

INTERNSHIP PROPOSAL

Laboratory name: SIMM, Soft Matter Science and Engineering

CNRS identification code: UMR 7615

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Internship location: ESPCI, 10 rue Vauquelin, Paris

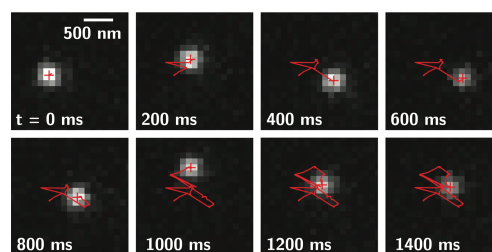
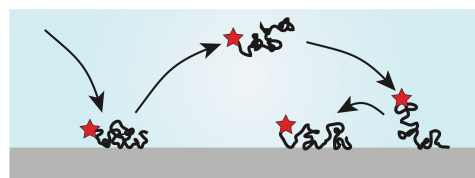
Thesis possibility after internship: YES

Funding: YES

If YES, which type of funding : Ecole Doctorale

Single Molecule Investigation of Polymer Chain Interfacial Dynamics under Flow

Molecular-scale interactions between polymers in solutions and solid surfaces govern a large number of processes in soft matter, ranging from surface functionalization with adsorbed or self-assembled polymer layers, polymer flow in porous media, lubrication and friction by thin polymer layers, etc... These interfacial processes are **typically probed at the ensemble level** and described by average phenomenological coefficients (slip length, surface concentration etc...). Going beyond this traditional description and rationalizing these coefficients requires to be able to **precisely measure and describe the molecular-scale processes taking place at these interfaces**, which remained - until recently - experimentally inaccessible. In the recent years, **novel experimental techniques combining Single Molecule Localization Microscopy with fluorescently tagged polymers** have demonstrated their potential for **direct, in-situ and spatially-resolved study of polymer dynamics at solid/liquid interfaces**, revealing in particular **heterogeneous diffusion of polymer chains at interfaces**, characterized by a succession of **transient adsorption events, followed by fast transport through the solvent** (see Figure and [1-3]).



Dynamics of a single PEG chain hopping at a solid/liquid interface.

The aim of this experimental internship is to take advantage of these **novel Single Molecule techniques** to probe **how interfacial polymer dynamics can be influenced by a flow of solvent**. In particular, close to attractive interfaces, **polymer adsorption may compete with the hydrodynamic flow of solvent**, leading to profound modification of the interfacial dynamics, with **biased chain motion, forced desorption of the chain and modification of the hydrodynamic boundary condition**, all of which remain up know **poorly characterized and understood** [4, 5]. We aim in particular, to probe how **stress transfer to the adsorbed chain is influenced by the flow boundary condition at the solid/liquid interface**, and **chain conformation**. A **fine control of the molecular-scale interactions** between polymer chains and surfaces will be obtained by tuning the physicochemistry of the solvent, polymer and surface, as well as the polymer chain size. These single molecule measurements which will be coupled with statistical analysis of the dynamics, allowing ultimately a **detailed understanding and modelling of polymer and solvent interactions with solid surfaces under flow**.

[1] Granick et al. (2013). ACS nano, 7(11), 9735-9742. [2] Schwartz et al. (2014). Journal of the American Chemical Society, 136(4), 1327-1332. [3] Schwartz et al. (2020). The Journal of Physical Chemistry C, 124(37), 19880-19891. [4] Kumar et al. (2015). ACS Macro Letters, 4(3), 271-274. [5] Granick et al. (2002). Macromolecules, 35(12), 4658-4663.

Associated publications :

Comtet et al. (2020). Nature Nanotechnology, 15(7), 598-604. Comtet et al. (2021). Science Advances

Condensed Matter Physics: NO
Quantum Physics: NO

Soft Matter and Biological Physics: YES
Theoretical Physics: NO