## PhD thesis offer

# Title: Microgels as recyclable sorbents and foaming agents for critical metal recovery.

**Keywords:** Soft matter, Nano-/Microgels, Responsive polymers, Biopolymers, Emulsions, Foams, Interfaces, Nano-ions, Adsorption, Recycling, Critical metal recovery.

**Context**: The CATCH project, funded by **the French National Research Agency (ANR)**, is a collaboration between the team of Valérie Ravaine, ISM, University of Bordeaux, CNRS, Bordeaux INP, the team of Véronique Schmitt, CRPP, CNRS, University of Bordeaux and the team of Pierre Bauduin, CEA, ICSM, Marcoule. The teams are experts in soft matter systems, including foams and emulsions.

**Summary of the project:** Microgels are soft colloidal particles made of lightly cross-linked polymers, swollen by a solvent. Microgels have received a growing interest over the past 20 years, due to their high potential in the fields of catalysis, drug delivery, (bio)sensing and even as formulation additives such as rheological modifiers or drilling fluids. Microgels have peculiar properties compared to other colloidal particles. Due to their **porous structures**, they can be used as payload carriers or **sorbents**. These particles are also **soft and deformable**, which give them special properties either at the individual scale or in their collective behavior. In addition, they are also well-known for their **stimuli-responsive properties**. Indeed, slight changes of temperature, pH, the presence of an analyte or the application of an external field can trigger important changes in their swelling degree.
**Microgels** are also able to adsorb spontaneously at liquid interfaces (liquid-gas or liquid-liquid). As such, they **can stabilize emulsions and foams**. These latter are called **Pickering emulsions and foams**. Due to the stimuli-responsiveness of microgels, emulsions and foams stabilized by microgels can be stable during storage but can also be destabilized on demand, upon the application of the stimulus.

In this project, our intention is to develop an innovative strategy for selective metal-cation separation based on the combination of superchaotropic nano-ions and responsive polymer microgels. In recent preliminary results, we have shown that **low-charge-density nano-ions**, exhibiting superchaotropic behavior, can be efficiently captured within microgel networks. In this hybrid system, nano-ions will act as anionic extractants to selectively bind critical or rare-earth metal cations from waste streams (e.g., lixiviates from e-waste or mining residues), while microgels serve both as recyclable sorption platforms and as foaming agents that transport nano-ion/metal complexes for separation by skimming of the foam. The added value of the project lies in introducing a **new conceptual framework for ion separation**, integrating nano-ion chemistry, responsive colloidal materials, and interfacial processes. This approach has strong potential for **circular economy applications**, ranging from fundamental studies to real-world samples, including the valorization of **mining residues** and recovery of critical metals from complex aqueous mixtures.

The PhD thesis will be part of a collaborative network. Specifically, the objectives of the proposed PhD thesis will be two-fold. 1) First, model temperature and pH-responsive microgels with controlled structure will be synthesized. Their interaction with nano-ions bearing various counterions will be studied in different conditions. These studies will allow a better understanding about the role of microgel structure on the binding. Then, the role of nano-ion adsorption on the behavior at the air-water interface or oil-water interface will be studied on either model interfaces or emulsions, before being transposed to foams. 2) The second objective of the project will be the development of bio-based microgels in replacement of model ones. The outcome of the thesis will be to open perspectives in the area of metal recovery using microgel-stabilized foams/emulsions, while providing a better understanding about the mechanisms underlying the stabilization/destabilization of these systems. The results will open perspectives in the area of water depollution as well as catalysis.

The CATCH project is inherently interdisciplinary, traversing concepts of chemistry and physics. It entails molecular and macromolecular organic synthesis, advanced characterization techniques (which cover the chemical, physical, and mechanical aspects of the new materials), polymer processing, and engineering of metal capture systems.

**Job description:**

The successful candidate will work at the ISM and CRPP, University of Bordeaux on the following activities:

- Synthesis of model polymer particles and original ones made of biopolymer;
- Characterization of the particle microstructure (individual scale);
- Study of the adsorption of nano-ions on microgels by spectroscopy;
- Study of their behavior in suspension, under stimulus, with and without nano-ions;
- Study of their behavior at interfaces;
- Study of the formulated systems, emulsions and foams.

He/she will spend short-term stays at ICSM - CEA in Marcoule for Small-Angle X-Ray scattering or flotation studies. Opportunities for international collaborations are expected in the course of the project.

**Supervision:**

Pr **Valérie RAVAINE**, ISM ; valerie.ravaine@ensmac.fr; tel : +33-(0)556846613.
Dr **Véronique Schmitt,** Centre de Recherche Paul Pascal. veronique.schmitt@crpp.cnrs.fr
**Host institution: University of Bordeaux - Institut des Sciences Moléculaires** (ISM, CNRS UMR 5255, NSYSA group) located at ENSMAC, Pessac, France

**Candidate profile**:

- Experimentalist, Master in Chemistry or Physics with a focus in polymers and/or colloid science
- Spoken and written competences in English and/or French (C1 level or higher)
- Aptitude for team-working; with critical thinking, in a highly organized fashion, ability for scientific communication (both written and oral), ability to operate a literature survey

- Practical experience in academic laboratories specializing in soft matter or polymer chemistry would be a significant asset.

**How to apply**: *e-mail the following documents*

- CV including your relevant professional experience and knowledge.
- Application letter with a brief description of why you want to pursue research studies, about what are your academic interests and how they relate to your previous studies and future goals. (Maximum 2 pages long)
- Copies of diplomas and grades from previous university studies and certificates of fulfilled language requirements (see above). Translations into English or French if the original document is not issued in one of these languages
- Recommendation letters are encouraged.

**Submission deadline: October 7th, 2026**

**Starting period:** January 2027.