CPP 38: Micro and Nanofluidics II

Time: Thursday 9:30–10:45 Location: H39

CPP 38.1 Thu 9:30 H39

Droplet and cell sorting in microfluidic channels by surface acoustic waves — Thomas Franke[1,2], Lothar Schmid[1], Susanne Braunmüller[1], Achim Wixforth[1], and •David Weitz[2] — [1]Universität Augsburg, EP1, Microfluidics Group, Augsburg — [2]Harvard University, SEAS, Cambridge, USA

We direct the motion of droplets in microfluidic channels using a surface acoustic wave device. This method allows individual drops to be directed along separate microchannel paths at high volume flow rates, which is useful for droplet sorting. The same principle can be applied for biological cell sorting which operates in continuous flow at high sorting rates. The device is based on a surface acoustic wave cell-sorting scheme and combines many advantages of fluorescence activated cell sorting (FACS) and fluorescence activated droplet sorting (FADS) in microfluidic channels. It is fully integrated on a PDMS device, and allows fast electronic control of cell diversion. We direct cells by acoustic streaming excited by a surface acoustic wave which deflects the fluid independently of the contrast in material properties of deflected objects and the continuous phase; thus the device underlying principle works without additional enhancement of the sorting by prior labelling of the cells with responsive markers such as magnetic or polarizable beads. Single cells are sorted directly from bulk media at rates as fast as several kHz without prior encapsulation into liquid droplet compartments as in traditional FACS. We have successfully directed HaCaT cells, fibroplasts from mice and MV3 melanoma cells.

CPP 38.2 Thu 9:45 H39

Stability of Nanobubbles — •Ralf Kaminke and Klaus Mecke — Institut für Theoretische Physik I, Staudtstr. 7, D - 91058 Erlangen

Gas nanobubbles on substrates were expected to be unstable due to a large Laplace pressure. But AFM images combined with infrared spectroscopy confirmed that they exist and that they are relatively stable [Zhan et al., Phys. Rev. Lett. 98, 136101 (2007)]. As they are not observable in bulk liquids, the substrate must play an important role and therefore density functional theory is the appropriate approach. The bubbles are modelled by spherical caps of nanometer thickness on a flat substrate, so that pressure and density inside the cap is determined by the substrate potential. The gas density is influenced by the substrate strength, the contact angle and the liquid density outside the cap. For a given radius of the spherical cap it is possible to find a contact angle, which minimizes the grand canonical potential and gives a metastable or stable solution depending on the size of the cap. This explains the existence of nanobubbles by substrate potentials.

CPP 38.3 Thu 10:00 H39

Equilibrium properties of polymer films and droplets — •Nikita Tretyakov and Marcus Müller — Institut für Theoretische Physik, Georg-August-Universität Göttingen

We study equilibrium properties of polymer films and droplets on a substrate by Molecular Dynamics simulation. We use a Lennard-Jones bead spring model for polymer chains and the substrate is represented by 2 layers of an fcc lattice. We use a dissipative particle dynamics (DPD) thermostat in our simulation. Various strengths of polymer-substrate interaction were used in order to tune the wettability.

The pressure tensor was calculated for different thicknesses of polymer films using a slab geometry. The values of the surface tensions of the substrate-liquid and liquid-vapor interfaces were derived. The wetting transition between complete (films) and partial wetting (droplets) was observed and the interface potential as function of thickness of the film was computed. The interface potential provides information about the contact angle and the stability of a thin film with respect to dewetting (spinodal or nucleation mechanisms). For ultra-thin films, no homogeneous layer can be observed and in this region the interface potential is a linear combination of contributions from the coexisting thin and thick films.

CPP 38.4 Thu 10:15 H39

Fluid-surface interaction models in Lattice-Boltzmann simulations — •Calin Dan[1], Martin Hecht[1,2], and Jens Harting[1,3] — [1]Institute for Computational Physics, Universität Stuttgart, Pfaffenwaldring 27, 70569 Stuttgart, Germany — [2]High Performance Computing Center, Universität Stuttgart, Nobelstraße 19, 70569 Stuttgart, Germany — [3]Department of Applied Physics, Technische Universiteit Eindhoven, Den Dolech 2, 5600 MB Eindhoven, The Netherlands

An accurate description of fluid-surface interactions is critical for simulations of microfluidic setups. The Molecular Dynamics method is preferred by many researchers to simulate the related phenomena, but these simulations are computationally extremely demanding. Alternatively, the Lattice-Boltzmann method can model the complex phenomena taking place at fluid-surface interfaces by applying for example a phenomenological model, which is based on the well-known Shan-Chen multi-component Lattice-Boltzmann model. However, it is a priori not clear how the influence of parameters like the temperature, charges, or impurities can be taken into account. In this work, we investigate the formulation of fluid-surface interactions within the Lattice-Boltzmann method and quantitatively compare our results to Molecular Dynamics simulations. We calibrate our model parameters using surface tension measurements and apply different implementations to investigate the behavior of a droplet in a capillary with complex fluid-surface interactions.

CPP 38.5 Thu 10:30 H39

Lattice Boltzmann simulations of a sphere approaching a superhydrophobic surface — •Christian Kunert[1] and Jens Harting[2] — [1]Institut für Computerphysik, Pfaffenwaldring 27, 70569 Stuttgart — [2]Dept. of Applied Physics, TU Eindhoven, Postbus 513, NL-5600MB Eindhove

When an object that is submerged in a liquid is approached towards a surface, the lubrication force raises. The measurement of the lubrication force allows to study the flow profile near objects and thus to deduce the flow boundary condition. In particular, such a measurement can be used to study the effect of boundary slippage. The slip on a surface can be increased by combining roughness and hydrophobic interactions. On such surfaces, vapor or gas might be trapped between the roughness asperities creating a so-called superhydrophobic surface. In this contribution we present lattice Boltzmann simulations of a sphere that approaches a superhydrophobic surface generated by bubbles that are trapped in holes on the surface.