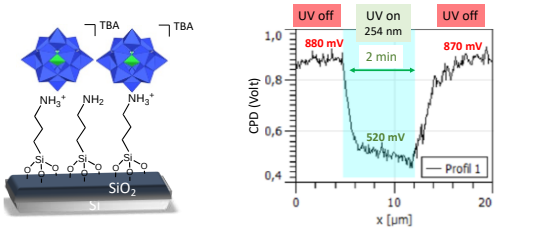
Post-doc offer at Sorbonne University, 12 months

Molecular electronics and surface characterization

Transduc-POM project

Molecular electronics was a challenge proposed by Aviram and Ratner in 1974 and this has now led for example to the AMOLED[1] displays which equip half of the mobile phones sold in the world in 2022. AMOLEDs deal with pixels that emit photons in order to reproduce images. The reverse process consists in collecting photons, transduce them into an electric signal and fabricate a photodetector. Nowadays the use of molecular materials for organic photodiodes is at the early stage of the proof of concept. Therefore, **the objective of the *Transduc-POM* project is to qualify a family of molecular oxides or polyoxometalates (POMs) as future components for molecular photodetectors.**



(a) POM monolayer on Si(100) || (b) Example of KPFM measures, where the Contact Potential Difference is monitored on a SOI substrate as a function of UV illumination.

Polyoxometalates (POMs) are nano-scaled molecular oxides of the early transition metals, in their highest oxidation state, obeying to the general formula $[X_xM_pO_y]^{n-}$ (X= P, Si …; M = Mo^{VI}, W^{VI}, V^{V}, $Nb^{V,}$ Ta^{V}…). They are unconventional photo-active molecules endowed with highly tunable redox properties. The POMs that we propose to use typically absorb light at 305 nm and 215 nm (see Figure). Charge modifications will be probed by depositing various POMs as monolayers on top of a Silicon-On-Insulator (SOI) substrate which is an efficient way of building a pseudo-Metal Oxide Semiconductor Field-Effect Transistor (**pseudo-MOSFET**) with almost no lithography. The electrical characterization of the POM monolayers before and after UV-light photoreduction will be carried out by **Kelvin Probe Force Microscopy** (KPFM). KPFM is based on an atomic force microscope (AFM) and allows measuring the electrostatics effects at the nanoscale in order to understand how the photoinduced charges accommodate in the monolayer. This step is crucial for unravelling the behavior of the molecules. Then, the detection of the global electric changes induced by the POMs deposition and their sensing of UV-light will be probed by measuring the Drain-Source current of the pseudo MOSFET.

This *Transduc-POM* project is carried out by three groups with complementary skills: the IPCM partner (A. Proust & F. Volatron) synthesizes the POM molecules, the INSP partner (O. Pluchery) is responsible for the surface characterization with AFM and KPFM, and the IMEP-LAHC (I. Ionica) carries out the electrical characterization in the photo-transistor geometry. A first stage of this research was investigated during a PhD thesis that was defended in January 2022.

The recruited post-doc will work mostly at INSP and IPCM, on the characterization of the POM-based monolayers, with short term scientific missions in Grenoble. The principal goal is unravelling the physical and electrical behavior of POM monolayers in relation with their molecular charges and organization. The fabrication of a proof of concept of a set of photoactive sensing pixels based on the POM monolayer is also targeted.

[1] AMOLED: Active Matrix Organic Light Emitting Device

References related to the project

1. *Covalent grafting of Polyoxometalate hybrids onto flat silicon oxide: insigths from POM layers on oxides*, M. Laurans, K. Trinh, K. Dalla Francesca, G. Izzet, V. Humblot, S. Alvez, O. Pluchery, D. Vuillaume, S. Lenfant, F. Volatron, A. Proust, ACS Applied Materials and Interfaces, **2020**, 12, 48109-48123 https://doi.org/10.1021/acsami.0c12300.
2. *Nanoimaging of Organic Charge Retention Effects: Implications for Nonvolatile Memory, Neuromorphic Computing, and High Dielectric Breakdown Devices.* Zhang, Y.; Kang, J.; Pluchery, O.; Caillard, L.; Chabal, Y. J.; Wang, L.-W.; Sanz, J. F.; Salmeron, M., *ACS Appl. Nano Mater* **2019,** *2* (8), 4711-4716. https://doi.org/10.1021/acsanm.9b01182
3. *Out-of-equilibrium body potential measurements in pseudo-MOSFET for sensing applications*. L. Benea, M. Bawedin, C. Delacour, and I. Ionica, Solid-State Electronics, **2018,** 143, 69-76, , https://doi.org/10.1016/j.sse.2017.11.010

About the partners and the supervisers.

Olivier Pluchery Institut des NanoSciences de Paris (INSP). Sorbonne Université, 4 place Jussieu. 75005 Paris. Tower 22. Office : 22-12, room 403 http://www.insp.jussieu.fr/-Olivier-Pluchery-.html	**Anna Proust, Florence Volatron.** Institut Parisien de Chimie Moléculaire (IPCM). Sorbonne Université, 4 place Jussieu. 75005 Paris. Tower 43. Office : 43-44, room 501 https://www.ipcm.fr/article285.html	**Irina Ionica** Inst. de Microélectronique Electromagnétisme et Photonique (IMEP-LAHC) MINATEC-INPG, 38000 Grenoble https://imep-lahc.grenoble-inp.fr/

Requested skills: the candidate should have an experience with either AFM, KPFM or STM techniques. He/she should be interested by the challenges of molecular electronics. Some experience in chemical functionalization of surfaces will be appreciated.

Start date: between July and Nov. 2022. [post-doc duration: 12 months]

Salary: about 35 k€/year (gross salary, depending on previous experience).

Application: send a motivation letter and a CV with contact details for potential referees to olivier.pluchery@sorbonne-universite.fr and anna.proust@sorbonne-universite.fr . Preferentially before June 26th, 2022.