



PhD position:

In situ monitoring of the growth and optimization of 2D materials using synchrotron X-ray

Context: The LANEF¹ is a ‘Laboratoire d’Excellence’ that associates five fundamental research labs based in Grenoble. It coordinates 740 scientists, engineers, technicians, and 400 PhD students and postdocs, in condensed matter and nanosciences. In the framework of the fast growing field of 2D materials, a LANEF “Chair of Excellence” (with associated PhD) has been allotted to forefront expert Pr. Dimoulas² in Grenoble to intimately collaborate with a joint task force between CNRS (Institut Néel³) and CEA (Institut Nanosciences and Cryogénie, INAC⁴). The scope is a basic research effort with the design of novel devices based 2D materials as medium-term goal. The uniqueness of the approach is the use of synchrotron X-rays from the dedicated synchrotron beamline⁵ that CEA and CNRS run at the European Synchrotron Radiation Facility (ESRF⁶).

Subject: Two-dimensional materials are of highly significant interest for many applications in nano-opto-electronics. Graphene is the prototype of this material family however the absence of gap limits its potential applications e.g. for making transistors logic field effect. Recently transition metal dichalcogenides (TMDs) have emerged in the growing field of 2D materials and give rise to a new area of research. The moderate structural quality of the 2D TMDs to date hinders access to their intrinsic properties and limits device performance. The main goal of this work is to substantially improve this quality by a close control of growth processes, for the first time owing to *in situ* diagnostics – enabled by state-of-the-art synchrotron X-ray surface diffraction/scattering. Together with experts involved in the project, fundamental physics and optoelectronic devices will be explored with these optimized, high quality 2D TMDs. The growth of MoS(e)₂ or WS(e)₂ will be performed on various substrates and optimized using a combination of physical and chemical beam epitaxy under the highly controlled conditions of ultra-high-vacuum, on the ESRF BM32 CRG/IF beamline⁵. Structural features having key influence over the (opto)electronic properties, noteworthy strain, defects, periodic nanorippling associated with a moiré translating the epitaxial relationship between the 2D TMD and the substrate, will be investigated as a function of growth conditions. Complementary information will be sought for with the help of high resolution scanning probe microscopy and optical spectroscopies.

Environment: The work will be pursued in the international lively atmosphere of the ESRF. It could start by a Master internship in spring 2016, followed by a PhD-thesis. The successful candidate will benefit from the scientific environments of the ESRF⁵ the INAC⁴ and Néel³ laboratories and the wider environment of GIANT and Minatec. She/he will work in close link with several experts from these different laboratories. She/he will learn to master a complex instrument, coupling a synchrotron beamline⁵ with a UHV chamber dedicated to epitaxial growth. The scope is fundamental research, with important potential impact in applied research. The student will integrate a team whose expertise for the *in situ* study of the growth with X-rays is internationally recognized, and which has many collaborations, local and international. The PhD will be supervised by Drs A. Dimoulas (LANEF), J. Coraux (I. Néel) and G. Renaud (INAC).

Desired skills and training: The candidate should have a strong background in general physics, and more specifically in solid state physics; material Science; nanosciences, and if possible knowledge of matter-radiation interaction. He (she) should be particularly motivated by experimental work and by team work, but should also be able to work alone.

Contract: The offer concerns a PhD contract for a three year period. A wide range of valuable training programs, research and upgrading opportunities will be accessible.

Applications: The application including a motivation letter, Curriculum Vitae and with the references should be sent to Gilles Renaud, CEA Grenoble INAC/MEM 17 rue des Martyrs, 38054 Grenoble France
e-mail : gilles.renaud@cea.fr Tel. : +33 (0)4 38 78 35 58 (CEA) or +33 (0)4 76 88 40 42 (ESRF)
with copies to A. Dimoulas (a.dimoulas@inn.demokritos.gr) and J. Coraux (johann.coraux@neel.cnrs.fr).

Application deadline: March 31st, 2016.

Job Location: Grenoble, France

¹ <http://www.grenoble-lanef.fr/>

² <http://inn.demokritos.gr/en/prosopiko/a.dimoulas/>

³ <http://neel.cnrs.fr/>

⁴ <http://inac.cea.fr/>

⁵ The BM32 CRG/IF beamline, see <http://www.esrf.eu/UsersAndScience/Experiments/CRG/BM32/>

⁶ <http://www.esrf.eu/>

