**MASTER DE CHIMIE DE PARIS CENTRE - M2S4**
**Proposition de stage 2019-2020**
***Internship Proposal 2019-2020***

**Domaine de formation visé / *Field of training targeted :***
☐ Chimie Analytique, Physique, et Théorique / *Analytical, Physical and Theoretical Chemistry* :
☐ Chimie Moléculaire / *Molecular Chemistry* :
X Matériaux / *Materials:*
☐ Ingénierie Chimique / *Chemical Engineering:*

**Laboratoire d'accueil / *Host Institution***
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Directeur / *Director (legal representative) :* Christian Bonhomme
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**Equipe d'accueil / *Hosting Team : Reactive Material for Energy Devices***
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Période de stage / *Internship period* * : 6 mois
Gratification / *Salary* : ~ 450 euros

***Conceived, Synthesized and Characterized Bio-anode for paper-based bacterial fuel cell***

**Projet scientifique (1 page maximum) / *Scientific Project (maximum 1 page):***

1. Projet / *Project*

This master thesis proposes **to design a paper based bio-electrodes** for integration in easy, scalable equipment for depolluting water and producing simultaneously electricity. The proposed **paper-based bacterial fuel cell** will have many advantages over other types of fuel cells, as (i) it is capable of **generating electricity from various kinds of organic matter**, such as glucose, urine, biomass, wastewater, and even commercial beverages. Moreover, (ii) **the device structure is much simpler than others**, (iii) the material/fabrication is **cost effective**, and (iv) **these devices are environmentally friendly**, so they can be economically disposed of by incineration.

To do so, we will use our recent development of carbon based paper (Figure 1a). Recently, we have optimized an easy, scalable processes allowing the fabrication of electrode made of intermingled carbon fibers with a diameter of ~ 150 nmm. These electrospun carbon microfibers bioanodes exhibit excellent electrochemical performances. Power and current densities of about 56 $mW.m^{-2}$ and 240 $mA.m^{-2}$, are achieved which is noticeably better than a conventional commercial carbon felts in the same conditions

* 5 à 6 mois à partir du 13 janv 2020 / *5 to 6 months not earlier than January 13, 2020.*

(Figure 1b). These is mainly due to the microstructure of the carbon fibers that is adapted to the bacteria dimension. More importantly, we have also developed a long-term storage of the bioanode through cryodessication.

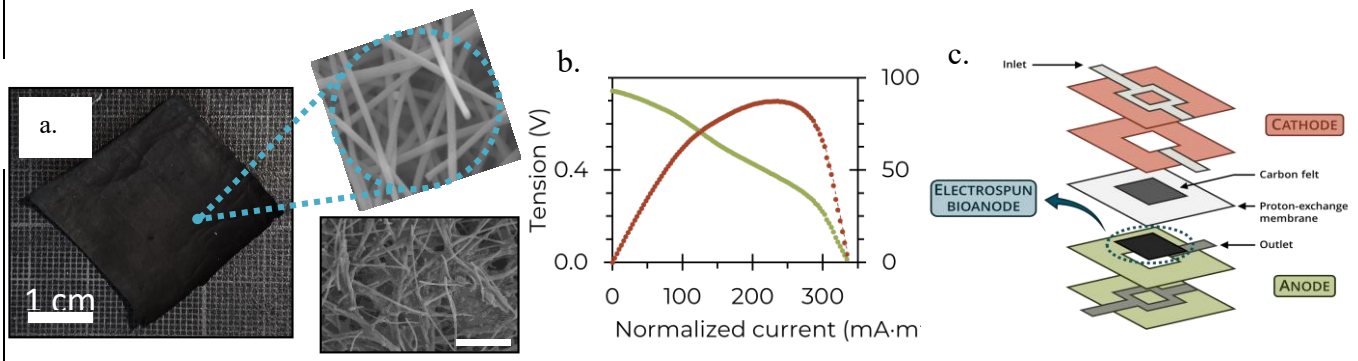


**Figure 1**. a) Colonized carbon paper electrode, b) Electrochemical performance of ex-situ single carbon paper, d) design of the paper-based fuel cell

The main objectives of this master thesis is to **develop a paper based bio-fuel cell** and to evaluate their properties. It will consist in a) the synthesis and the characterization of the carbon paper, b) the integration of the carbon paper in paper based bacterial fuel cell (Figure 1c), c) and the evaluation of their electrochemical characteristic (power and density) at the ambient temperature. Two different anolytes will be used, synthetic anolyte and wastewater. The impact of flow will be analysed onto the electrochemical performances.

2. Techniques ou méthodes utilisées / *Specific techniques or methods*

The synthesis of carbon paper will be performed by electrospinning. The characterization of the carbon paper will be used through Raman Spectroscopy, X-ray diffraction, SEM-EDX analyses and XPS in order to define the structure, the microstructure and the chemical composition. The ex-situ colonization will be performed and the bio-anode will be characterized through different live-dead tests, SEM-EDX analyses in order to localize bacteria and to evaluate their viability. Finally, the performance of the biolectrode will be performed via cyclovoltametry and polarization curves. The impact of anolyte flow as well as the nature of the anolyte will be studied onto the performances.

3. Références / *References*

B. E. Logan & K. Rabaey. Conversion of Wastes into Bioelectricity and Chemicals by Using Microbial Electrochemical Technologies. *Science* **337,** 686 LP – 690 (2012).
B. R. Ringeisen et al. High power density from a miniature microbial fuel cell using Shewanella oneidensis DSP10. Environ. Sci. Technol. 40, 2629–2634 (2006).
D. Pinto. Electronic transfer within a microbial fuel cell. Better understanding of Experimental and Structural Parameters at the Interface between Electro-active Bacteria and Carbon-based Electrodes. *École doctorale Physique et chimie des matériaux (Paris)* (Sorbonne Université, 2016).
J.L Sanchez, (Université de Paris, 2019)