13-month postdoc position

# Dynamics and structure of polymers in deep eutectic solvents

**Laboratory**: Institut Charles Sadron*, CNRS
**Location**: Strasbourg, France
**Starting date:** January-February 2025
**Advisor:** Mehdi Vahdati and Fouzia Boulmedais
**Group website**: www.vahdatiresearchlab.com

*Note that the lab is within a ZRR (Zone à Régime Restrictive).

**Context.** The use of typical gels (like hydrogels) for potential applications is limited by their low fracture resistance and their short-term environmental stability. [1] Both shortcomings are related to the solvent which typically comprises most of the volume of the material. However, little research effort has been directed toward the design of this component, mainly because the physico-chemical properties of conventional solvents are weakly tunable. Deep Eutectic Solvents (DES) are an emerging class of green, "designer" solvents formed due to hydrogen bonding interactions between hydrogen bond donor and acceptor species at specific compositions. [2] These typically viscous liquids are particularly interesting due to their widely tunable physico-chemical properties and extremely low volatility.

Research from our group shows that model polymer networks swollen in a DES exhibit enhanced nonlinear mechanical properties compared to their counterparts in conventional solvents. Molecular dynamics simulations suggest that specific solvent-polymer interactions play an important role in the modification of the bulk properties. Investigating the structure and dynamic properties of polymer-in-DES solutions can provide original insights in this context. This study will have wider implications for the design of future DES-based polymer materials for diverse applications.

**Objectives.** This project aims to cast light on the structure and dynamics of model polymer solutions based on deep eutectic solvents in an attempt to explain the role of the solvent in the bulk mechanical properties of polymer gels. Solutions of model polymers in DES will be studied via viscosity measurements to determine the concentration regimes and the relevant scaling behaviors. A similar investigation will be performed via X-ray scattering to establish structure-properties relationships. The results will be compared with molecular dynamics simulations (performed by a collaborator). Polymer solutions and gels will be compared to elucidate the role of solvent-polymer interactions. Some of the technics used include rheology, SAXS, TGA, and FTIR. Depending on the motivations of the selected candidate, the project may involve the development of an experimental setup.

**Candidate's profile.** Curious and interactive Ph.D. graduates in polymer physics or physical chemistry, soft matter mechanics, or materials science are encouraged to apply. Previous experience in rheology and scattering will be an advantage. Experience in polymer chemistry is *not* required but will be a plus. 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 fouzia.boulmedais@ics-cnrs.unistra.fr. The CV must provide the contact information of three references. The motivation letter must clearly indicate the motivations of the candidate for the project, the assets they would bring to the team, and the skills they hope to acquire during this project.

**References**

**[1]** Creton, C. Macromolecules, 50 8297–8316 (2017); **[2]** Hansen, B. Chemical Reviews, 121 1232–1285 (2021).