

CPP 20: General Session to the Symposium: Interplay of Substrate Adaptivity and Wetting Dynamics from Soft Matter to Biology (joint session CPP/DY)

Time: Wednesday 9:30–11:15

Location: H39

CPP 20.1 Wed 9:30 H39

Adaptive two capacitor model to describe slide electrification in moving water drops — ●PRAVASH BISTA¹, AMY Z. STETTEN¹, WILLIAM S.Y. WONG¹, HANS-JÜRGEN BUTT¹, and STEFAN A.L. WEBER^{1,2} — ¹Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany — ²Johannes Gutenberg University, Department of Physics, Staudingerweg 10, 55128 Mainz, Germany

Slide electrification is a contact-charge separation where neutral water drops slide over a neutral hydrophobic surface, accumulating and leaving behind a net charge. The accumulated drop charge for successive sliding drops decreases and eventually reaches a steady state. On hydrophobic and hydrophilic mixed surfaces, even a polarity flipping of drop charge depending on a drop rate was observed. Here, we describe this effect in terms of a voltage generated at the three-phase contact line. This voltage moves charges between capacitors, one formed by the drop combined with the solid surface and one on the solid-surface. By introducing an adaptation of the voltage upon water contact, we can model drop charge experiments on different surfaces, including more exotic ones with drop-rate-dependent charge polarity. Thus, the adaptive two capacitor model enables new insights into the molecular details of the charge separation mechanism.

CPP 20.2 Wed 9:45 H39

Memory effects of PNIPAAm brushes in different atmospheres — ●SIMON SCHUBOTZ, MARISA FISCHER, JENS-UWE SOMMER, PETRA UHLMANN, ANDREAS FERY, and GÜNTER AUERNHAMMER — Leibniz-Institut für Polymerforschung Dresden e.V., 01069 Dresden, Germany

Some polymer brushes show a co-nonsolvency effect: They collapse in a mixture of two good solvents at some specific mixing ratio. In contrast to previous studies we concentrate on partial wetting of co-nonsolvent polymer brushes, i.e., on the dynamics of a three-phase contact line moving over such brushes.

We found that Poly(N-isopropylacrylamide) (PNIPAAm) brushes experiences a memory effect when consecutively depositing drops at the same position. Previously deposited drops adapt the brush and changes the wetting behavior (advancing contact angle) of subsequent drops.

We measure water drops in an ethanol-saturated atmosphere on PNIPAAm brushes. The measurements show that the memory effect is strongly effected by an ethanol-enriched atmosphere. At the three-phase contact line, due to evaporation from the drop, the composition of the atmosphere and probably also the brush will transition from an ethanol-rich state to a water-enriched state. Thus, the brush might pass through the co-nonsolvency regime. On large time scales the ethanol enriched gas phase and the water drop will become mixtures of ethanol and water. We present strategies to counter this mixing effect.

CPP 20.3 Wed 10:00 H39

Fast contact lines on soft solids — ●HANSOL JEON^{1,2} and STEFAN KARPITSCHKA¹ — ¹Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — ²Georg-August-Universität Göttingen, Göttingen, Germany

When a droplet is resting on a soft surface, the capillary forces deform the surface into a sharp wetting ridge. The amplitude of the wetting ridge is determined by elasto-capillary length, but the angles by which the interfaces meet at the ridge tip only depend on the balance of surface tensions, the so-called Neumann balance. For moving contact lines, dissipation in the wetting ridge leads to viscoelastic braking. In recent literature, various effects that could alter Neumann balance and viscoelastic braking have been suggested, ranging from free, extractable oligomers to point forces emerging from bulk viscoelasticity. We visualize moving wetting ridges at high spatio-temporal resolution and determine the tip geometry for various liquids and PDMS substrates. We observe an increase of the ridge opening angle at large speeds, even for very mild deformations caused by the low surface tension of a fluorinated oil. We also find no significant change in ridge rotation and opening angle for gels with different fractions of cross-linked and free chains, nor for different bulk rheological properties. These findings highlight the need for a non-trivial surface constitu-

tional relation that is different from the bulk.

CPP 20.4 Wed 10:15 H39

Mixed grafted homopolymer and diblock copolymer functional brush layers upon humidity alterations: nanoscale morphology and transformations — ●APOSTOLOS VAGIAS¹, THEODORE MANOURAS², ELEFTHERIOS KOUFAKIS^{2,3}, PEIXI WANG⁴, MARCELL WOLF¹, FABIAN A. C. APFELBECK⁴, SIGRID BERNSTORFF⁵, MARIA VAMVAKAKI^{2,3}, and PETER MÜLLER-BUSCHBAUM^{1,4} — ¹Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, 85748 Garching, Germany — ²Foundation for Research and Technology (F.O.R.T.H.) Hellas, Institute of Electronic Structure and Laser, 700 13 Heraklion, Crete, Greece — ³Department of Materials Science and Technology, University of Crete, 700 13 Heraklion, Crete, Greece — ⁴Physik-Department, Lehrstuhl für Funktionelle Materialien, Technische Universität München, 85748 Garching, Germany — ⁵Elettra Sincrotrone Trieste S.C.p.A., Basovizza, 34149 Trieste, Italy

Using in situ grazing-incident small-angle X-ray scattering (GISAXS) measurements during water vapor uptake, we study the nanostructure morphology in the dry state, during vapor swelling and in the fully swollen state, for thin (<100nm) films of poly(2-(dimethylamino)ethyl methacrylate) (PDMAEMA) and poly(fluoroalkyl methacrylate) (POFPMA) homopolymer and PDMAEMA-b-POFPMA block copolymer dual functional, bactericidal and antifouling, brushes. Our surface energy and swelling studies, stress on the role alkyl chain length, charged groups and brush topology in morphology, for the brush functionality.

CPP 20.5 Wed 10:30 H39

Steering droplets on substrates with periodic wettability patterns and deformations — ●JOSUA GRAWITTER and HOLGER STARK — Technische Universität Berlin, Institut für Theoretische Physik, Straße des 17. Juni 135, 10623 Berlin

Droplets are set in motion on substrates with a spatio-temporal wettability pattern as generated, for example, on light-switchable surfaces. To study such cases, we implement the boundary-element method to solve the governing Stokes equations for the fluid flow field inside and on the surface of a droplet and supplement it by the Cox*Voinov law for the dynamics of the contact line. Our approach reproduces the relaxation of an axisymmetric droplet in experiments, which we initiate by instantaneously switching the uniform wettability of a substrate quantified by the equilibrium contact angle.

First, we investigate a droplet on substrates with planar-wave-like wettability profile by varying the speed an wave length of the pattern. When the profile moves slowly, it moves the droplet moves steadily forward. Above a critical pattern speed the droplet performs steady oscillations, the effective (time-averaged) velocity of which decreases with the square of the pattern speed.

Second, we investigate a droplet on substrates which deform periodically according to a planar-wave profile. We analyze the effective velocity again as a function of wave speed and length and investigate specifically the influence of curvature changes on droplet motion.

CPP 20.6 Wed 10:45 H39

Spontaneous charging affects the motion of sliding drops — XIAOMEI LI¹, PRAVASH BISTA¹, RÜDIGER BERGER¹, STEFFEN HARDT², HOLGER MARSCHALL³, HANS-JÜRGEN BUTT¹, and ●STEFAN A.L. WEBER^{1,4} — ¹MPI for Polymer Research, Ackermannweg 10, Mainz, Germany — ²Institute for Nano- and Microfluidics, Technische Universität Darmstadt, Darmstadt, Germany — ³Computational Multiphase Flows, Technische Universität Darmstadt, Darmstadt, Germany — ⁴Institute of Physics, Johannes Gutenberg University Mainz, Mainz, Germany

The motion of water drops on surfaces is still far from being fully understood. Previous understanding is that drop motion is dictated by viscous dissipation and activated dynamics at the contact line. To accurately measure the forces experienced by moving drops, we imaged their trajectory when sliding down a tilted surface, and applied the relevant equations of motion [1]. We found that drop motion on low-permittivity substrates is substantially influenced by electrostatic forces. Our findings confirm that electrostatics must be taken into

consideration for the description of the motion of water, aqueous electrolytes and ethylene glycol on hydrophobic surfaces. Our results are relevant for improving the control of drop motion in many applications, including printing, microfluidics, water management and triboelectric nanogenerators. [1] Li, X. et al. Spontaneous charging affects the motion of sliding drops. *Nat. Phys.* (2022).

CPP 20.7 Wed 11:00 H39

Dynamic mesoscopic model for two-component compound drops — •JAN DIEKMANN and UWE THIELE — Westfälische Wilhelms-Universität, Münster, Deutschland

We consider a mesoscopic model for two immiscible fluids forming two-layer liquid films or compound drops on a rigid solid substrate. The earlier macroscale description [1,2] is connected to our mesoscopic approach (building on [3]) via consistency conditions. Thereby we relate

macroscale and mesoscale versions of the Young and Neumann relations at the liquid 1/solid/gas and liquid 1/liquid 2/gas contact lines, respectively. Furthermore, we employ the mesoscale model to investigate selected dewetting and coarsening processes for physically realistic parameters. The steady compound drops emerging from the time simulations are related to bifurcation scenarios determined via macroscale and mesoscale descriptions.

[1] L. Mahadevan, M. Adda-Bedia, and Y. Pomeau. "Four-phase merging in sessile compound drops". In: *J. Fluid Mech.* 451 (2002), pp. 411-420. [2] M. J. Neeson et al. "Compound sessile drops". In: *Soft Matter* 8 (2012), pp. 11042-11050. doi: 10.1039/c2sm26637g. [3] A. Pototsky et al. "Morphology changes in the evolution of liquid two-layer films". In: *J. Chem. Phys.* 122 (2005), p. 224711. doi: 10.1063/1.1927512. [4] Uwe Thiele et al. "Equilibrium contact angle and adsorption layer properties with surfactants". In: *Langmuir* 34.24 (2018), pp. 7210-7221.