DROPIT

THEMATIC AREA B

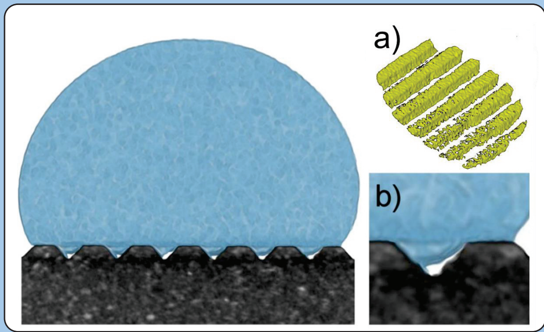
DROP-WALL INTERACTION

FOCUS: DROP IMPINGEMENT ON SOLID SURFACES

GOAL: To understand and model droplet impingement on solid surfaces including porous structures and pre-treated hydrophilic and hydrophobic surfaces

List of planned sub-projects (principal investigators):

- SP-B1: Droplet Collisions with Solid Superhydrophilic Surfaces
  (N. Roth, G. Cossali)
- SP-B2: Drop Impact/Deposition onto Micro-structured Hydrophobic and Superhydrophobic Surfaces
  (M. Santini, N. Roth)
- SP-B3: Characterization of Porous Media by X-Ray Micro Computed Tomography
  (M. Santini, T. Ertl)
- SP-B4: Compressible Effects in Droplet Interactions with Textured Walls
  (C. Rohde, F. Bassi)
- SP-B5: Numerical Computation for Drop Impact on Textured Surfaces
  (B. Weigand, Dumbser)
- SP-B6: Upscaling of Coupled Free-Flow Porous Media Flow Processes
  (R. Helmig, M. Santini)



Rendered tomographic acquisition of a drop deposed on a vinyl surface coated with a dispersion of super-hydrophobic nano-agglomerates: (a) real wetted surface; (b) effect of non-uniformity of coating causes partial hydrophobization [1].

SP-B1: Droplet Collisions with Solid Superhydrophilic Surfaces

GOAL: Understanding and predicting the behaviour of droplets on superhydrophilic surfaces

METHODS:

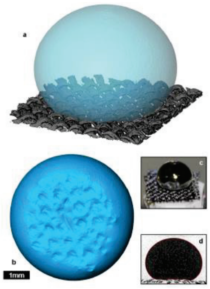
- Micro-structures on the surface will be altered and optimized to enhance superhydrophilic behaviour
- Experiments performed with different impact angles, droplet sizes and velocities
- Validation with numerical simulations performed in SP-B5 and SP-B6

SP-B2: Drop Impact/Deposition onto Micro-structured Hydrophobic and Superhydrophobic Surfaces

GOAL: To understand the physical mechanisms of wetting transition in order to design efficient superhydrophobic materials

METHODS:

- Geometrical characterization of surface structures by micro-CT
- Wetting transition on hydrophobic and super-hydrophobic surfaces with well-defined and characterized topography
- Direct experimental evidencing of the Cassie impregnating state
- Experimental study of dynamics of the triple line under wetting transition
- Wetting transition of various organic liquids



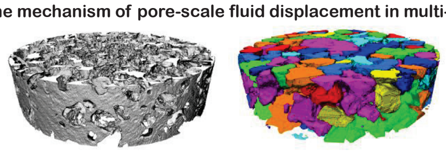
Micro-CT of complex artificial substrate and a sessile water drop [2]

SP-B3: Characterization of Porous Media by X-Ray Micro Computed Tomography

GOAL: To apply micro-CT with a multi-scale approach to multi-phase systems

METHODS:

- Geometrical characterization of micro-pore structure and estimation of porosity and permeability of porous medium
- Analysis of interfacial characteristics of multi-phase fluid system
- Visualizations of the mechanism of pore-scale fluid displacement in multi-phase fluid systems



Visualization of aluminium foil iso-surface [2]

SP-B4: Compressible Effects in Droplet Interactions with Textured Walls

GOAL: Provide mathematical models and numerical methods to describe compressible dynamics and to explore possible limitations of incompressible approaches

METHODS:

- Development of a compressible phase field model/numerical discretization
- Direct numerical simulation employing walls with less complex surface structure
- Development of a heterogeneous multi-scale method (HMM)

SP-B5: Numerical Computation for Drop Impact on Textured Surfaces

GOAL: To numerically study in detail: Drop impact and wetting behaviour on a textured surface with different micro-structures on the surface

METHODS:

- Multi-phase flows simulated using the in-house code Free Surface 3D (FS3D)
- Interface described using Volume of Fluid (VOF) method
- Numerical fluxes of the volume transport calculations based on a piecewise linear interface calculation (PLIC) method
- Poisson equation solved by an optimized multi-grid solver at the High Performance Computer Centre in Stuttgart (HLRS)

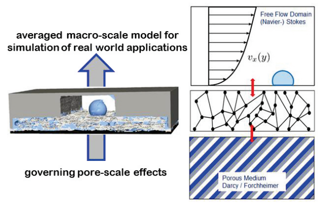
Time dependent impact of a droplet on a thin liquid layer [3]

SP-B6: Upscaling of Coupled Free-Flow Porous Media Flow Processes

GOAL: To develop a multi-scale, multi-physics model to understand and predict the influence of droplet related micro-scale interface processes on the macroscopic flow behaviour

METHODS:

- Pore-scale effects evaluated with the coupled model
- Averaged macro-scale flow model [4] in order to make larger scale simulations and real world application technically feasible



References

[1] Santini et al., Rev. Sci. Instrum. 86, 023708, 2015.

[2] Santini et al., Colloids and Interface Science Communications, 1:14-17, 2014.

[3] Gomaa et al., Atomization Sprays, 20(4):281-296, 2010.

[4] Jackson et al., Adv. Water Resour., 42:71-90, 2012.

Research Training Group 2160/1: Droplet Interaction Technologies

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DFG Deutsche Forschungsgemeinschaft