CPP 8: Wetting, Fluidics and Liquids at Interfaces and Surfaces II (joint session CPP/DY)

Time: Monday 11:30–12:45 Location: ZEU/0260

CPP 8.1 Mon 11:30 ZEU/0260

Do the particle number and wettability affect their removability by a single water drop? — •Franziska Sabath[1], Abhinav Naga[2], Halim Kusumaatmaja[2], and Doris Vollmer[1] — [1]Max Planck Institute for Polymer Research, 55128 Mainz, Germany — [2]Institute for Multiscale Thermofluids, School of Engineering, University of Edinburgh, United Kingdom

The accumulation of dust on surfaces, *e.g.* windows and solar panels, is a well-known phenomenon in everyday life. The ratio of the capillary force between particles and drop and the resistive forces between particles and surface, *i.e.* friction and adhesion, determine whether the particles can be removed by a water drop. The likeliness of particle removal depends on both particle and surface wettability. It is still questionable how the particle arrangement, the total resistive force acting and the unwanted redeposition of particles depend on the number and wettability of the particles. Here, we investigate the removal of hydrophobic and hydrophilic spherical particles from a flat surface. As the number of hydrophobic particles increases, the total resistive force increases, but not linearly, and overcomes the capillary force, causing particle redeposition. In contrast, the hydrophilic particles slide on a thin water film, reducing the particle-surface friction and no resistive force is measured within our experimental resolution.

CPP 8.2 Mon 11:45 ZEU/0260

Modelling and simulation of capillary adhesion between rough surfaces — •Yizhen Wang, Martin Ladecký, and Lars Pastewka — University of Freiburg, Freiburg, Germany

At a small enough length scale, surfaces are always rough, regardless whether they are generated by nature or via artificial process. When two such surfaces are placed close enough, the water molecules in the humid air are adsorbed and hence form capillary bridges. Theories for adhesive interactions typically use simple cohesive laws, which are good models for Van-der-Waals interactions but may not be appropriate for capillary adhesion. We here construct a phase-field model that explicitly represents water present between two contacting rough interfaces. We show results obtained with this model on synthetic, computer-generated, self-affine rough interfaces. In quasi-static simulation, we observe the merging and splitting of droplets under the normal and shear movement of the interfaces. The overall force is dominated by the perimeter of the droplet, indicating the importance of a detailed understanding of droplet morphology.

CPP 8.3 Mon 12:00 ZEU/0260

Impact of surface wettability on the removal of montmorillonite aggregates by water drops How natural dirt is removed from various surfaces — •Stefanie Kirschner, Franziska. Sabath, Azadeh Sharifi-Aghili, Tarik Karakaya, and Doris Vollmer — Max Planck Institute for Polymer Research, 55128 Mainz, Germany

Natural dust on photovoltaic modules or windows, is a critical factor that reduces their performance. Previous experiments focused on the removal on single or many spherical particles. The removal of aggregates of natural particles, is not yet understood. Here, we focus on minerals, commonly present in desert dust. Using confocal laser scanning microscopy the detachment behavior upon contact with a water drop is measured on surfaces with different wettability. In addition, the force required to remove the aggregate by a sliding water drop was investigated. During drying on a hydrophilic surface, the dispersed particles cover a larger area. This increases the total contact area, resulting in higher adhesion and reduced detachment. In contrast, hydrophobic surfaces promoted more compact aggregates with improved removability. Finally, I will compare the detachment forces and the removal behavior of different natural aggregates, e.g. soot, salt and humic acid.

CPP 8.4 Mon 12:15 ZEU/0260

Equilibrium droplets on deformable substrates exhibit cloaking and demixing at the three-phase contact line — •Khalil Remini[1], Ralf Seemann[1], Dirk Peschka[2], and Barbara Wagner[2] — [1]Universität des Saarlandes — [2]Weierstrass Institute for Applied Analysis and Stochastics

This work examines the equilibrium shape of liquid droplets on viscoelastic PDMS substrates with varying elasticities. By combining atomic force microscopy (AFM) with an initial lift-off step, we reveal not only the top contour of the droplets but also the buried droplet*substrate interface. A second lift-off step provides additional structural details near the three-phase contact line (TPCL), where the interfacial tensions adopt a Neumann balance. Quantitative analysis of the reconstructed 3D droplet shapes shows that non-crosslinked, liquid PDMS molecules are extracted from the elastic network under stress and accumulate as a liquid rim around the droplet base, thereby altering both the droplet shape and the substrate profile close to the TPCL. These liquid molecules also cloak the droplets with a thin film, modifying the effective surface tensions. Furthermore, dewetting experiments demonstrate that this demixed liquid already appears at an early stage of dewetting and remains at an approximately constant amount throughout the process.

CPP 8.5 Mon 12:30 ZEU/0260

Tuning Sliding Drop Shape — •Fiona Berner, Chaurasia Rishi, Sajjad Shumaly, Chirag Hinduja, Hans-Jürgen Butt, and Rüdiger Berger — Max-Planck-Institut für Polymerforschung

The understanding of wetting phenomena plays a crucial role in many daily processes. For example, dirt repelling glasses can be achieved by a hydrophobic coating. Recently, Hinduja et al, reported on a scanning drop friction force instrument (sDoFFI) to analyse friction forces of drops on surfaces. A drop is fixated to an elastic force sensor with spring constant κ. The sample underneath the drop is moved with a constant speed u leading to sliding of the drop at a defined trajectory along surfaces. The deflection of the capillary,d, provides information about the friction force between the drop and the surface, $F_{meas} = \kappa \cdot d$ Forces arising from CAH are given by the Furmidge equation, where the drop*s sliding force F_{CAH} corresponds to

$$F_{CAH} = k \cdot \gamma \cdot w \cdot \big(cos(\theta_{rec}) - cos(\theta_{adv})\big) \quad (1)$$

where k is a geometrical factor, γ is the liquid surface tension, w the width of the drop and θ_{rec} and θ_{adv} are the receding and advancing contact angles, respectively. For small u we assume $F_{meas} = F_{CAH}$. The parameters γ, w, θ_{rec} and θ_{adv} are known or can be measured optically. Thus, the geometrical factor k can be calculated. We realize different geometries of the drop by glueing metal rings to the elastic glass capillary. Shaping the metal rings forces the drop to shape. We discuss experiments where we shape the drop into different width and length and discuss dependence of the geometrical factor k.