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ONDES ET IMAGES

Single-molecule fluorescence lifetime imaging nanoscopy to study plasmonic and biomimetic materials

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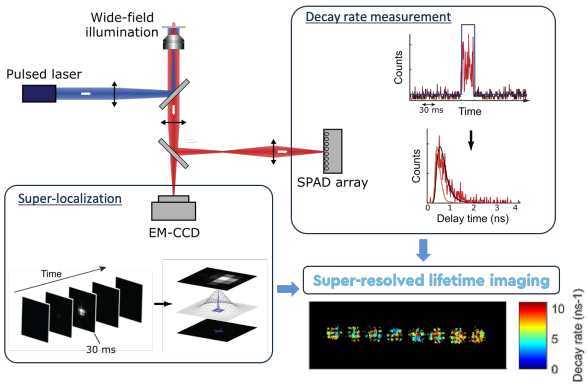
The field of optical fluorescence microscopy has been revolutionized with the emergence of super-resolution imaging, recognized with the Nobel Prize in chemistry 2014. These techniques allow us to image objects with a resolution at the nanometer length scale (~10 nm), well below the classical limit imposed by the diffraction of light (typically ~200 nm). Among these, single-molecule localization microscopy (SMLM) approaches are based on the capacity of detecting single-molecules and the ability of switching on and off fluorescent emitters. **At Institut Langevin, ESPCI Paris, we have further developed such concept and conceived a novel microscopy system capable of simultaneously detecting single fluorescent molecules as well as their fluorescence lifetime, and thus obtaining super-resolved fluorescence lifetime images (smFLIM)**.

smFLIM offers a new way to study single molecule-environment interactions, since it achieves the ultimate spatio-temporal resolution and gives access to multiple scales from 10 µm to 10 nm and from s to ps. So far, we have applied our system to study light-matter interactions in plasmonic nanostructures and obtained super-resolved cartographies of the local density of electromagnetic states (LDOS) of nanostructured plasmonic samples. **This new approach opens up new and exciting applications not only in the fields of materials science and nanophotonics, but also for biological imaging and biophysics.**



Principle of smFLIM. A single emitter is super-localized to determine its position. Simultaneously, its fluorescence lifetime is measured by single photon counting.

We are looking for a motivated student to work with us in the applications of smFLIM on the study of antigen-antibody recognition at the single-molecule level. We will study, in collaboration with the Enzyme and Cell Engineering Laboratory (Compiegne), an emerging class of biomimetic nanomaterials: molecularly imprinted polymer-based (MIP) synthetic antibodies which will be in our case structured in the form of nanoparticles. MIPs are promising materials to replace antibodies in many fields, including bioseparation, bioanalysis, bioimaging, and even medical treatment. While the properties of MIPs have been studied at the macroscopic level, the investigation of single MIPs through the characterization of single binding events is still missing. In the frame of this project, we will set a new experimental framework to study molecular interactions in single MIPs at the single molecule level. **During the PhD project, nanostructured plasmonic materials for efficient second harmonic generation will also be studied in collaboration with the Hong Kong University.**

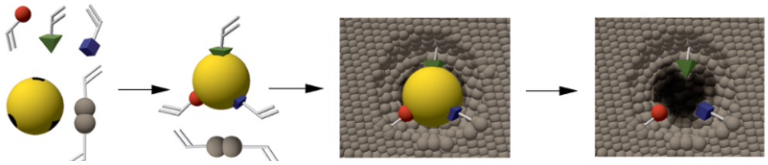


Figure 1: General principle of molecular imprinting. The antigen (yellow) is put in contact with monomers that establish non-covalent interactions. Polymerization is initiated in the presence of a cross-linking monomer (grey) and proceeds around the antigen which acts as a molecular template. Removal of the template reveals specific binding sites in the MIP.

This project has been financed by the ANR and the PhD funding is already secured.