LABORATOIRE D'ELECTROCHIMIE MOLECULAIRE
Université de Paris
Unité Mixte de Recherche CNRS 7591

Post-doctoral Fellowship

Funded by the ANR (National Agency for Research) – 2019

ANR *Project* : SIBI

Title

Full counting statistics of single-electron transfer events in electrochemical processes as a new approach for ultimate biosensing

Keywords *Bio-nano-electrochemistry, Atomic-force electrochemical microscopy, Single molecule electrochemistry, end-tethered DNA dynamics, E-DNA, conformational DNA sensor*

Salary : From 2100 € / month (net income) ***Duration*** : 1 year (renewable)
Starting date : ***From January 2019***
Host Laboratory : Laboratoire d'Electrochimie Moléculaire LEM – Université de Paris, 15 rue Jean Antoine de Baïf, 75013 Paris, France – www.lemp7.cnrs.fr
SIBI project : Coordinator Dr. Christophe Demaille (LEM) - *Research Team* **:** Biomacromolecular systems-Electron transport at the nanoscale. Partner: Dr. Nicolas Clément - Laboratory for Integrated Micro Mechatronics Systems – CNRS.

The main objective of the SIBI project, is to develop a fully original "all-electrical" technology able to sense single electrochemical electron transfer events. We intend to show that this ultimate detection scheme notably enables designing electrochemical conformational DNA sensors (E-DNA sensors) displaying single molecule sensitivity. A redox-labelled single stranded DNA chain, used as a capturing (probe) strand, will be end-attached to a 10 nm size gold nanodot aligned on top of a nanocapacitor. The capacitive sensing platform will be provided by the physicist partner of the project.[1] To establish the proof of principle of capacitive single electron transfer detection, the nanoelectrode-tip of an atomic force electrochemical microscope, operated in molecular touching mode (Mt/AFM-SECM),[2,3] will be used to address electrochemically the redox-reporter of the DNA probe strand. Discrete charging steps of the nanocapacitor, corresponding to the cycling motions of the redox label being oxidized at the tip and reduced at the nanodot, will be detected using state of the art silicon transistor nanotechnology. Observation of these steps will be the first ever demonstration of *single electron counting in electrochemistry*. Beyond this unprecedented detection, measurement of the frequency of the charging steps will yield unique access to quantitative information regarding the conformational dynamics of the end-anchored DNA chain. This experimental setup will be the starting point to the development of an on-chip digital nanoarray E-DNA platform enabling to address modern challenges in DNA nanotechnology and biosensing.

[1] Clément, N.; Nishiguchi, K.; Dufreche, J. F.; Guerin, D.; Fujiwara, A.; Vuillaume, D. A Silicon Nanowire Ion-Sensitive Field-Effect Transistor with Elementary Charge Sensitivity. *Appl. Phys. Lett.* **2011**, *98*, 14104.

[2] Wang, K.; Goyer, C.; Anne, A.; Demaille, C. Exploring the Motional Dynamics of End-Grafted DNA Oligonucleotides by in Situ Electrochemical Atomic Force Microscopy. *J. Phys. Chem. B* **2007**, *111*, 6051–6058.

[3] Chennit, K.; Trasobares, J.; Anne, A.; Cambril, E.; Chovin, A.; Clément, N.; Demaille, C. Electrochemical Imaging of Dense Molecular Nanoarrays. *Anal. Chem.* **2017**, *89*, 11061–11069.

Candidates profile:
The candidate must hold a doctoral degree in chemistry, physics, biology or biophysics. She/he should be a skilled experimentalist. Some experience in local probe microscopies (AFM,…) and in (bio)electrochemistry would be appreciated. Practical knowledge of DNA bioconjugation chemistry would also be a plus.

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