Molecular liquids under micro/mesoporous confinement

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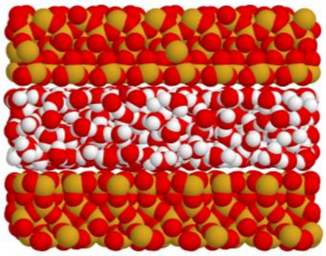

Figure Liquid water confined in a silica nanopore

For the last decades, the scientific community has been increasingly requested to improve the ground basis knowledge in different fields of high potential of technological innovation in order to help solving global societal challenges. Some major issues are related to the sustainable management of the environmental and energy resources: The limited access to pure water requires the development of efficient and low-energy demanding processes for water treatment and desalinization. The conditions for an environment-friendly chemical industry depend on the development of advanced processes for the recycling of organic solvents. The development of renewable energy with low carbon impact requires the improvement of electrochemical energy storage and transport.

It is noteworthy that many technological solutions of current interest comprise fluids embedded in soft (e.g. polymeric membranes) or hard (e.g. inorganic porous frameworks) micro/mesoporous media. If one just recall the few above-mentioned examples, it is obvious that nanoconfinement effects govern the water distribution and transport in membranes for fuel cell, the properties of hybrid solid/liquid electrolytes comprising ionic liquids in mesoporous media for battery, the efficiency of nanofiltration membranes for desalinization and water/solvent treatment, and the possible phase transitions that may occur due to capillary-induced negative pressure.

From a fundamental point of view, it is striking that the physical properties of interfacial fluids with typical thickness of a few molecular sizes as well as fluids confined in micro/mesoporous geometry are generally very different from their bulk counterparts. There exist many recent reports on new thermodynamic (possibly metastable) states, spontaneous nanostructuration, enhanced or glassy dynamics, multiscale mobility, fluid cavitation or phase transitions which are critically dependent on the nature of the fluid, surface interaction and porosity.

In order to gain a better understanding of such systems, the combination of complementary experimental (neutrons scattering, X-rays scattering, NMR, dielectric spectroscopy…) or simulation techniques (molecular dynamics, DFT…) have proven to be especially powerful. The aim of this colloquium is indeed to underline the added-value of such multi-technical approaches to study hybrid materials comprising molecular liquids confined in soft or hard micro/mesoporous media and envision new opportunities for the future, provided by enhanced instrumental capability to be developed at existing and forthcoming neutron large scale facilities.

Keywords: porous materials, confinement, phase transition, liquid interfaces, neutron scattering

Acknowledgements: This mini-colloquium is supported by the Société Française de la Neutronique.