Institut d'Electronique, de Microélectronique et de Nanotechnologie
UMR CNRS 8520

Master and Engineer Internship: 2019-2020

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Research group: NCM @ IEMN (UMR8520)

Title: Chemorecognition through the Molecular Tuning of Conducting Polymers onto Conductimetric Micro- Sensing Arrays

Framework: Chemo-sensing has for long being a quest for us to understand the (bio-)chemical aspects of our world as good as its physical properties, enabling disruptive applications such as threat-level pollutant recognition for indoor/outdoor air quality monitoring,[1] or disease biomarker recognition between healthy/ill patients.[2] Due to the lack of chemo-detecting/electro-transducing universal systems, it has always been more challenging to build chemo-sensors than physical ones. But thanks to the current innovations in artificial intelligence from software (machine learning)[3] and hardware (neuromorphic sensing),[4] new paradigms with different excellence criteria have just been defined:

Goals: In this direction, the master/engineer thesis is focused on defining these new figure-of-merits, by the micro-integration, electrical characterization and data processing of a new molecular sensing technology. By systematically evaluating the sensing properties of doped-conducting polymer, iteratively functionalized on electrode arrays, exposed to different molecular environment, a student will have to show from the support of multivariate data analysis that molecular recognition is enabled by variance maximizing in the highest-dimensionality feature-space, by sensing properties others than selectivity/sensitivity. Both experimental and analytical, the interdisciplinary work will be performed in a highly multidisciplinary team involved also in bioelectronics, neuromorphic electronics and near-field microscopy, where perspectives of a follow-up doctoral thesis will strongly depend on the quality of the results generated by this outstanding master student for the mission.

Methodology: To demonstrate it, the candidate will perform:
- The electrochemical deposition of conducting polymers onto micro-fabricated electrodes, with chemical/electrochemical conditions control/variation on the monomer/dopant.
- Electrical characterization (DC, impedance, pulsed) of the conductimetric microsensing array exposed to different aerial environments.
- Electrical prototyping for sequential (multiplexing) data acquisition (Arduino based).
- Multivariate analysis of high-dimensional electrical signals (such as PCA or DMD).

Disciplines: Organic Electronics; Applied Electrochemistry; Chemical Sensing; Electrical Prototyping; Multivariate Data Analysis.

[1] EC-JRC's Technical Report on "Review of sensors for air quality monitoring" 2019 [link]
[2] Vishinkin et al. *Small* **11**, 6142 (2015).
[3] Li et al. *Sensors* **19**(5), 993 (2019) [open].
[4] Pecqueur et al. *Adv. Electron. Mater.* **4**, 1800166 (2018) [arXiv]