ITI HiFunMat Master Internship Proposal

☐ M 1 ☒ M 2

Title Dynamics of Bottlebrush Complex Coacervates

Internship supervisor

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Laboratory	CNRS, Institut Charles Sadron
Collaboration with a HiFunMat member (*please indicate their name*)	☐ No ☒ Yes : Chan-Seng, Delphine

Student profile looked for

Master program (*more than one box can be ticked)*	☒ Material science and engineering ☒ Chemistry ☐ Physics
Other indications if necessary	Candidates interested in polymer chemistry and physical chemistry are encouraged to apply. Experience and or good marks in polymerization reactions and polymer physical chemistry will be an advantage.

Internship description

Context

Polyelectrolytes complex coacervates are obtained via associative phase separation of oppositely charged polyelectrolytes in aqueous medium. From biological cell compartments to the sandcastle worm glue, complex coacervates are ubiquitous in nature [1,2]. They are particularly interesting for being water-rich but immiscible with their supernatant and for their widely tunable mechanical properties. Recent research has highlighted the importance of the macromolecular parameters such as polymer molecular weight, chemistry, and architecture on the properties of the resulting complex coacervates. For instance, bottlebrush polyelectrolytes were shown to lead to gel-like complexes due to the interpenetration of the side chains [3].

However, a systematic understanding of the impact of the macromolecular parameters of bottlebrush polyelectrolytes, namely the branching density and the molar mass of the backbone and the side chains, on the phase behavior and the mechanical properties of the resulting complex coacervates. Previous research has shown the nontrivial impact of these parameters on the mechanical properties of chemically crosslinked polymer networks [4].

Objectives

The internship subject aims to synthesize oppositely charged polyelectrolytes with bottlebrush architectures and study the phase behavior and mechanical properties of the resulting complex coacervates. The intern will synthesize branched polymers of various branching densities by controlled radical polymerization. The polymers obtained will be characterized via nuclear magnetic resonance (NMR) spectroscopy and size-exclusion chromatography (SEC). A series of complex coacervates will then be prepared based on these polyelectrolytes. The composition of the complex coacervates will be determined via thermogravimetric analysis and the mechanical properties will be characterized using a rheometer.

References

[1] Martin, *ChemBioChem*, 2019, 20, 2553; **[2]** Vahdati, et al. *Prog. Polym. Sci*, 2023, 1392; **[3]** Stevens, Tirrell, *J. Polym. Sci*, 2023, 62, 1; **[4]** Maw, et al. *Macromolecules*, 2022, 55, 2940.