PHD POSITION

PHENIX

SORBONNE UNIVERSITÉ

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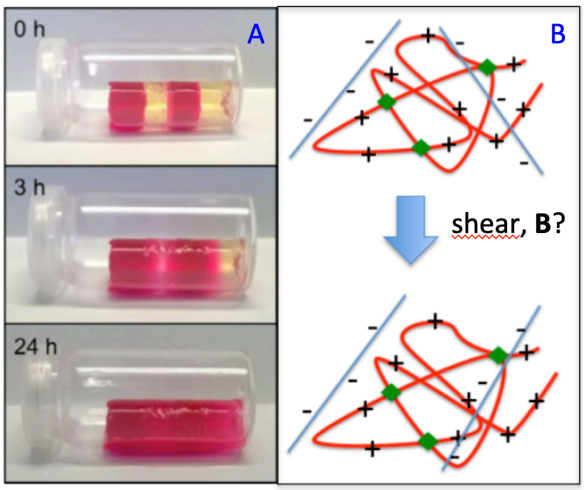
Towards hydrogels with switchable permeability

PHENIX laboratory has a recognized experience in the study of charged porous systems, including charged polymers (polyelectrolytes) as well as charged inorganic nanoparticles such as clays. A particular attention is given to the study of *transport or dynamics* in such systems, under different degrees of water content. Recently, we have initiated research into yet another type of charged porous matrix - polyelectrolyte-based hydrogels. In contrast to nanoparticle-based porous matrices, the cross-linked polyelectrolyte network in a hydrogel presents an added matrix flexibility and even the possibility of reversible switching on/off of chain cross-linking. Stimuli-responsive changes in the polyelectrolyte matrix bring immediately interesting biological and environmental applications to mind, with controlled substance release as one potential goal. Hydrogels have indeed key potential applications in the biological and biomedical fields (artificial tissues or biosensors) or in material science (new generation plastics).

We have been successful in optimizing the synthesis of ionene-based hydrogels [1] and have achieved modifications of such hydrogels by the addition of anisotropic, plate-like clay nanoparticles, leading to mechanically stronger gels [2]. Regular stacking of clay nanoplatelets in the hydrogel paves the way to a highly interesting system with potentially anisotropic permeability.

The focus of the proposed PhD is the study of diffusion, from small molecules (water, ions) to larger species (organic molecules, small colloids) inside the hydrogel, using a wide panel of experimental techniques ranging from quasi-elastic neutron scattering (QENS), via NMR (relaxometry and PFG-NMR), and all the way to macroscopic visualization of diffusion of a coloured dye [1]. Firstly, we expect to be able to tune the diffusion of guest molecules/colloids in the matrix by changing the counterions of the ionene polyelectrolytes [3,4]. Secondly, the possibility of tuning the orientation of clay nanoplatelets is to be explored in order to tune at will the anisotropy of permeation properties of the hydrogel.



(A) Dye diffusion in an ionene-based hydrogel [1]
(B) Can we tune the hydrogel permeability via the ordering of clay nanoplatelets inside the hydrogel?

[1] M. Haring, S. Grijalvo, D. Haldar, C. Saldias, D. Diaz Diaz, Polymer topology-controlled self-healing properties of polyelectrolyte hydrogels based on DABCO-containing aromatic ionenes, *Eur. Polym. J.* 115, 221-224, **2019**.
[2] C. Hotton, J. Sirieix-Plenet, G. Ducouret, L. Michot and N. Malikova, Organisation of clay nanoplatelets in a polyelectrolyte-based hydrogel, *in submission*.
[3] F. Arends, R. Baumgartel and O. Lieleg, Ion-specific effects modulate the diffusive mobility of colloids in an extracellular matrix gel, *Langmuir* **2013**, *29*, 15965-15973.
[4] N. Malikova, A.-L. Rollet, S. Cebasek, M. Tomsic and V. Vlachy, On the crossreads of current polyelectrolyte theory and counterion-specific effects, *Phys. Chem. Chem. Phys.* **2015**, *17,* pp. 5650-5658.

Keywords: *polyelectrolytes, water, hydrogels, clays, permeability, neutron/X-ray scattering, NMR, rheology*

Period: 3-year grant starting in October/November 2021.

Salary: French ministry of education - gross salary 1768€/month.

Candidate Profile: The candidate should have a strong background in physical chemistry (level Master), with a good knowledge of scattering techniques. Experience in organic synthesis is an advantage.

Contact: Please send a CV and a motivation letter to Natalie MALIKOVA, natalie.malikova@sorbonne-universite.fr, PHENIX laboratory, Tel: +33 144274031.

Sorbonne University is a world-class, research-intensive university bringing together a broad range of arts, humanities, social sciences, natural sciences, engineering and medicine. The scientific Pierre and Marie Curie campus was completely refurbished in 2016.

PHENIX is a laboratory at the interface between Chemistry, Physics and Materials Science with a long-standing expertise of colloidal systems, electrolytes and fluids under confinement. Its strength lies in a combination of experimental and modelling activities (numerical simulations). Several international projects and networks are in place in PHENIX, providing a rich and multinational environment.