Centre National de la Recherche Scientifique (CNRS)
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Thesis offer:

Thesis on the tailoring the electrical properties of transition metal dichalcogenides monolayer by molecule grafting

Workplace: Institut d'Electronique, de Microélectronique et de Nanotechnologies (http://www.iemn.fr), Lille
Contract Period: 36 months
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Supervisors / Contact: Stéphane Lenfant; Thierry Mélin, Sylvie Godey, Imen Hnid
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Abstract:
Progress in research and development of novel 2D materials such as transition metal dichalcogenides (TMD) of the type MX_2 (M = Mo, W, Pt; X=S, Se, Te) opens a new way for the fabrication of low-dimensional nanometer structures with unique electronic, optical, and mechanical properties. In order to tune the electronic properties, the doping of the TMD monolayer by the covalent grafting of thiol molecules offers additional possibilities for these systems.

In the framework of the ANR project COMODES, our main goal is to investigate the modification of the TMD (WSe2, MoS2, MoSe2 and PtSe2) monolayer properties with different molecules grafted on the monolayer. The molecules considered here are thiol molecules forming a covalent bond with the monolayer. Different thiol molecules (alkyl, phenyl…), with different lengths, and different terminal groups (-H, $-CH_3$, -F or $-CF_3$) will be investigated in the project. Characterizations will be done at the nanoscale by using scanning probe microscopes (in air or in ultra-high vacuum and at low temperature). The TMD monolayer properties study will be (i) the density and homogeneity of molecules grafted with the help of AFM; STM; (ii) the work function by KPFM; (iii) conductivity by C-AFM, and (iv) current-voltage characteristics (I=f(V)) by STM.

The final goal will be to (i) study the impact of the molecular structure on the TMD monolayer properties, and (ii) identify the best couple TMD/molecule for field emission, in collaboration with the partners of the project COMODES.
This project paves the way for the demonstration of a new field emission tip source terminated by functional monolayers