Physics and mechanics of polymer solutions and gels in novel green solvents

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Approximate starting date: Jan-March 2025
*Note that the lab is within a ZRR (Zone à Régime Restrictive)

Context

Organic- Soft polymers networks swollen in water, known as hydrogels, are promising for many applications from biomedical devices to soft robotics. The use of hydrogels is limited by their low fracture resistance and their short-term environmental stability. Current strategies to reinforce the fracture resistance of hydrogels consist in providing the polymer network with energy dissipation mechanisms [1], for instance, by introducing a first sacrificial network into double-network hydrogels [2].
In this context, little attention has been paid to potential effects of the solvent. Deep Eutectic Solvents (DES) are an emerging class of green solvents formed due to hydrogen bonding interactions between hydrogen bond donors and acceptors at specific compositions. These typically viscous liquids are particularly interesting due to their widely tunable physico-chemical properties, dense network of hydrogen bonding, and extremely low volatility [3]. Preliminary results from our group show that single-network gels prepared in a model DES have enhanced nonlinear mechanical properties compared to their hydrogel counterparts.

Objectives

The goal of the internship is to investigate DES as polymerization medium and its effects on the network structure and mechanical properties of polymer networks. The role of the solvent viscosity and hydrogen bonding network will be studied for a library of polymer solutions and gels synthesized in different solvents. The solutions will be characterized via size exclusion chromatography and rheology. In the case of the gels, the swelling degree, gel content, and mechanical properties (in compression) will be determined.

Candidate's profile and selection criteria: An open-minded, curious, and interactive student ready to work as part of a multidisciplinary research team. Candidates with a profile in polymer physical chemistry, polymer physics, and soft matter mechanics are encouraged to apply. Experience in polymer physical chemistry is a plus; no experience in polymer chemistry is required. Applications will be assessed based on motivations, relevance, and DE&I (Diversity, Equity, and Inclusion). Fluent communication in English is a requirement.

How to apply: Please send a CV and a motivation letter to mehdi.vahdati@ics-cnrs.unistra.fr and mathilde.lescure@ics-cnrs.unistra.fr. The motivation letter must clearly state the relevance of the application to the group's areas of research.

References

[1] Creton, C. Macromolecules, 50 8297–8316 (2017); [2] Gong, J. P. Advanced Materials, 1155–1158 (2003); [3] Hansen, B. Chemical Reviews, 121 1232–1285 (2021).