PhD position
Anisotropic liquid phases for a new path in liquid-liquid extraction process

Context and work environment

Context: Recycling and depolluting are some of the biggest tasks of our society in the current time. For this purpose, finding greener processes for ionic or molecular extraction, based on liquid-liquid phase separation, is one of the very challenging problems faced to material scientists. In this aim, thermomorphic Aqueous Biphasic Systems (ABS) have been explored and concept has been proved. Beyond this nowadays established extraction process, further properties of the solutions, at equilibrium or under external constraints, can be explored to optimize the extraction paths.

In this context, the objective of this project is to explore a system based on decanoic acid and lidocaine, a deep eutectic solvent avoiding the use of strong (HCl, HNO_3…) acids, still enabling extraction of organic pollutants or nickel ions. It presents rich organization properties at the nanometric scale, even leading to anisotropic phases, and viscosities spanning several orders of magnitude between the different liquid phases. Regarding extraction processes, rheological properties play an important role in terms of transport of pollutants from one phase to another, flow velocity during mixing, separation kinetics etc.

Understanding the relation between rheological properties and phase separation, as well as rheology and transport in the bulk solution and across the liquid-liquid interface is the first aim of this project. Furthermore, the anisotropic organisation, at the molecular level, of the solution, may have consequences in terms of impurities locations and transport. We therefore aim at understanding the implications of this anisotropy on the extraction process. Eventually, a shear flow will reinforce this anisotropy and may be a new way of improving these processes in such self-organized liquid systems.

The PhD will be carried on between two laboratories located on the Grenoble campus:

- The Laboratory for Interdisciplinary Physics (LIPhy), which has expertise in scattering techniques (neutron, X-rays) and knowledge on the aqueous biphasic systems
- The Laboratory of Rheology and Processes (LRP), which has expertise in rheology and develops techniques for out of equilibrium X-ray scattering experiments.
- And a minimum of 2 months in the society APERAM, where analytical chemical characterizations will be performed in real metallic extraction conditions.

The PhD will be carried out under the direction of Marie Plazanet (LIPhy) and Frédéric Pignon (LRP). Isabelle Billard (LEPMI, Grenoble), as collaborator, is also part of the team.

This recruitment takes place within the PhD@Tec21 Program, which is co-funded as part of the Marie Skłodowska-Curie COFUND actions under the grant agreement #101217261. The recruitment process follows a specific selection and evaluation procedure with particular eligibility criteria, all of which are detailed in the applicant guide available on PhD@Tec21 Website.

Anisotropic liquid phases for a new path in liquid-liquid extraction process
Description of the project: The objective of this project is to explore the system based on decanoic acid and lidocaine. This particular system combines the properties of aqueous, thermomorphic systems and deep eutectic solvents. It presents rich organization properties at the nanometric scale because of dimers formations and organisation, even leading to anisotropic phases, and viscosities spanning several orders of magnitude between the different liquid phases. We will first investigate the aqueous biphasic properties for extraction processes. Here, rheological properties play an important role in terms of transport of pollutants from one phase to another, flow velocity during mixing, phase separation kinetics etc. Understanding, at different scales, the relation between rheological properties and phase separation, as well as rheology and transport in the bulk solution and across the liquid-liquid interface is the first aim of this project. Furthermore, the anisotropic organization, at the molecular level, of the solution, may have consequences in terms of impurities locations and transport. This can be explored either in monophasic or biphasic states. We therefore aim at understanding the implications of this anisotropy on the extraction process. Eventually, a shear flow will reinforce this anisotropy and may be a new way of improving these processes in such self-organized liquid systems. The proposed work is split into three axes. The first one is centered on a deeper characterization of the system at equilibrium. The second one aims at giving a microscopic description of the origins of the flow properties, using structural characterizations (small-angle X-ray and light scattering dichroism) under shear flow. Eventually, the third package will investigate the transport properties, in characterizing diffusion processes in the different phases or shear/flow conditions in order evaluate the effect on the extraction efficiencies and kinetics. Following a first work of characterizations across the phase diagram, different axis could be taken: **Possible research axes:** **1. Analytical physical-chemistry, optimization of extraction of different type of compounds** **2. Structural characterizations of the different phases and analysis of transport phenomena** **3. Out of equilibrium behavior of the mixture and implication on the extraction processes**
Supervisors: Marie Plazanet (LIPhy) and Frédéric Pignon (LRP)
Research fields: Chemical Physics, Chemical Engineering, Fluid Mechanics, Soft Matter
Possible secondments: *APERAM*
Doctoral school: ED PHYS: Physics

Desired profile and expected skills

Education, diplomas. The ideal candidate should hold a Master's degree (or equivalent) in physics, chemistry or chemical engineering, with a strong background in one or more of the following fields: liquid-liquid extraction, scattering techniques (light, X-ray or neutrons), rheology, characterization techniques for soft matter.

Disciplinary skills, experience. Strong experimental and analytical skills, interests in interdisciplinary research are essential.

Personal skills. The project requires good organizational, time management abilities and strong communication skills to collaborate with different research teams. Candidate's key assets for success in this project are strong scientific curiosity together with a proactive attitude, perseverance, and openness to learning new methods. The candidate should be capable of working independently and creatively, with excellent analytical and problem-solving skills and a high precision in experimentation and reporting.

Employment benefits and conditions

Université Grenoble Alpes (UGA) is offering a 36-month full-time work contract. In line with the European Commission rules for Marie Skłodowska-Curie grant holders, the remuneration will consist of a gross monthly salary of 2,669 EUR. The estimated net salary to be perceived by the PhD fellow will be between 2,050 and 2,152 EUR[1].

Benefits include:

- Access to a high-quality work environment, including a personal computer, scientific equipment and access to library and shared lab facilities
- Full social security benefits and participation to health insurance
- Access to high-level scientific and inter-sectoral training through 120 hours of doctoral courses and workshops
- Opportunity for 2-month secondments at an academic institution or industrial partner during the 2nd year of the PhD
- A vast choice of networking events and activities within the PhD@Tec21 Programme and through the international network of MSCA fellows
- Access to the UGA International Student Office, to assist the PhD fellows in searching for accommodation in Grenoble and support with administrative issues including visas, health, bank accounts, etc.
- Visa fees and registration to the UGA Doctoral School are covered by PhD@Tec21
- Sick leave, parental leave, 45 days of paid holidays

General information

Contact for the questions related to the position:
PhD@Tec21 Management Board: guillaume.chambon@univ-grenoble-alpes.fr / amelie.bataille@univ-grenoble-alpes.fr

[1] As an average over the 3 years, depending on French tax regulations. Fellows might benefit from an additional allowance depending on their family situation (74 EUR monthly net allowance)