique Lille (France); Lund University (Sweden); University of Liverpool (UK) and University of Newcastle (UK)

Industrial partners: (8)
EV Group GmbH (Austria); Labman Automation (UK); ST Microelectronics (Italy); Bruker UK Ltd (UK); SemiMetrics Ltd (UK); Alphasense Ltd (UK); Picosun Oy (Finland); Riber S.A. (France).