MASTER DE CHIMIE DE PARIS CENTRE - M2S2
Proposition de stage 2018-2019/Internship Proposal 2018-2019

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*
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Période de stage / *Internship period* * : février - juin
Gratification / *Salary*

Title: Stimuli-responsive emulsion stabilized by amphiphilic block copolymers for drug delivery systems

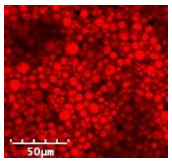
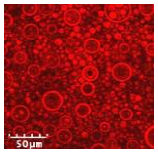
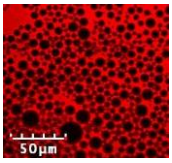
Projet scientifique (1 page maximum) / *Scientific Project (maximum 1 page):*

1. Projet / *Project*

Emulsions (out-of-equilibrium mixtures of oil and water stabilized by surfactants) are a very important subject in applied science due fact that they bring together two incompatible liquids. In particular, there is a special need for designing stimulable emulsions where an oil-in-water phase (O/W) can be switched into a water-in-oil phase (W/O) by external stimulus. Multiple emulsions (like W/O/W phase) are more complicated to stabilize on the long run and this has limited their practical importance. However their potential is important either in drug delivery or in cosmetics and food industry. In our laboratory, we have designed a class of new amphiphilic copolymers which are able to stabilize such emulsions. These copolymers are made of a poly(styrene) block (PS) and of a statistical block of PS and poly((2-dimethylamino)ethyl methacrylate) (PDMAEMA) by controlled radical polymerization. At low pH and low temperatures, such copolymers stabilize O/W phases while at higher pH and temperatures W/O phases are found if the copolymer is enough hydrophobic. This change of phases is dynamical since, when prepared at pH around 6, a rise in the temperature induces a transition from an O/W to a W/O phase [1] while decreasing the temperature reverses the transition. More recently, we have explored in greater

* 5-6 mois à partir du 21 janv 2019 / *5-6 months not earlier than January, 21st 2019.*

detail the pattern of phases for O/W emulsions and discovered that very stable multiple emulsions are also stabilized by such copolymers. This is very intriguing phenomenon since usually two kinds of surfactants are needed for the formation of stable multiple emulsions. The pH range where such multiple emulsions appear is highly dependent on the polymer architecture. We thus propose to extend our knowledge in studying the effect of the molar mass of the copolymers on the encapsulation potential of the multiple emulsions. Varying this parameter is very challenging and may give a much better fondamental understanding of the making of multiple emulsions for encapsulation applications, in particular in cosmetics or pharmaceutical industries.

		
Oil in water emulsion at pH : 2-4	Multiple emulsion at pH : 4-7	Water in oil at pH : 7-11

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

Synthesis of block copolymers by atom transfer radical polymerization (ATRP), Size Exclusion Chromatography (SEC), Differential scanning calorimetry (DSC), emulsification process, Scanning electronic microscopy (SEM), optical microscopy

Expected results: Synthesis and characterization of styrene and (2-dimethylamino)ethyl methacrylate based copolymers; Diagrams of emulsion type as a function of pH, ionic strength, temperature and copolymer molar mass.

3. Références / *References*

- L. Besnard *et al. Advanced Materials*, **25(20)**, 2844-2848 (2013); *Soft Matter*, **10**, 7073-7087 (2014)
- M. Protat *et al*. *Langmuir*, **32**, 10912-10919 (2016)