- Axe de GANEX : **7**
- Titre du sujet : *Optical characterization of hBN epilayers*
- Nom et e-mail du porteur de projet : *guillaume.cassabois@umontpellier.fr*
- Nature de la thèse *(effacer les mentions inutiles)*
  - Simple : GANEX 50%, laboratoire bénéficiaire : L2C (co-financement 50 % ANR Flexible demandé en 2016)
- Date souhaitée de démarrage : *01/10/2017*
- Lien avec un projet ANR ou H2020: *ANR Flexible (C2N, L2C, UMI GT-CNRS) déposée en 2016*
- Sujet développé : *(jusqu'au bas de page, police 11-12)*

Hexagonal boron nitride (hBN) is a lamellar wide-bandgap semiconductor which gathers increasing interest from two important communities : UV optoelectronics devices and two-dimensional (2D) crystals.

In the former case, it has already been demonstrated that 2D sacrificial buffer layers made of hBN can be used to detach advanced III-V epitaxial opto-electronic devices from the expensive substrate used for growth [1]. This is particularly important for short wavelength light emitters and high power-electronic devices based on the utilization of wurtzite nitrides, including GaN, AlN and their alloys, where no bulk lattice-matched substrates are available. The development of large-scale epitaxial growth of high quality hBN by both metal organic chemical vapour deposition (MOCVD) and molecular beam epitaxy (MBE) will be crucial for these applications. In this context, UMI GT-CNRS has been developing an approach for fabricating flexible opto-electronic devices by growing sacrificial hBN epilayers by MOCVD (cf. ANR Flexible).

In the latter case of van der Waals heterostructures made of 2D crystals, exfoliation methods using adhesive tape techniques have been used extensively to produce the first 2D materials such as graphene, hBN and the transition metal dichalcogenides, with typical planar dimensions of a few tens of micrometres [2]. Such methods have enabled the fabrication of monolayer-thick graphene and multilayer van der Waals devices [2]. However, these methods are difficult, time-consuming and are not scalable. Therefore, the development of an alternative scalable growth technology is urgently required for 2D materials and devices. This need has triggered many attempts to grow high-quality hBN by MOCVD, and more recently by high-temperature MBE in Nottingham University [3].

This PhD project is dedicated to performing advanced optical characterization in the deep UV in hBN epilayers grown either by MOCVD at UMI GT-CNRS (A. Ougazzaden), or by MBE at Nottingham University (S. Novikov).

The preferred spectroscopic tool will be photoluminescence (PL) excited at 195 nm by the fourth harmonic of a TiSa laser. Our strategy will consist in comparing the PL spectrum of hBN epilayers with the one of few monolayer-thick hBN crystals obtained by exfoliation of a bulk crystal. The observation of the intrinsic phonon-assisted recombination lines identified in bulk hBN [4-6] will be a direct signature of the high-quality of the hBN epilayers.

Moreover, we intend to characterize the spatial homogeneity of the hBN epilayers by means of our new setup of micro-PL at 200 nm, which is currently under development. This setup will allow us to map the PL signal intensity in the deep UV with a spatial resolution of the order of 1 µm.

References

[1] Y. Kobayashi, K. Kumakura, T. Akasaka, and T. Makimoto, Nature **484**, 223 (2012).
[2] A. K. Geim and I. V. Grigorieva, Nature **499**, 419 (2013).
[3] T. Q. P. Vuong, G. Cassabois, P. Valvin, E. Rousseau, A. Summerfield, C. J. Mellor, Y. Cho, T. S. Cheng, J. D. Albar, L. Eaves, C. T. Foxon, P. H. Beton, S. V. Novikov , B. Gil, submitted to 2D Materials.
[4] G. Cassabois, P. Valvin, and B. Gil, Nature Photon. **10**, 262 (2016).
[5] G. Cassabois, P. Valvin, and B. Gil, Phys. Rev. B **93**, 35207 (2016).
[6] T. Q. P. Vuong, G. Cassabois, P. Valvin, V. Jacques, A. Van Der Lee, A. Zobelli, K. Watanabe, T. Taniguchi, B. Gil, 2D Mater. **4**, 011004 (2017).