

M2 Internship and funded PhD offer

A nanofluidic exchanger for osmotic power

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 LIPhy MODI team



The **recovery of the mixing energy of saline gradient**, such as freshwater/seawater, offers a decarbonated, renewable and non-intermittent energy source, whose potential is comparable to the current global demand in electricity¹. This “blue energy” is currently unexploited because the best processes, based on ion-selective membranes², deliver power densities of the order of a few W/m², too low to be economically viable.

Ten years ago, the discovery of single nanotubes or nanopores capable of converting saline energy at densities of kW or even MW per square meter of cross-sectional area opened up a promising new field of research³. However, the transition from a single nanopore to a macroscopic membrane revealed fundamental scaling challenges. It is now established that the phenomenon of concentration polarization at the membrane/reservoir interface, reduces the power density produced by nanopores by several orders of magnitude⁴.

Beyond materials, it is necessary to develop completely new approaches at the process level. We recently proposed the concept of **nanofluidic exchanger**⁵ that is theoretically able to convert several hundreds W/m². The objective of this M2 project is to **study experimentally an elementary brick of such a nanofluidic exchanger**. The chip, made in collaboration with IPGG, comprises a nanoslit feeded by two microchannels equipped with in situ electrodes. The coupled electrical and fluidic characterisation will rely on the team's expertise in **high-resolution nanofluidic instrumentation** and measurements⁶.

This internship will be part of the recently funded **Tiamo ANR project**, between ESPCI Paris, LIPhy Grenoble, LAMA Chambéry and the technological platform at IPGG Paris. The internship may be **followed by a PhD funded by this project** aiming at understanding the influence of ultra-confinement of ions on electro-diffusion-osmotic transport properties and its impact on osmotic energy conversion.

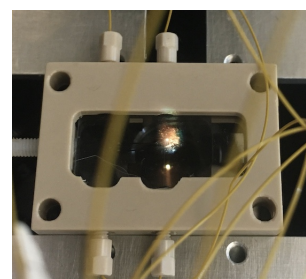
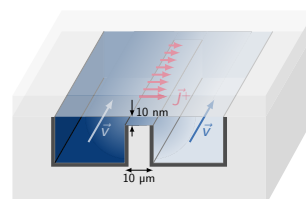
Requirements

Candidates should have a strong background in soft matter physics as well as a good interests in physico-chemistry. More generally the candidate should feel at ease with interdisciplinarity and motivated by instrumentation and experimental challenges !

Application

Please submit by email a curriculum vitae mentioning at least one referee and a cover letter.

You will be contacted by email if your skills and experience match the profile.



Schematic and picture of the chip.

1. B. E. Logan and M. Elimelech. *Membrane-based processes for sustainable power generation using water*. *Nature*, **488**.7411 (2012),
2. C. Picard. “Membranes nanoporeuses, de l'énergie en domptant le mélange”. *Etonnants matériaux*. Ed. by S. Martrenchard, L. Orgéas, and A. V. Foillard Ruzette. CNRS Editions, 2026. Chap. 3, pp. 120–125.
3. J. D. Feng et al. *Single-Layer MoS₂ Nanopores as Nanopower Generators*, *Nature*, **536** (2016),
4. L. Wang et al. *Nanopore-Based Power Generation from Salinity Gradient: Why It Is Not Viable*, *ACS Nano*, **15** (2021),
5. S. Sriprya et al. *A nanofluidic exchanger for harvesting saline gradient energy*, *Lab on a Chip*, **24**.23 (2024),
6. P. Sharma et al. *A direct sensor to measure minute liquid flow rates*, *Nano Letters*, **18**.9 (2018),