

SUJET DE THESE / PhD SUBJECT



OFFRE D'ALLOCATION DE THESE

ÉCOLE DOCTORALE SCIENCES EXACTES ET LEURS APPLICATIONS - ED 211

Avenue de l'université BP 1155 64 013 PAU Cedex – France

Synthesis and Characterisation of Amphiphilic Copolymers for Bioelectronic Applications

RESUME : This PhD focuses on the synthesis, modelling and characterisation of novel polymers and copolymers for bioelectronics. There is a desperate need for new materials suitable for bioelectronic applications, in particular for neural interfacing and bio-sensing, where low biological toxicities, and high sensitivity to mixed coupled electronic & ionic conductivities, are required. The PhD Fellow will be trained to employ polymer chemistry, modeling, and a wide range of characterisation techniques, to deliver innovative materials to meet these demands.

Specifically, the successful candidate will be trained to use established chemistry in a novel methodology to deliver a library of polymers and copolymers targeting high mixed electronic & ionic conductivities. The PhD Fellow will employ a range of techniques (NMR, GPC, UV etc.) to confirm their structures, utilise dynamic molecular modelling (Gromacs and LAMMPS) to generate most probable organisation structures to understand their self-assembly, and perform solid state characterisations (electron microscopy, AFM etc.) to map their fundamental behaviour in the solid state, thereby yielding key initial results for expansion into wider applications.

Collaborations with Prof. N. Stingelin (Bordeaux) and Prof. G. G. Malliaras (Saint-Etienne) will allow further understanding and characterisations thereby providing understanding of, respectively, phase diagrams to better detail structures; and organic electrochemical transistors to characterise mixed electronic & ionic conductivities.

Keywords: polymer chemistry; copolymers; bioelectronics; neurology

CONDITIONS D'EXERCICE / WORKING CONDITIONS

Laboratoire (Laboratory): EPCP et ECP IPREM (UMR 5254), 2 avenue President Angot, 54053 Pau, FRANCE

Site web : <http://iprem.univ-pau.fr/live/>

Directeur et co-Directeur de thèse (PhD Director): Dr. Roger HIORNS, HDR ; Prof. D. Bégué

Lieu (place) EPCP & ECP, IPREM (UMR 5254), 2 avenue President Angot, 54053 Pau, FRANCE

Date début (start): 01/09/2017

Durée (duration): 3 years

Employeur : Université de Pau et des Pays de l'Adour (UPPA)

Salaire mensuel brut (monthly salary before taxes): 1685 € (pour contrat doctoral sur crédits UPPA et collectivités locales)

SAVOIR-FAIRE DU LABORATOIRE / HOST LABORATORY PROFILE

The *Equipe de Physique et Chimie des Polymères* (EPCP) and the *Equipe Chimie-Physique* (ECP) within the IPREM have a long history of creating and modelling new polymers for applications such as organic photovoltaics and have established through international projects strong ties with world-leading groups and companies. The labs have 24 state of the art fume cupboards and a wide range of characterisation equipment along with permanent access to *Centre Informatique de l'Enseignement Supérieur* (supercomputer). This project is supported by world leading groups in solid state polymer characterisation (Stingelin), mixed conductivities (Malliaras).

MISSION - ACTIVITES PRINCIPALES / MISSION – PRINCIPAL ACTIVITIES

Le contexte scientifique - Scientific Context

Mixed electronic/ionic transport in organic materials is attracting attention due to new devices that leverage carrier coupling to enable new modes of operation. One example is the organic electrochemical transistor (OECT), consisting of an organic semiconductor in which injected ions modify electronic conductivity. These devices are efficient transducers¹ of biological activity with applications including neural interfacing^{2,3} and biosensing.⁴

1 D. Khodagholy, J. Rivnay, M. Sessolo, M. Gurfinkel, P. Leleux, L. H. Jimison, E. Stavrinidou, T Herve, S. Sanaur, R. M. Owens, G. Malliaras, *Nature Commun.* **2013**, 4, 2133.

The current lack of fundamental understanding of combined ionic/electronic transport and its connection to morphology and solid-state microstructure hinders rational materials- and device design. The fruit fly for mixed electronic/ionic applications has been poly(3,4-ethylenedioxythiophene)-*compl*-poly(styrene sulfonate) (PEDOT:PSS).⁵ However, being a processed blend without copolymers, film formation gives large variations in film morphology and devices, sparking the race for the development of new materials.⁶

Les objectifs - Science Objectives

- O1. Synthesise new amphiphilic copolymers for bioelectronics;
- O2. Model their aggregative behaviour;
- O3. Work with collaborators to develop understanding of the relations between polymer structures, chain-lengths, self-assembly, and mixed conductivities.

Les résultats attendus - Deliverables

- D1. A newly synthesised library of new polymers and their copolymers;
- D2. A model of their associative behaviour;
- D3. 1 PhD thesis, 5 papers in high impact journals and 1 patent

Les collaborations de recherche – Collaborations

Strong interactions (material exchanges and meetings in person, by Skype and at conferences) with supporting partners in Bordeaux (Prof. N. Stingelin) and EdM Saint-Etienne (Prof. G. Malliaras) will enhance the value of this work through their characterisations and modelling work.

COMPÉTENCES REQUISES / REQUIRED COMPETENCES

The successful candidate will be highly motivated to learn new high-purity synthetic techniques in polymer chemistry. A sound knowledge and background in synthetic chemistry is required. Experience in modelling is advantageous. Excellent communication skills are essential; good English will be a clear advantage.

CRITÈRES D'ÉVALUATION DE LA CANDIDATURE / CRITERIA USED TO SELECT THE CANDIDATE

Traitement du dossier :	Jury de sélection	(The successful candidate will be chosen by jury)
Les candidats seront sélectionnés d'abord sur dossier. Un entretien sera organisé après la première phase de sélection du dossier de candidature.		(1 st selection is made on the application, 2 nd by jury)
• Adéquation entre le diplôme de Master (ou équivalents) et le sujet de these	(Relevance of prior studies to the PhD)	
• Notes et classements en Master, et régularité dans le cursus universitaire	(Consistency of marks in prior exams)	
• Maîtrise de l'anglais	(English proficiency)	
• Capacité du candidat à présenter ses travaux	(Capacity to report work)	
• Expériences professionnelle de type stage(s) en laboratoire ou autre ; éventuels travaux de recherche déjà réalisés (rapports, publications).	(Relevant laboratory and related experiences)	

CONSTITUTION DU DOSSIER DE CANDIDATURE, DATE LIMITE DE DEPOT / REQUIRED DOSSIER, DATE

Envoyer par email un dossier de candidature comprenant / send an e-mail with your candidature containing	
• CV	
• lettre de motivation	cover letter detailing your motivations
• relevé de notes et classements en Master (sous réserve d'obtention du Master 2)	your MSc marks or expected MSc subjects if Master to be completed after April
• lettres de recommandation	any letters of recommendation
• coordonnées des personnes du milieu professionnel (minimum 2) à contacter	contact details for 2 referees

DATE LIMITE DE DEPOT DU DOSSIER (limiting date) :	30 / 4 / 2017
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CONTACT

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- 2 D. Khodagholy, T. Doublet, P. Quilichini, M. Gurfinkel, P. Leleux, A. Ghestem, E. Ismailova, T. Hervé, S. Sanaur, C. Bernard, G. G. Malliaras, *Nature Commun.* **2013**, *4*, 1575.
- 3 J. Rivnay, P. Leleux, M. Ferro, M. Sessolo, A. Williamson, D. A. Koutsouras, Dion Khodagholy, Marc Ramuz, X. Strakosas, R. M. Owens, C. Benar, J.-M. Badier, C. Bernard, G. G. Malliaras *Sci. Adv.* **2015**, *1*, e1400251.
- 4 P. Lin, F. Yan, J. Yu, H. L. W. Chan, M. Yang, *Adv. Mater.* **2010**, *22*, 3655.
- 5 J. Rivnay, S. Inal, B. A. Collins, M. Sessolo, E. Stavrinidou, X. Strakosas, C. Tassone, D. M. DeLongchamp, G. G. Malliaras. *Nature Commun.* **2016**, *7*, 11287.
- 6 A. Giovannitti, C. B. Nielsen, D.-T. Sbircea, S. Inal, M. Donahue, M. R. Niazi, D. A. Hanifi, A. Amassian, G. G. Malliaras, J. Rivnay, I. McCulloch *Nature Commun.* **2016**, *7*, 13066.