PhD 4D-E Biocell

"4D microporous and electrostimulable scaffold as innovative cell culture platform"

CY Cergy Paris Université, Labs of I-MAT :

LPPI : https://www.cyu.fr/cy-lppi-laboratoire-de-physicochimie-des-polymeres-et-des-interfaces

ERRMECe : https://errmece.u-cergy.fr/

The PhD project is to develop a *4D microporous and electrostimulable scaffold as innovative cell culture platform* that will combine controlled biochemical, topographical, mechanical and electrical cues, along with tunable actuation. This smart and electro-responsive 4D-cell culture scaffold aims at recapitulating *in vitro* the diversity and dynamic of *in vivo* signals, which physio/pathologically regulate cells' behavior. To better mimic the native cells' biological living 4D-environment, the development of relevant in vitro cell culture platform is a long-standing challenge with perspectives in advanced cell biology, drug screening and tissue engineering [i]. To date promising *in vitro* **3D-porous polyHIPE**-based scaffolds are developed. The emergence of electronic conducting polymers (ECPs) is of interest to turn synthetic scaffolds from passive to **active conducting scaffolds**. Additionally, conducting polymers can provide **electromechanical dynamic** (volume, stiffness, force…) when reversibly switched from oxidized to reduced states, using low electrochemical potentials (~ 1V). This uncommon behavior of ECPs makes possible the development of materials with **controllable volume/pore size changes**[ii]**,** adding a 4th dimension to 3D scaffolds and allowing theoretically both **electrical and mechanical stimulations during cell culture.**

Work program:

Synthesis of 3D passive polyHIPE scaffolds with a wide range of properties will be carried out at LPPI by photopolymerization of foam-like high internal phase emulsions (figure 1a). Mechanical properties, scaffold porosity, and interconnecting hole size will be evaluated and optimized. SEM analyses and confocal (CLSM) microscopy will show the porous structure at different scale.

Passive polyHIPEs will be functionalized with ECP according to a two-step procedure involving vapor phase swelling with EDOT following by its oxidative polymerization into PEDOT (figure 1b). 3D electroactive polyHIPEs will be characterized in terms of electrochemical stimulation/beating and mechanical forces using 3D imaging reconstruction in CLSM and time-resolved bio-indentation experiments, respectively.

Then colonization of the 3D-electroactive scaffolds by fibroblasts cells will be studied at ERRMECe using wide-field, confocal and electron microscopies (figure 1c). Cells viability, proliferation, spreading, and adhesion will be analyzed. With respect to material properties, cells' phenotypes as well as cells' responses to electrostimulation and to 4D-modulation of cell culture platform will be followed

using biochemical and cell biology approaches. A marked attention will be paid to phenotypic transitions. In collaboration with IBPS, the opportunity to use the 4D-electroactive cell culture platform to develop a model of cardiac fibrosis microenvironment will be evaluated.

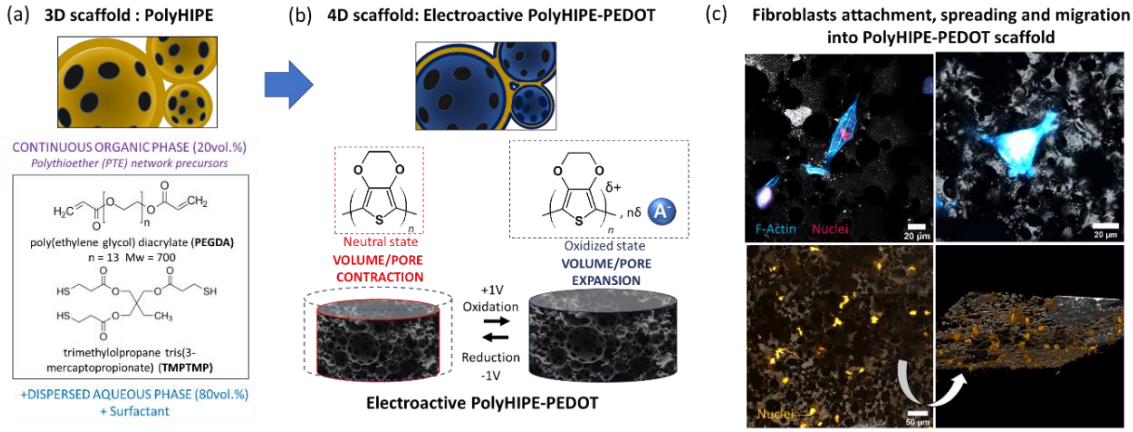

Figure 1 : (a) 3D micro-porous PolyHIPE, (b) electromechanical stimulation of electroactive polHIPE-PEDOT, (c) SEM of the electroactive PolyHIPE and (d) confocal laser scanning microscopy (CLSM) image of stained fibroblasts on the porous scaffold

By the end of the thesis, the PhD candidate will be competent in polyHIPEs synthesis and characterization, ECP functionalization, imagery analysis, cell culture, cell biology, and biochemistry.

Candidate Profile

- Master degree graduated in biology / biochemistry / biomaterials /chemistry with a strong scientific interest on material chemistry and multidisciplinary approaches.
- Skills in cell culture, imagery acquisition and analysis, and material synthesis**.**
- A high level of scientific English and correct expression/writing.
- Curiosity, autonomy, rigor and capacity to work within multidisciplinary team are required.

Starting date, duration, funding

Starting from Autumn 2021, for a duration of 36 months.

Funding : Respore (https://www.respore.fr/)

Localization and Supervision :

The thesis student will participate in the Respore funded project 4D-eBioCell under the supervision of C. Plesse, HDR, A. Ferrandez-Montero, C. Vancaeyzeele (LPPI) J. Leroy-Dudal & R. Agniel (ERRMECe).

She/ he will be integrated into LPPI/ERRMECE/I-MAT units– CY Paris Cergy University.

The student will benefit from the experience of the host teams and will interact with post-docs and other students in the groups to carry PhD in a highly dynamic and stimulating environment.

Application - Dead line June 01st 6.00 PM.

Send a complete CV and a letter of motivation to (in a unique pdf file named "Application4DeBioCell2021-NAME") : remy.agniel@cyu.fr

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[i] Huang G. et al. Chem. Rev. (2017), 117, 20, 12764–12850.

[ii] Otero et al. J. Mater. Chem. B, 2016, 4, 2069--2085