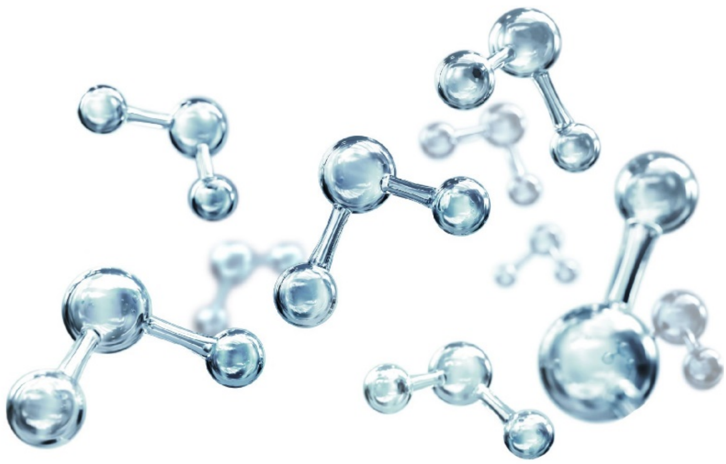
Seminar

CMWS Centre for Molecular Water Science

10th of June 2021
12:00 h

Zoom Virtual Meeting:
https://desy.zoom.us/j/97518013893
Meeting-ID: 975 1801 3893
Password: 320247



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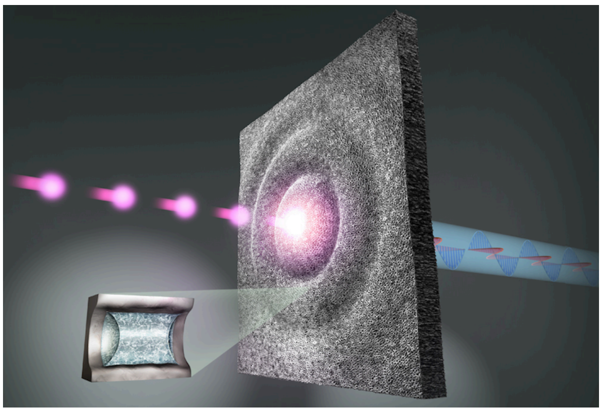
Water confined in nanopores: What do we know about it and what is it good for?

Water confined in pores a few nanometers across plays a dominant role in many natural and technological processes ranging from clay swelling, frost heave, and catalysis via colloidal stability and protein folding to transport across artificial nanostructures and bio-membranes. In nanoporous media the geometrical confinement and pore wall-fluid interactions as well as complex pore morphologies may significantly alter water's physico-chemical equilibrium and non-equilibrium properties, causing, for example, the molecular structuring of the fluid, huge negative Laplace pressures in the liquid and changed shear viscosities.



Laser-ultrasound experiment on water-infiltrated nanoporous silicon. (TUHH/DESY/Künsting)

In the first part of my talk I will present opto-fluidic, X-ray and neutron scattering experiments on capillarity-driven transport, self-diffusion dynamics of water and aqueous electrolytes in nanoporous solids [1, 2] as well on the interplay of water's capillarity with the confining solids' elasticity [3, 4]. The observations on the effective, porous-medium scale will be related to the single-nanopore fluid properties [2], also by resorting to computer simulations. In the second part of my talk I will exemplify that exploiting water's peculiar nanofluidics in combination with self-organized porosity in solids offers an entirely novel design space for sustainable, active integrated materials with functional diversity. In particular, I will present porous materials with electrically switchable wettability and hydraulic permeability [5] as well as large electrochemo-mechanical actuation for potential applications in Lab-on-a-Chip fluidics, sensorics, water filtration and energy conversion [5,6].

References: [1] *Capillary rise of water in hydrophilic nanopores*. S. Gruener and T. Hofmann and D. Wallacher and A.V. Kityk, P. Huber, Phys. Rev. E 79, 067301 (2009). [2] *Dynamics of water confined in mesopores with variable surface interaction.* A. Jani, M. Busch, J.B. Mietner, J. Ollivier, M. Appel, B. Frick, J.M. Zanotti, P. Huber, M. Fröba, D. Morineau. J. Chem. Phys. 154, 094505 (2021). [3] *Elastic response of mesoporous silicon to capillary pressures in the pores*. G.Y. Gor, L Bertinetti, N. Bernstein, T Hofmann, P. Fratzl, P. Huber, Appl. Phys. Lett. 106, 261901 (2015). [4] *Laser-excited elastic guided waves reveal the complex mechanics of nanoporous silicon*. M. Thelen, N. Bochud, M. Brinker, C. Prada, P. Huber, Nat. Comm. (2021, in press). [5] *Switchable imbibition in nanoporous gold*, Y. Xue, J. Markmann, H. Duan, J. Weissmüller, P. Huber, Nat. Comm. 5, 4237 (2014). [6] *Giant electrochemical actuation in a nanoporous silicon-polypyrrole hybrid material*. M. Brinker, G. Dittrich, C. Richert, P. Lakner, T. Krekeler, T.F. Keller, N. Huber, P. Huber. Sci. Adv. 6 eaba1483 (2020).