

CPP 10: Wetting, Fluidics and Liquids at Interfaces and Surfaces I (joint session CPP/DY)

Time: Monday 16:15–17:15

Location: H34

CPP 10.1 Mon 16:15 H34

Beyond contact angle measurements of aerophilic surfaces — ●ALEXANDER TESLER¹, WOLFGANG GOLDMANN¹, ANCA MAZARE², BEN FABRY¹, STEFAN KOLLE³, ROBIN A.H. RAS⁴, HEIKKI NURMI⁴, GEORGE SARAU⁵, and SILKE CHRISTIANSEN⁵ — ¹Biophysics Chair, Erlangen, Germany — ²WW4-LKO, Erlangen, Germany — ³UCSD, San Diego, USA — ⁴Aalto University, Espoo, Finland — ⁵Fraunhofer Institute, Forchheim, Germany

Aerophilicity can provide surface resilience to the detrimental effects of wetting-related phenomena. However, the development of such superhydrophobic surfaces with a long-lasting entrapped air layer, called plastron, is hampered by the lack of evaluation criteria and methods that can unambiguously distinguish between stable and metastable Cassie-Baxter wetting regimes. The information to evaluate the stability of the wetting regime is missing from the commonly used contact angle goniometry. Therefore, it is necessary to determine which surface features can be used as a signature to identify thermodynamically stable plastron. Here, I describe a methodology for evaluating the thermodynamic underwater stability of the Cassie-Baxter wetting regime of superhydrophobic surfaces by measuring the surface roughness, solid-liquid area fraction, and Young's contact angle. The method allowed the prediction of passive plastron stability for over one year of continuous submersion,[1] impeding mussel and barnacle adhesion,[2] and inhibition of metal corrosion in seawater.[3] [1] Tesler et al., *Commun. Mater.* 2024, 5, 112. [2] Tesler et al., *Nat. Mater.* 2023, 22, 1548. [3] Prado et al., *Adv. Funct. Mater.* 2024, 35, 2407444.

CPP 10.2 Mon 16:30 H34

Fluid flow inside slit-shaped nanopores: the role of molecular surface morphology — ●GIORGIA MARCELLI¹, TECLA BOTTINELLI MONTADON¹, ROYA EBRAHIMI VIAND¹, and FELIX HÖFLING^{1,2} — ¹Institute of Mathematics, Freie Universität Berlin, Germany — ²Zuse Institute Berlin, Germany

The boundary conditions of nanoscale flows near surfaces can deviate from the no-slip condition observed at macroscopic scales, and used in classical fluid mechanics. In this context, we investigate the influence of surface morphology on fluid flow inside slit-shaped nanopores [1]. Using non-equilibrium molecular dynamics (NEMD) simulations, we demonstrate that the surface morphology effectively controls the slip length, which approaches zero when the molecular structures of the pore wall and the fluid are matched. We examine two types of pore walls, mimicking a crystalline and an amorphous material, that exhibit markedly different surface resistances to flow. The resulting flow velocity profiles are consistent with Hagen–Poiseuille theory for incompressible, Newtonian fluids when adjusted for surface slip and effective viscosity; the latter is found to vary substantially with the pore width. Moreover, analysis of the hydrodynamic permeability shows that the simulated flows are in the Darcy regime. We further show that thermal isolation within the pore causes a linear increase in fluid temperature along the flow, which we relate to strong viscous dissipation and heat convection, utilizing the conservation laws of fluid mechanics.

[1] G. Marcelli, T. Bottinelli Montadon, R. Ebrahimi Viand, and F. Höfling, arXiv:2411.04882 [cond-mat.soft].

CPP 10.3 Mon 16:45 H34

How do polymers of different architecture penetrate nanochannels? — ●PANAGIOTIS KARDASIS¹ and GEORGE FLOUDAS² — ¹Department of Physics, University of Ioannina, 45110 Ioannina, Greece — ²Max Planck Institute for Polymer Research, 55128 Mainz, Germany

The way that polymers penetrate narrow pores is of both academic and technological importance. Capillary force can drag polymer chains into nanopores, a process called imbibition. Using in situ nanodielectric spectroscopy (nDS), we report the imbibition and following adsorption kinetics of star cis-1,4-polyisoprenes (SPI) and of bottlebrush polymers directly at the chain length scale by monitoring the evolution of the normal modes, during the flow within in alumina nanopores (AAO), as a function of chain architecture (vs linear), pore size, molar mass, and temperature. We demonstrate that the imbibition kinetics of SPIs proceeds via a slow adsorption mechanism, about 2 orders of magnitude slower than in linear polyisoprenes (PI). We further demonstrate that the bottlebrush topology results in slower adsorption in nanopores in comparison to linear counterpart, albeit, with different dependence. Additionally, bottlebrushes present weaker temperature dependence comparing to both linear and star polymers. Furthermore, we explore how symmetric star / linear and brush / linear blends penetrate the same nanopores and we demonstrate that differences in the imbibition and adsorption kinetics can be used to separate the homogeneous blend to its components, giving rise to *topology sorting*, based on the relative viscosities and pore diameter.

CPP 10.4 Mon 17:00 H34

Removing particles from hydrophobic surfaces by single water drops — ●FRANZISKA SABATH, STEFANIE KIRSCHNER, and DORIS VOLLMER — Max Planck Institute for Polymer Research, 55128 Mainz, Germany

The accumulation of dust on surfaces is a well-known phenomenon in everyday life, for example on windows and solar panels. Both manual cleaning and self-cleaning of hydrophobic surfaces with water can restore the properties of soiled surfaces. However, it is not yet understood how particles are removed by a water drop and which forces play a role for successfully removing the particles. We investigated the removal of two or more particles from hydrophobic coatings by a single water drop. For this purpose, we used a confocal microscope with a sliding drop setup. This implies that the particles was moved at constant velocity while the drop is hold in position by a blade. The sliding drop and the way in which the particles are picked up and pulled along by the water drop can be imaged. From the deflection of the blade, we can determine the force required to pull the particles along with the drop. Here, we focus on the removal of spherical model particles and the impact of drop volume, particles size and particle velocity on the particle removal. At low velocities the particles remain attached to the drop. With increasing velocity we observe that the particle detachment becomes more likely. In case of particle detachment, we observe a correlative effect: after the second particle has reached the rear side of the drop, both particles can detach together.