PhD position

Entropy and thermal properties of water near hydrophobic interfaces

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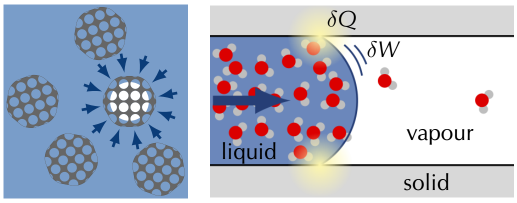
LIPHy MODI team



Interfacial water is ubiquitous in nature. It plays a crucial role in biochemical processes that sustain life but also in various nanoscale phenomena which are fundamental for tackling pressing societal challenges, such as ensuring a sustainable supply of drinking water and achieving decarbonization of our energy sources[1].
In this context, this PhD project, which is funded by the Franco-Bresilian ANR project HTD-PoM, aims to explore how the confinement of water within hydrophobic nanopores affects its thermomechanical properties and that of the confining walls through interfacial couplings.
The experimental approach will leverage porous fluids made of ordered hydrophobic nanoporous particles (see Fig. 1) immersed in water or aqueous solution and dynamical calo-porosimetry measurements using an innovative apparatus recently developed at LIPhy. This instrument enables the characterization of forced filling under pressure of the hydrophobic nanoporous particles, as well as their spontaneous drying when the pressure is released. Such macroscopic measurements reflect the interfacial phenomena and contact line phenomena occurring at the angstrom scale within the nanopores which constitute the particles.
To date, most experimental studies of these systems have been conducted in a quasi-static regime. However, dynamical measurements open a new route to shed light on the rich physics of wetting and drying under confinement[2] such as thermal effects[3]. Rapid calorimetric measurements will enable the determination of the heat released during particle filling from which will be determined the entropy change associated to wetting and liquid confinement. These measurement will also give access to the thermoelastic properties of the confined liquids and the heat conductivity of the nanoporous particle according to their empty or filled state. As predicted from numerical simulations[3], interfaces play a key role at these nanometric scale and may lead to surprising behaviours that this project will explore experimentally such as a decrease of the heat conductivity of particles when they are filled with water.

Requirements

Candidates should have a strong background in physics, soft matter and thermodynamics 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 mentionning at least 2 referees and a cover letter.

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

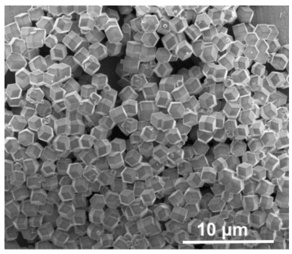


Fig.1 Ordered nanoporous particles.

1. B. E. Logan and M. Elimelech. Membrane-based processes for sustainable power generation using water. *Nature*, **488**.7411 (2012), DOI: 10.1038/nature11477.
2. C. Picard et al. Dynamics of heterogeneous wetting in periodic hybrid nanopores, *Journal of Chemical Physics*, **154**.164710 (2021), DOI: 10.1063/5.0044391.
3. N. Ferreira de Souza et al. Thermal Conductivity of a Fluid-Filled Nanoporous Material: Underlying Molecular Mechanisms and the Rattle Effect, *The Journal of Physical Chemistry B*, **128**.10 (2024), DOI: 10.1021/acs.jpcb.3c07088.