

CPP 52: Wetting, Fluidics and Liquids at Interfaces and Surfaces III (joint session CPP/DY)

Time: Thursday 15:00–16:15

Location: MER 02

CPP 52.1 Thu 15:00 MER 02

Hierarchical superhydrophobic composite membrane for enhanced distillation with excellent fouling resistance — ●PREXA SHAH¹, YOUJIN HOU², MICHAEL KAPPL¹, and HANS JÜRGEN BUTT¹ — ¹Max-Planck-Institute for Polymer Research, Physics at Interfaces group, Ackermannweg 10, 55128 Mainz, Germany. — ²School of Power and Mechanical Engineering, Wuhan University, 430072, Wuhan, China.

In arid areas near the coast, seawater desalination has become an essential supply of clean water. As a result, energy-efficient desalination systems must be developed to avoid overburdening the restricted energy supply. Membrane distillation (MD) is gaining popularity as a hybrid thermal/membrane-based desalination approach that may use waste heat for small-scale desalination as well as treating high-salinity brines. The objective is now to maximize the distillation rate while avoiding membrane wetting and fouling. In this work, composite membranes with multiscale pore sizes are formed by depositing a thin layer of nano-porous nanofilaments over microporous membranes. Distillation performance and fouling resistance are explored utilizing low surface tension impurities, which might enhance the chance of membrane wetting. The resistance of protein adsorption to organic fouling is also examined. Our unique multiscale porous membranes outperform traditional hydrophobic membranes in terms of fouling resistance while achieving better distillation flow. This research shows how to optimize MD procedures for wastewater and saltwater treatment.

CPP 52.2 Thu 15:15 MER 02

Surface tension of cavitation bubbles — ●MARINE BOSSERT¹, PANAYOTIS SPATHIS², PIERRE-ÉTIENNE WOLF², LAURENT CAGNON², ISABELLE TRIMAILLE³, and ÉTIENNE ROLLEY⁴ — ¹Institut of Materials Physics and Technology, Hamburg University of Technology, Germany — ²Institut Néel, Grenoble, France — ³Institut des NanoSciences de Paris, Paris, France — ⁴Laboratoire de Physique de l'École Normale Supérieure, Paris, France

The evaporation of a fluid contained in a porous material occurs by cavitation when the pores are connected to the outer gas reservoir through small constrictions. Using monolithic transparent porous samples, we have measured the cavitation rate J as a function of the departure from equilibrium for hexane at room temperature [1] and nitrogen over a wide temperature range.

When the radius of the critical nucleus R^* is large, our measurements are in agreement with the prediction of the Classical Nucleation Theory. However, when the thickness of the interface is not negligible compared to R^* , we find that J is much larger than predicted. We show that this shift can be accounted for if the liquid-vapor surface tension is allowed to depend on the interface curvature. This dependence is in reasonable agreement with Density Functional calculations for Lennard-Jones fluid, including the correction to second order in curvature.

[1] V. Doebele, et al, Phys. Rev. Lett. 125 (2020) 255701.

CPP 52.3 Thu 15:30 MER 02

Simulations for Wetting of Biomembranes — ●MARCEL MOKBEL and SEBASTIAN ALAND — TU Bergakademie Freiberg, Freiberg, Germany

The dynamics of membranes, shells, and capsules in fluid flow has become an active research area in computational physics and computational biology. The small thickness of these elastic materials enables their efficient approximation as a hypersurface, which exhibits an elastic response to in-plane bending and out-of-plane stretching deformations. If such a closed thin shell is filled with (and/or surrounded by) multiple fluids, capillary forces on the contact line between the fluids

and the shell may arise and force the shell to deform.

In this work, we present a novel Arbitrary Lagrangian-Eulerian (ALE) method to simulate such elastic surfaces immersed in Navier-Stokes fluids, which is combined with a phase field approach to model droplets inside and/or outside the surface. This method combines high accuracy with computational efficiency, since the grid is matched to the elastic surface and can therefore be resolved with relatively few grid points near the surface. We formulate elastic surface forces and propose an evolving finite-element discretization. Several wetting test cases demonstrate the versatility of the proposed method. Examples are simulations of single or multiple droplets deforming a vesicle-like shell.

CPP 52.4 Thu 15:45 MER 02

Dilute suspensions of chemically active particles in thin liquid films — ●TILMAN RICHTER, PAOLO MALGERETTI, and JENS HARTING — HELMHOLTZ-INSTITUT ERLANGEN-NÜRNBERG FÜR ERNEUERBARE ENERGIEN, Erlangen, Germany

Thin liquid films are important for many microfluidic applications such as printing or coating of e.g. printable electronics or photovoltaic cells as well as so called lab-on-a-chip devices. Also in catalysis at liquid interfaces thin film dynamics are important. It is well known that a thin film on a solid substrate can be unstable and droplet formation may arise.

The dynamics of thin liquid films and their instability has been the subject of intensive experimental, analytical, and numerical studies, the latter often based on the thin film equation. We propose a set of newly developed equations for the influence of chemical active colloids suspended in a thin liquid film based on the lubrication and Fick-Jacobs approximation. For this novel set of equations we perform a linear stability analysis (LSA) that reveals surprisingly interesting dynamics. We identify the subset of parameters for which the thin film becomes stable i.e. is not rupturing, as well as a variety of different dominating wave-modes. This allows us to control not only the stability but also the droplet size distribution after film rupture, as well as the time it takes for an initially flat film to rupture.

In order to assess the asymptotic state of the thin film, the LSA results are compared against numerical simulations using the Lattice Boltzmann method.

CPP 52.5 Thu 16:00 MER 02

Light properties and water resistant of combined sobrerol methacrylate cellulose thin films. — ●CONSTANTIN HARDER^{1,2}, ALEXANDROS E. ALEXAKIS³, MARIE BETKER^{1,3}, YUSUF BULUT^{1,2}, BENEDIKT SOCHOR¹, HUAYING ZHONG², GUANGJIU PAN², MANUEL REUS², KORNELIYA GOORDEYEVA³, APOSTOLOS VAGIAS^{2,4}, DANIEL SÖDERBERG³, EVA MALMSTRÖM³, PETER MÜLLER-BUSCHBAUM^{2,4}, and STEPHAN V. ROTH^{1,3} — ¹DESY, 22607 Hamburg, Germany — ²TUM School of Natural Sciences, Chair for Functional Materials, 85748 Garching, Germany — ³KTH Royal Institute of Technology, 10044 Stockholm, Sweden — ⁴MLZ, TUM, 85748 Garching, Germany

Functionalization of porous materials in terms of optical, chemical and mechanical properties is achieved by applying fully wood-based layers materials. In this project, the refraction index, extinction coefficient and water adhesion properties of cellulose thin films combined with sobrerol methacrylate colloids are investigated together with their topography and morphology. Cellulose nanofibrils (CNF) are a hydrophilic material, and form networks during the drying with specific refraction index, extinction coefficient. Applying additional colloids, their optical properties and water-contact angle can be tuned. Hence, in order to produce water-resistant thin film, a combination of CNF and colloids is a perfect candidate.