PhD Position

Manipulating individual molecular machines using atomic force microscopy

Labs : Laboratoire de Réactivité de Surface (LRS) & Laboratoire Interfaces et Systèmes Electrochimiques (LISE), Sorbonne Université, 4 place Jussieu, 7525 Paris.

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Speciality : Surface science

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Context

Molecular machines are supramolecular systems for which a movement between at least two entities can be triggered by a stimulus. Molecular machines are expected to play a major role in future smart devices in various fields (electronics, biology or sensing among others). In this framework, we are interested in "daisy chains" that result from the association of self-complementary monomers bearing both a threadable macrocycle (host) and a linear thread (guest).[1],[2] In such systems, the molecular design requires a thread with two distinct binding sites for the macrocycle. In the initial state, the macrocycle is preferentially located over one particular binding site. A chemical, electrochemical or photochemical input is then responsible for an increased affinity of the unoccupied binding site. As a result, the input is converted into mechanical motions leading to a reversible contraction/extension. In this project we will use pillar[5]arene-based [c2]daisy chain molecules, developed in the Nierengartern group (LCMM, Univ Starsbourg), and investigate the possibility of controlling their extension/contraction behavior with an external stimulus. By incorporating appropriate functions onto the stoppers, the molecules will be grafted onto surfaces in order to perform in-depth atomic force microscopy (AFM) measurements.

Objectives

Pillar[5]arene-containing daisy chains will be synthesized by our partner (Nierengarten group). The resulting building blocks will be used to develop new molecular machines in which a chemical input is converted into mechanical motions leading to a reversible contraction/extension, mimicking a molecular muscle. The molecular machines will be grafted onto surfaces using specific protocols, which will be evaluated by means of surface science techniques, including X-ray photoelectron spectroscopy (XPS), IR and Raman spectroscopy. The intramolecular interactions leading to the contraction/extension will be probed by using atomic force spectroscopy at the single-molecule level. Moreover, dynamic force

[1] P. R. Ashton, I. Baxter, S. J. Cantrill, M. C. T. Fyfe, P. T. Glink, J. F. Stoddart, A. J. P. White, D. J. Williams, Angew. Chem. Int. Ed. Engl. 1998, 37, 1294-1297.
[2] M. C. Jiménez, C. Dietrich-Buchecker, J. P. Sauvage, Angew. Chem. Int. Ed. Engl. 2000, 39, 3284-3287.

spectroscopy will be used for the manipulation of individual molecules, with the aim to provide information on the unfolding mechanism of the studied macromolecules.

Candidate background

The candidate must hold a Master 2 in chemistry, physical chemistry, materials science or closely related field. We are seeking a highly motivated candidate, particularly interested on surface chemistry. A knowledge and prior experience in scanning probe microscopies (AFM, STM, …) is a plus.

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