Proposition de stage de M2 2020-2021
M2 Internship Proposal 2020-2021

Spécialité(s) / *Specialty(ies) :*
☐ Chimie Analytique, Physique, et Théorique / *Analytical, Physical and Theoretical Chemistry* :
☑ Chimie Moléculaire / *Molecular Chemistry* :
☑ Matériaux / *Materials :*
☐ Ingénierie Chimique / *Chemical Engineering :*

Laboratoire d'accueil / *Host Institution*
Intitulés / *Name* : Institut Parisien de Chimie Moléculaire (IPCM), UMR 8232
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Site Web / ***Web site :*** http://www.ipcm.fr/article599.html
Responsable du stage (encadrant) / *Direct Supervisor : François Stoffelbach, Jutta Rieger*
Fonction / *Position :* Maitre de Conférences (S.U.) - Chargé de Recherche (CNRS)
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Période de stage / *Internship period**: 18 janvier 2021 – juin/juillet 2021
Gratification / *Salary:* ~550 €/mois

Sujet / Title
Synthesis and Characterizations of Thermoresponsive Block Copolymers in Water for Drug Delivery Applications

Projet scientifique / *Scientific Project:*

1. Projet / *Project*

The efficiency and effectiveness of *drug delivery* (DD) is dependent on the properties and chemical structure of the drug carrier. Therefore, the synthesis and formulation of new drug delivery systems (DDS) is an important research subject in material science. Polymer is a promising material in this field because of its versatility, diversity and the possibility to design nanometric drug delivery systems that are tunable in size and morphology. While *Reversible Deactivation Radical Polymerization* (RDRP) is a useful polymerization technique for the preparation of well-defined macromolecular architectures, *Polymerization-Induced Self-Assembly* (PISA) process in water is a straightforward and effective method to prepare *in situ* nano-objects of different morphologies based on amphiphilic block copolymers [1]. In PISA, the most used RDRP technique is RAFT (*Reversible Addition-Fragmentation chain-Transfer*). This strategy has been extensively studied in the past ten years for the elaboration of nano-objects with original morphologies like nanometric spheres, cylinders, fibers or vesicles [2].

* min. 5 mois à partir du 18 janvier 2021 / *min. 5 months not earlier than January, 18th 2021.*

In terms of intelligent materials, *stimuli-responsive polymers* are of great interest in polymer chemistry and material science. In this class of polymers, *thermoresponsive polymers* with either a Lower Critical Solution Temperature (LCST) or an Upper Critical Solution Temperature (UCST) are the most explored. Indeed, thermosensitive polymers respond differently with temperature variations: LCST polymers are soluble at low temperature and precipitate at high temperature and UCST polymers precipitate at low temperature and are soluble at high temperature. Thanks to this property, a great variety of thermo-responsive systems have been designed for biological and environmental applications such as drug delivery, molecular purification/separation or development of thermal sensors [3].

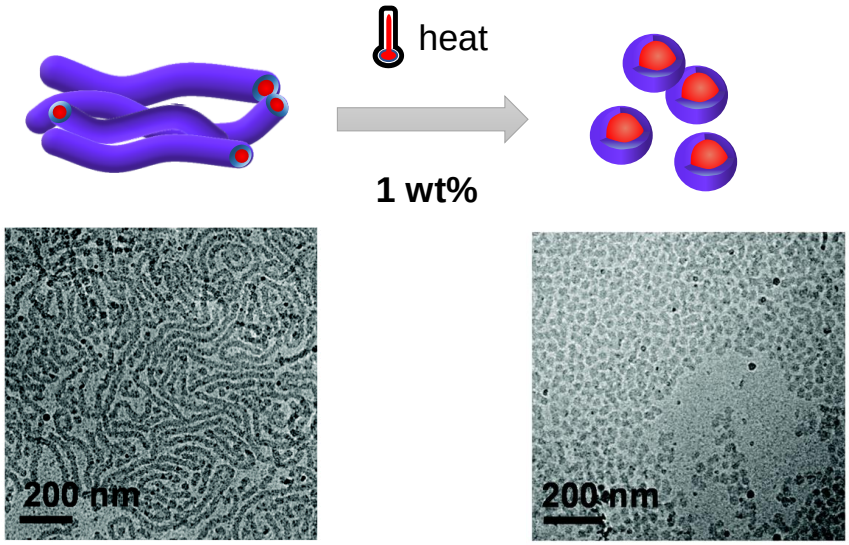

Figure 1*: Morphology transition of thermoresponsive block copolymers synthesized by PISA [4]*

In this internship project, the aim is to use the PISA procedure to synthesize *-in water-* nano-objects of different morphologies with thermoresponsive characteristics such as temperature-induced morphological transition (Figure 1), which are expected to provide great efficiency in drug delivery.

We are looking for a highly motivated M2 student interested in polymer synthesis with good lab skills. Knowledge on RDRP techniques, synthesis of block copolymers as well as polymer characterization is highly appreciated. This project offers the possibility to the intern to work on polymer synthesis using a new technology (PISA) and various characterization techniques that will be highly useful either for an academic career or in industry.

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

The main work of this internship will be to (1) synthesize polymers by radical polymerization in emulsion or dispersion in water, (2) characterize the polymers and (3) study their self-assembly and thermoresponsiveness.

3. Références / *References*

[1] B. Charleux, G. Delaittre, J. Rieger, F. D'Agosto, *Macromolecules* **2012**, 45, 6753.
[2] J. Rieger, *Macromol. Rapid Commun.* **2015**, 36, 1458.
[3] P. Zarrintaj, M. Jouyandeh, M. R. Ganjali, B. S. Hadavand, M. Mozafari, S. S. Sheiko, M. Vatankhah-Varnoosfaderani, T. J. Gutiérrez, M. R. Saeb, *European Polymer Journal*, **2019**, 117, 402–423
[4] N. Audureau, F. Coumes, J. M. Guigner, T. P. T. Nguyen, C. Ménager, F. Stoffelbach, J. Rieger, *Polym. Chem.* **2020**, *in press*