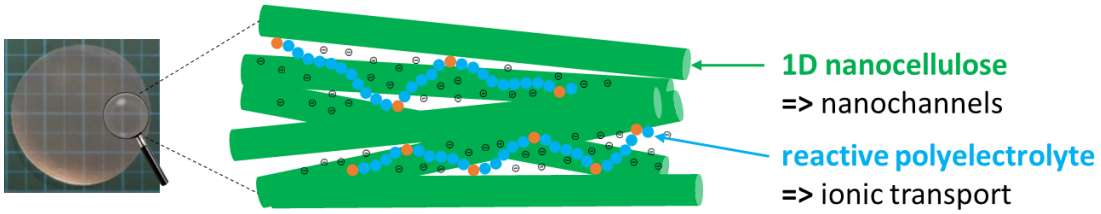
Nanocellulose ionic membrane for blue energy

Master internship 2025 (+ PhD) – CERMAV Grenoble

Keywords : blue energy, membrane, polyelectrolyte, nanocellulose

Context. Blue energy is a renewable and non intermittent energy source originating from salinity gradients between fresh (river) and salty water (sea, brine), whose potential (1 TW) largely exceeds hydroelectricity for instance. It can be converted to electricity by reverse electrodialysis, a technology relying on the employement of anionic and cationic membranes. [1] Membranes currently available are non renewable and present low performances to harvest blue energy, which is due to their poor nanostructure and the impossibility to tune the membrane critical parameters (ionic content and spatial distribution, pore size).



In order to overcome those issues, we propose a new design for those membranes based on the employement of nanocellulose which provide a biosourced nanostructured scaffold once hydrated, [2] further associated to grafted polyelectrolytes [3] which can bring the ionic transport properties. The purpose of the internship is to establish the full potential of such approach.

[1] Jang, J., Kang, Y., Han, J. H., Jang, K., Kim, C. M., & Kim, I. S. (2020). **Developments and future prospects of reverse electrodialysis for salinity gradient power generation: Influence of ion exchange membranes and electrodes**. Desalination, 491, 114540.
[2] Nicolas, M., Serghei, A., Lucas, C., Beyou, E., & Fumagalli, M. (2023). **Grafting of polyamines onto periodate oxidized nanocellulose, and its application to the fabrication of ionic nanopapers**. Polymer, 270, 125760.
[3] Nicolas, M., Beyou, E., & Fumagalli, M. (2021). **Two-step synthesis of polystyrene sulfonate based copolymers bearing pendant primary amines**. European Polymer Journal, 152, 110455.

Goals. (i) Investigate the chemistry and processing to graft reactive polyelectrolyte onto nanocellulose surface and to subsequently obtain ionic membranes. (ii) Establish relations between nanocellulose ionic membrane composition, nanostructure and its capability to harvest blue energy.

Methodology. Membrane grafting chemistry (*titration, FTIR, solid state NMR*), membrane nanostructure (*swelling coefficient, electron microscopy, small angle scattering*), membrane performance to harvest blue energy (***in collaboration with Sweetch Energy*** *a start-up pioneer in the field of blue energy*). Polyelectrolytes will be provided by the IMP lab @ Lyon.

Practical informations. Internship for at least 6 months which can start as early as January 2025, and which can be pursued by a PhD (funding ANR CELLOSMO).

We are looking for a physical chemist with a degree in chemistry or in material science. A backgroud in biosourced materials and polymer chemistry will be appreciated.

To apply please send your CV, a motivation letter and the contact of a reference person to bruno.jean@cermav.cnrs.fr, heux@cermav.cnrs.fr and matthieu.fumagalli@univ-lyon1.fr.