Title	Photoactive molecular layers for nanoelectronics	
(Co)-Directeur	Stéphane LENFANT	E-mail : stephane.lenfant@iemn.fr
(Co)-Encadrant (s)	Imen HNID	E-mail : imen.hnid@iemn.fr
Laboratoire(s)	IEMN	Web : https://www.iemn.fr
Groupe(s)	NCM	Web :
Financement acquis ?	Oui ☐ Origine :	Non ☒
Financement demandé	Contrat Doctoral ☒	Etablissement porteur : Univ. Lille ☒ Centrale Lille ☐ JUNIA ☐
	Région ☐	Co-financement acquis : Oui ☐ Non ☐ Préciser son origine (qu'il soit acquis ou non) :
	Autre :	

Abstract :

Molecular electronics is a scientific domain, aiming at developing devices for information technologies. It uses pi-conjugated molecules deposited as ultrathin or monolayers, or in single-molecule devices. It has obvious potential for extreme miniaturization. The molecular junction (MJ) is the basic component of molecular electronics and consists of a single molecule or an assembly of many molecules between two conducting electrodes.

This PhD proposal lies within this context. The main goal is to generate new building blocks that could be used in Metal/molecules/Metal devices with molecular layers 5-20 nm thick. Since this thickness range is much shorter than that in current organic electronic devices, the transport will be truly “nanoscale” and mainly intramolecular. Transport distances will be of the same order of magnitude compared to scattering or hopping lengths and charge carrier sizes. Therefore transport will be almost activation-less and ultrafast. Since this thickness range is above the non-resonant tunneling limit, the transport will also be truly molecular and much more sensitive to the structural and electronic properties of the layer.

A part of this proposal will be devoted to the deposition of new photoactive molecular system as ultrathin films and will be characterized by usual means (electrochemistry, XPS, IR spectroscopies, AFM, MEB, thickness measurements using scratching technics or ellipsometry). The deposition process of the organic layers used in the proposal is based on electro-generated radical grafting processes using diazonium reduction. This process is becoming rapidly a versatile and efficient alternative to Self-Assembled Monolayers (SAM) on gold through thiol adsorption. It is now involved in many applications in the domains of materials, surface science and electronic. As thickness and roughness is a major issue, it will be carefully addressed and the influence of surface preparation on the quality of the grafted layer will be studied. The main goal is to improve the electrochemical fabrication process to obtain reliable multifunctional molecular layers with a controlled thickness.

Characterizations will be done at the nanoscale by using scanning probe microscopes in air and the transport properties of the resulting MJs, incorporating photoactive molecules, will be measured. We will first perform standard measurement of the current-voltage characteristics as function of the molecular layer thickness. In a second step, these devices will be studied under irradiation in order to study various photoeffects including induced photocurrent, photovoltage and photo-switch. To do so current-voltage curves with and without irradiation will be recorded and in all cases, the relation between the molecular structure, the molecular rectification and/or the memory properties of the device will be investigated. Some of these properties will be tuned by light.

The proposed approach represents a major step away from the “classic molecular electronics” operative when the device thickness is below 5 nm toward “realistic molecular electronics” which exploits phenomena not possible with conventional semiconductors.