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Institut d'Electronique, de Microélectronique et de Nanotechnologie
UMR CNRS 8520

Master and Engineer Internship: 2020-2021

Proposed by : Xavier WALLART

Phone number : 03 20 19 78 57

E-mail : Xavier.wallart@univ-lille.fr

Research group : EPIPHY

Title : **Epitaxial growth and characterization of transition metal dichalcogenide heterostructu**res

Abstract :

Two-dimensional materials (2DMs) offer some unique properties mainly related to their crystallographic structure composed of weakly coupled layers made of a few atomic planes (1 to 4) in which atoms are covalently bounded. This peculiar structure results in the absence of surface dangling bonds and therefore allows the formation of heterostructures, which do not require lattice matching and make strain-free integration possible. Among 2DMs, the transition metal dichalcogenides (TMDs) of formula MX_2 (M=metal atom, X=S, Se or Te) are particularly appealing since, contrarily to graphene, they exhibit sizeable band gaps in the 0.5 - 2 eV range and a variety of band alignments. These properties make TMDs promising candidates for a number of devices, among them interband tunneling-based ones. However, up to now, the fabricated devices rely mainly on exfoliated or transferred layers or flakes, several μm^2 wide, with severe issues regarding the interface integrity, the precise rotational alignment between successive layers and the process reliability when working on flakes.

The proposed work aims at addressing part of these issues by studying the growth of TMD layers using molecular beam epitaxy thanks to a new machine recently launched in the IEMN clean room. A particular emphasis will be placed on the crystalline quality of the resulting layers according to the growth conditions. To this end, they will be thoroughly characterized to assess: *i)* their morphology by atomic force microscopy (AFM) and Scanning Electron Microscopy (SEM); *ii)* their crystallography by electron and X-ray diffraction and *iii)* their electronic properties by X-ray and UV electron spectroscopies.

The work will be performed in the micro and nano fabrication facility and in the multi physics characterization platform of the' Laboratoire central de l'IEMN'.