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*
Intitulés / *Name* : Chimie de la Matière Condensée de Paris
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Directeur / *Director (legal representative) :* Christian Bonhomme
Tél / *Tel* :
E-mail : christian.bonhomme@sorbonne-universite.fr

Equipe d'accueil / *Hosting Team : Reactive Material for Energy Devices*
Adresse / *Address :* 4, place Jussieu, 75005 Paris
Responsable équipe / *Team leader* : Christel Laberty-Robert
Site Web / *Web site:* https://lcmcp.upmc.fr/site/rmes-2/
Responsable du stage (encadrant) / *Direct Supervisor: Christel Laberty-Robert*
Fonction / *Position : Professeur*
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Période de stage / *Internship period* * : 6 mois
Gratification / *Salary* : ~ 450 euros

Design of efficient electrode for fuel cell using an innovative approach including electrospinning and electrodeposition processes

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

1. Projet / *Project*

This master thesis proposes **to synthesisze and characterize an electrode for fuel cell working at high temperature under low humidity.** The proposed **geometry** will have many advantages over other types of fuel cells, as (i) it is capable of **generating electricity at high temperature and low humidity conditions, which is highly desirable for automotive application**. Moreover, (ii) **the electrode architecture is much simpler than others**, (iii) the material/fabrication is **cost effective**.

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 have been used as air-electrode in Li-air battery. Because of their open porous network and their excellent electrical conductivity, we have demonstrated that they exhibit excellent performances in term of discharge capacity (Figure 1b).

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

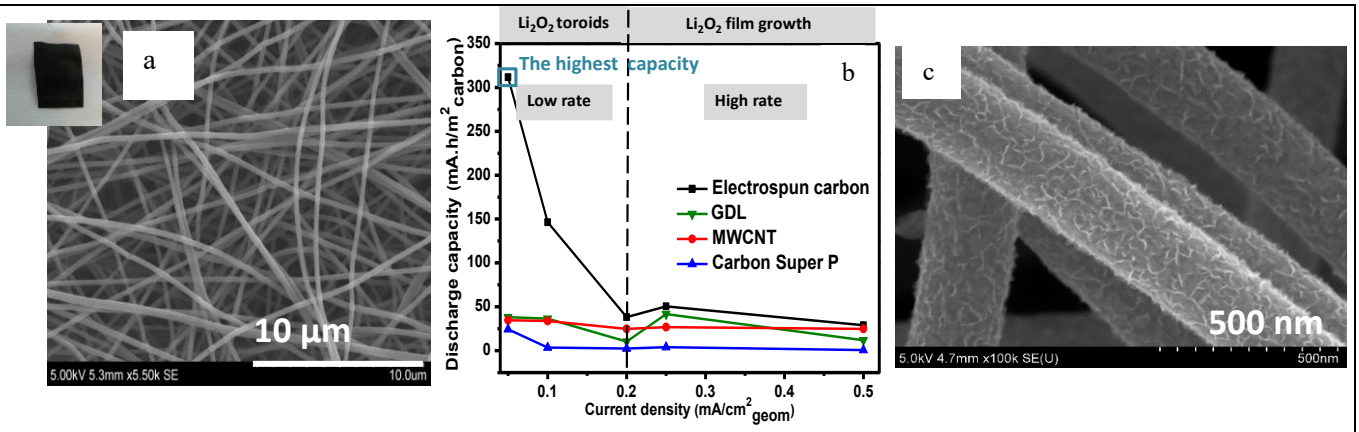

Figure 1. a) Electrospun carbon paper, b) Discharge capacity of electrospun carbon paper, c) electrodeposition of nickel over carbon fibers.

We propose to use these carbon plateform to electrodeposit Pt nanoparticles. We have already experiences in the electrodeposition of nickel nanoparticles under the carbon fibers (Figure 1c). The morphology as well as the density of Pt nanoparticles will be studied as function of the electrodeposition parameters. To control the morphology of the Pt nanoparticles, the use of surfactant is also envisioned.

The electrochemical performance toward the reduction of oxygen will be evaluated by using rotating disk electrode. The performances will be discussed as function of the morphology of Pt nanoparticle, their size as well as their density. Correlations between structure/microstructure and performances will be proposed.

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. HR-TEM analyses will be also explored to characterize the size of Pt nanoparticles as well as their interfaces with the carbon substrate.

The electrochemical deposition will be performed by galvanostatic or amperometric conditions. Different experimental parameters will be studied including current, potential, time.

3. Références / *References*

Kaur, N., Kumar, V. & Dhakate, S. R. Synthesis and characterization of multiwalled CNT–PAN based composite carbon nanofibers via electrospinning. *Springerplus* **5,** (2016).
Improvement of PEMFC performance with Nafion/inorganic nanocomposite membrane electrode assembly prepared by ultrasonic coating technique. *Int. J. Hydrogen Energy* **37,** 16748–16758 (2012).
Nanofiber Fuel Cell MEAs with a PtCo/C Cathode, *Journal of The Electrochemical Society* 166(7):F3202-F3209 · January 2019