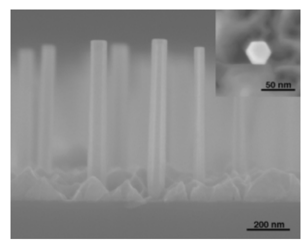
COHERENT SPECTROSCOPY OF LOW-DIMENSIONALITY NANOSYSTEMS

DIRECTEUR DE THESE : MATHIEU GALLART (HDR)
IPCMS-DON, 23 RUE DU LŒSS, 7, 67034 STRASBOURG
TEL : 03 88 10 71 93 ; E-MAIL : PIERRE.GILLIOT@IPCMS.U-STRASBG.FR, MATHIEU.GALLART@IPCMS.U-STRASBG.FR, FRAS@IPCMS.UNISTRA.FR

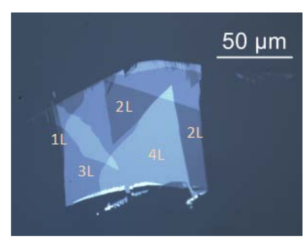
Research in the field of nanophysics is motivated by the possibility to control physical, optical and electronic properties of nanostructures in order to use them in future electronic devices. In particular, one could take advantage of the quantum behavior of single nano-objects to implement quantum information and quantum computing. Ultrafast spectroscopy is a powerful tool to measure the lifetime of charges and spins in semiconductor nanostructures. Moreover, it allows to optically create coherent superposition of quantum states and to measure their evolution. Because of sample spatial inhomogeneities, the subtle properties of nanostructure are only revealed at the micrometric scale. We plan to perform non-linear time and spatially resolved spectroscopy in order to study coherent optical properties of nano-objects which exhibit unique electronic and optical properties, and can be integrated in nano- and micro-optoelectronic devices, such as:

-Gallium nitride nano-columns:



Gallium nitride (GaN) and its alloys still remain the subject of intense research[1] for optoelectronics applications in the visible and UV range. High crystalline quality GaN nano-columns are promising systems for decreasing the size of electronic devices and constitute a model-system of crystaline bulk. Spin dynamics and excitons coherence will be studied in view of the use of GaN nano-column in spintronics applications.

-Two dimensional graphene like semiconductors:



Layered metal chalcogenides such as MoS_2 represent a class of atomically thin two dimensional crystals materials offering a broad range of exciting fundamental and applied perspectives. In particular, due to strong spin-orbit interaction and to the lack of inversion symmetry, it is possible, in MoS_2, to optically create electrons in specific valleys of the

[1] See the subject of the 2014 Nobel prize in physics “for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources”.

reciprocal space by using circularly polarized light. We are strongly interested in the optical creation and manipulation of coherent superpositions of valley states for potential applications in quantum information and quantum computing.

The PhD student will be fully involved in the implementation of a four wave mixing experimental set-up in order to study these new and promising systems. Some new and unexpected physical effects, specific to the low dimensionality of these systems are likely to be highlighted.

Required profile : Solid knowledge of semiconductor physics and/or quantum mechanics. strongly self-inclined towards experimental work.