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

Post-doctoral Fellowship

Funded by the ANR (National Agency for Research) – 2024

ANR *Project* : ESHOT

Title

Measuring the shot noise of redox events: a novel sensing approach for nano-bio-electrochemistry

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

Salary : From 2200 € / month (net income) ***Duration*** : 1 year (renewable 2 times)
Starting date : ***From January 2025***
Host Laboratory : Laboratoire d'Electrochimie Moléculaire LEM – Université Paris Cité, 15 rue Jean Antoine de Baïf, 75013 Paris, France – www.lemp7.cnrs.fr
ESHOT project : Coordinator Dr. Christophe Demaille (LEM) - *Research Team* **:** Biomacromolecular systems-Electron transport at the nanoscale. Partner: Dr. Nicolas Clément - Laboratory of system analysis and architecture (LAAS) – CNRS.

The measurement of low faradaic currents associated with the detection of single molecules remains a major instrumental challenge in nano-electrochemistry. Beyond this sensitivity limit, the nature of the measurement itself changes as soon as a "small" number of molecules are involved: deterministic signals give way to the detection of random phenomena. These are manifested in the form of "noise" superimposed on the mean signal, which becomes more important as the number of molecules being probed decreases. In this case, information is not obtained from the time-averaged signal but rather from a statistical analysis of stochastic events. Therefore, the design of electrochemical sensors on the nanoscale must be accompanied by the development of new measurement schemes that allow for the recording and analysis of the stochastic noise component of electrochemical signals.[1]

The objective of this project is to explore this new path for nanoscale/single molecule conformational DNA electrochemical biosensors.

The research in LEM will focus on the study of the redox-cycling noise, generated by redox DNA chains attached by their extremity and confined in electrochemical nanogaps produced by Electrochemical-Atomic Force Microscopy (AFM-SECM).[2] The redox-cycling noise will be acquired and analyzed with the help of a molecular dynamics software, capable of reproducing the Brownian motion of DNA chains and associated electron transfer events,[3] developed by the physicist partner of this project (LAAS). The aim is to understand the underlying physical-chemistry of the redox-noise and determine its potential as an observable for DNA nanodetection.

(1) Grall, S.; Li, S.; Jalabert, L.; Kim, S. H.; Chovin, A.; Demaille, C.; Clément, N. Electrochemical Shot Noise of a Redox Monolayer. *Phys. Rev. Lett.* **2023**, *130* (21), 218001. https://doi.org/10.1103/PhysRevLett.130.218001.

(2) Zheng, Z.; Grall, S.; Kim, S. H.; Chovin, A.; Clement, N.; Demaille, C. Activationless Electron Transfer of Redox-DNA in Electrochemical Nanogaps. *J. Am. Chem. Soc.* **2024**, *146* (9), 6094–6103. https://doi.org/10.1021/jacs.3c13532.

(3) Madrid, I.; Zheng, Z.; Gerbelot, C.; Fujiwara, A.; Li, S.; Grall, S.; Nishiguchi, K.; Kim, S.-H.; Chovin, A.; Demaille, C.; Clement, N. Ballistic Brownian Motion of Nanoconfined DNA. *ACS Nano* **2023**, *17* (17), 17031–17040. https://doi.org/10.1021/acsnano.3c04349.

Candidates profile:

The candidate must have a Ph.D. in chemistry, physics or biophysics. She/he should be a skilled experimentalist. Some experience in local probe microscopies (AFM,…) and/or in electrochemistry would be appreciated.

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