

Covalent 2D organic nanostructures by optically controlled cross-linking of molecular self-assemblies

Supervision: [Nicolas Fabre](mailto:nicolas.fabre@cea.fr) (nicolas.fabre@cea.fr), [Mylène Sauty](mailto:mylene.sauty@cea.fr) (mylene.sauty@cea.fr)

Starting date: PhD starting in Fall 2027, can be combined to a M2 internship before

Laboratory: SPEC, Orme des Merisiers, CEA-Saclay (<https://iramis.cea.fr/spec/>)

Context

The interaction between a material and its environment occurs primarily at its surface. Producing high-quality surfaces is therefore an important scientific goal. Nano-structuring this surface makes interactions more selective and allows for new optoelectronic properties. One promising approach is the **self-assembly of molecules** on a crystalline substrate. This method is flexible and allows to obtain a wide variety of organized 2D supramolecular networks with promising properties for optoelectronics and sensing. However, these assemblies are based on non-covalent bonds, making them fragile and thermally unstable.

To strengthen these networks, our approach is to bond molecules together on the surface, thus creating a covalent 2D network. This covalent network formation can be achieved by heating under ultra-high vacuum, which can however induce defects in the surface. An interesting alternative is to **trigger the cross-linking of the network with optical excitation**, which allows for new control parameters: wavelength and polarization of light. We propose to create such molecular assemblies under ambient or ultra-high vacuum conditions and characterize them using optics and scanning probe microscopies.

Objectives

- Preparation and characterization of molecular assemblies, in air or at the liquid–solid interface and in ultra-high vacuum condition, using optical and scanning probe microscopies (scanning tunneling microscopy (STM), atomic force microscopy (AFM)).
- Monitor their evolution under light excitation to demonstrate localized photochemical cross-linking under ambient conditions.

The project will thus establish a proof of principle of light-induced nanoscale chemistry at the wavelength scale, combining optics and scanning probe techniques.

Experimental techniques

Scanning Tunnelling Microscopy

Atomic Force Microscopy

Optical spectroscopy

Sample preparation (spin-coating, Langmuir-Blodgett)

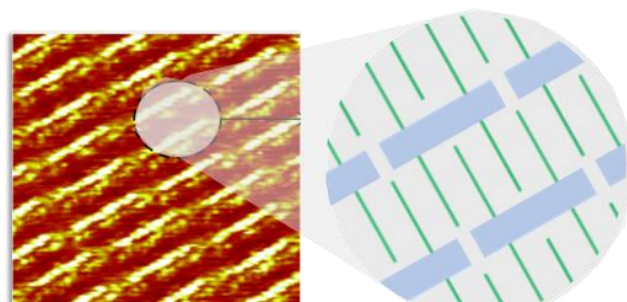


Figure 1: STM image of an assembly of paraphenyl derivative

Environment

We are looking for a motivated candidate with a strong academic background in chemistry or physics, willing to continue for a PhD thesis after the internship. **The thesis is fully funded by an ANR grant.** A visit of the lab and the discussion of the project to adapt to the candidate's interest is possible.