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

Time: Monday 9:30–11:00 Location: ZEU/0260

Invited Talk DY 10.1 Mon 9:30 ZEU/0260

Cleaning of dusty surfaces — •Doris Vollmer[1], Franziska Sabath[1], Abhinav Naga[2], Stefanie Kirschner[1], Tarik Karakaya[1], Rüdiger Berger[1], Hans-Jürgen Butt[1], and Halim Kusumaatmaja[2] — [1]Max Planck Institute for Polymer Research, 55128 Mainz, Germany — [2]Ackermannweg 10

The accumulation of dust, sand or other contaminants on solar modules leads to significant efficiency losses. Billions of litres of water are used annually to clean solar modules, and other natural or manmade surfaces. However, the complex interplay between capillary and frictional forces, which determines successful removal or unwanted redeposition, is still poorly understood. By combining confocal microscopy and Boltzmann lattice simulations, we observe and quantify the removal of particles from smooth and rough surfaces by a water droplet, varying the hydrophobicity of the surface and the particles. Hydrophilic particles aquaplane, resulting in negligible friction and easy particle removal. For hydrophobic particles, the tangential component of the capillary force promotes or counteracts particle removal. Undesirable redeposition depends on the number and wettability of the particles. On superhydrophobic surfaces, the small contact area facilitates easy removal. For individual particles, we propose a phase diagram for particle removal.

DY 10.2 Mon 10:00 ZEU/0260

Marangoni contracted droplets on Textured Surfaces: Insights from Lubrication Theory — •Raphael Saiseau, Ze Xu, and Stefan Karpitschka — Fachbereich Physik, Universität Konstanz, 78464 Konstanz, Germany

Wetting and evaporation of droplets on micropatterned surfaces are central to both natural processes and technological applications, from anti-icing and spray cooling to inkjet printing and semiconductor processing. Droplet behavior on such surfaces is set by surface chemistry and topography, and most control strategies traditionally rely on specific materials or designs, limiting their versatility.

By depositing droplets on top of a pillars-decorated substrate in a vapor-controlled chamber, we show that the spreading and wicking can be controlled, and even temporarily suppressed, by using the vapor of a second, low-surface tension liquid, generating Marangoni stresses through its condensation near the droplet edge. We present numerical and semi-analytical solutions of the thin film equation coupled to a composition evolution equation, and diffusion-limited evaporation. The wicking effect of the texture is implemented through an effective height-dependent pressure, analogous to classical hemiwicking models. The emerging Marangoni flows oppose the prevailing capillary flows, leading to a quasi-stationary rather than a spreading or wicking drop. We derive a predictive relation between material parameters and drop shape, opening the way for designing controlled coating, cleaning and drying strategies on textured surfaces.

DY 10.3 Mon 10:15 ZEU/0260

Photoswitchable Arylazopyrazole Monolayers on Aluminum Oxide for Tunable Wettability — •Tim Blinzer, Christian Honnigfort, and Björn Braunschweig — Institute of Physical Chemistry and Center of Soft Nanoscience, University of Münster, Corrensstraße 28-30, Münster 48149, Germany

Smart surfaces that can change their wettability on demand are interesting for applications such as self-cleaning or microreactors. To tune the surface wettability, we functionalized aluminum oxide surfaces with arylazopyrazole (AAP) phosphonic acids using a Langmuir-Blodgett transfer. AAP molecules in the deposited monolayers undergo reversible E/Z photoisomerization driving changes in surface wettability. This was investigated as a function of surface coverage, where the responsiveness—i.e. the changes in molecular structure and in the apparent contact angle—was studied in detail. Here time-dependent sum-frequency generation (SFG) was used to obtain in situ information on the dynamic changes in monolayer upon E/Z switching with 520 nm green and 365 nm UV light. Furthermore, we show that increasing surface roughness by depositing nanoaggregates of the AAP phosphonic acid leads to a drastic increase in the change of the contact angle when switching from the E to the Z isomer. Indeed, the change in contact angle increased from only 7° for homogeneous monolayers to about 20° for nanostructured surfaces using AAP aggregates.

DY 10.4 Mon 10:30 ZEU/0260

Motion and interaction of Marangoni contracted droplets on micropatterned surfaces — •Ze Xu, Raphael Saiseau, and Stefan Karpitschka — Fachbereich Physik, Universität Konstanz, Konstanz, Germany

Wetting of micropatterned surfaces is ubiquitous in nature and key to many technological applications like inkjet printing and semiconductor processing. Overcoming the intrinsic, chemistry- and topography-governed wetting behaviors often requires specific materials, leading to contradicting requirements between the processing strategy and the final product. Here, we demonstrate that droplet spreading and wicking on hydrophilic patterns can be controlled by the vapor of a lower-surface-tension liquid. Condensation of the vapor induces Marangoni forces that delay capillary wicking and contract liquid into a droplet on top of the imbibed film. Consequently, a Marangoni-contracted droplet coexists with a finite imbibition film for prolonged times. We demonstrate how these droplets interact with each other, both by their vapor cloud, and by the imbibed liquid film that surrounds them. Modulating the ambient vapor, also these interactions can be modulated, devising new strategies for coating, cleaning, and drying functional surfaces.

DY 10.5 Mon 10:45 ZEU/0260

Wetting of Swelling Polyelectrolyte Surfaces on a Macroscopic and Nanoscopic Scale — •Mona Meltschoch and Regine von Klitzing — Soft Matter at Interfaces, Institute for Condensed Matter Physics, TU Darmstadt, Hochschulstraße 8, D-64289 Darmstadt, Germany

Wetting on adaptive polymer interfaces plays an important role in soft matter physics, particularly when spreading is affected by substrate hydration. Polyelectrolyte multilayers (PEMs) are suitable model systems because they absorb water and evolve across multiple time scales, creating a link between nanoscale polymer mobility and macroscopic contact line motion. PEM films were prepared by the layer-by-layer method, and their wetting behaviour was examined at different scales. Nanoscale morphology and hydration were characterised by atomic force microscopy (AFM), while macroscopic wetting was followed via optical contact angle (CA) measurements. Previous studies report a decrease in water CA on PSS-terminated PEMs under humid atmosphere. To assess how film architecture affects wetting, PEMs with varying bilayer numbers and terminal charge (PSS vs. PAH) were fabricated, showing smooth surfaces and a linear thickness increase. Current work explores AFM beyond static surface imaging by applying it directly to droplets on PEM films. This approach aims to track local swelling, interface deformation and contact line behaviour under liquid exposure. Measurements with different droplet liquids are being established, with the long-term goal to link nanoscale hydration dynamics to macroscopic changes in contact angle and wetting evolution.