Offre de stage/thèse 2022-2023

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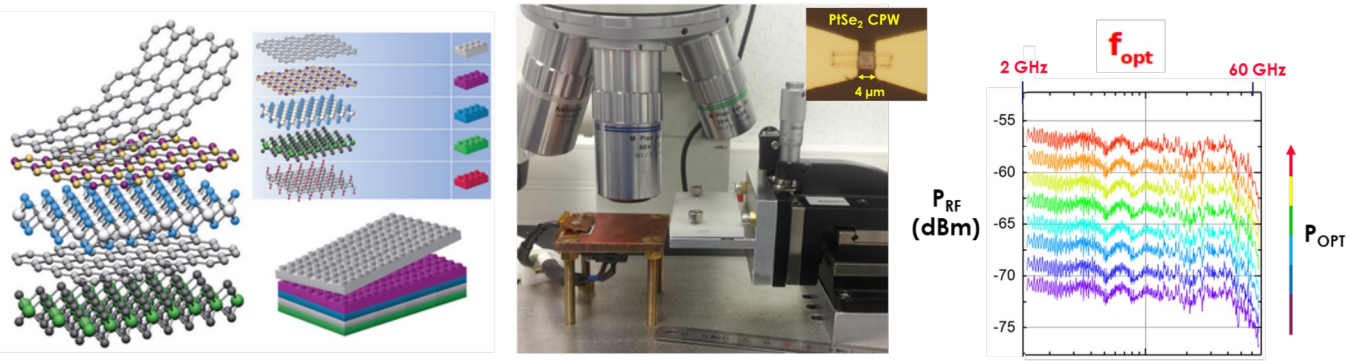
Title

Ultimate limits of Optoelectronics of 2D materials

Scientific project:



(a) 2D materials can be stacked as legos (b) The 2D material transfer setup at ENS clean room (c) Preliminary measurements of ultra-high frequency photoresponse of PtSe2 made with PtSe2 grown at Thales TRT.

Following the isolation of a single layer of graphene from a graphite crystal by mechanical exfoliation in the 2000's, a large class of similar crystals with equivalent mechanical properties have been discovered. This field of research around the so-called "2D materials" has been growing rapidely because those materials can be combined by stacking of monolayers alternatively metallic, semi-conducting or insulating, which allows to forsee new opto-electronic devices with extreme properties in photo-detection, energy harvesting or emission of light.

At LPENS, we are currently focusing our effort on a promising 2D material : PtSe2. The reason for our interest in this material is two-fold : Rather exceptionnally, it has a tunable bandgap depending on the number of stacked layer, and its electronic mobility compares favorably to the best 2D materials available today. We aim in particular at exploring this material's potential for photodetection in the telecom wavalengths (1,26-1,63µm). The exploration of carrier generation mechanism, in-plane and out-of-plane electronic transport will be of major importance to determine if this device can be used as an ultrafast photodetector or photomixer (up to 50 GHz).
This project has been pioneered by 2 PhD students at ENS, who have developped the RF and optical spectroscopic tools to explore the intriguing properties of this exotic material. Th goal is now to fabricate high mobility devices to understand understand the mechanisms at stake in high-frequency photodetection and determine its intrinsic limits. This project is made in collaboration with Thales TRT and CEA Grenoble.

The candidate will have bases in physics of condensed matter, a taste for nano-fabrication and testing combining optical spectroscopy techniques and radio-frequency electronics.

Methods and techniques: Exfoliation, Van der Waals stacking, photo/electro-lithography, Optical spectroscopy (absorption&PL), cryogenics, electronics, RF electronic and optoelectronic characterization.