CPP 25: Micro and Nano Fluidics III: Lab-on-Chip Geometries

Time: Thursday 17:15–19:00 Location: H37

Invited Talk CPP 25.1 Thu 17:15 H37

Coupled electro-hydrodynamic force fields for the manipulation of objects in solutions — •Magnus Jaeger[1], Maika Felten[2], Guenter Fuhr[1], Michael Stuke[3], and Claus Duschl[2] — [1]Saarland University, Faculty Clinical Medicine, Department Medical Technology, Ensheimer Strasse 48, 66386 St. Ingbert, Germany — [2]Fraunhofer Institute for Biomedical Engineering, Am Muehlenberg 13, 14476 Potsdam, Germany — [3]Max Planck Institute for Biophysical Chemistry, Am Fassberg 11, 37077 Goettingen, Germany

Presently, pumping of fluids in lab-on-chip systems still suffers from serious limitations. Theoretical and experimental investigations have shown that high-frequency travelling electric waves are well-suited to pump liquids through microchannels. The absence of any moving parts pre-destines this method for the design of microscaled fluid pumps. Depending on the frequency of the electric field used, different mechanisms lead to an effective fluid transport. We used impedance measurements to quantify the processes in the different frequency regimes. To analyse the flow profile above the electrodes, Fluorescence Correlation Spectroscopy was carried out. Furthermore, we scaled the whole system down to the nanometer range. Since the electrodes that generate the force on the fluid are installed at the channel walls, this method shows great promise for overcoming the enormous frictional forces in nanostructures. This work is part of the Priority Programme 1164 "Nano- & Microfluidics: Bridging the Gap between Molecular Motion and Continuum Flow" and funded by the Deutsche Forschungsgemeinschaft under the reference number JA 17 17 / 1 - 2.

CPP 25.2 Thu 17:45 H37

Field mediated self assembly and actuation of highly parallel microfluidic devices — •Stefan Bleil[1], Tobias Sawetzki[1], David Marr[2], and Clemens Bechinger[1] — [1]2. Physikalisches Institut, Universität Stuttgart, Germany — [2]Colorado School of Mines, USA

The use of microfluidic devices requires active components (pumps, valves and mixers) which can direct and control liquids in such structures. We present a novel approach where pumps and valves are created by a self assembly process which allows the realization of thousands of pumps at the same time. This is achieved by subjecting super paramagnetic colloidal particles to a rotating magnetic field, which results in a rotation of particles and thus leads to a fluid flow. The rotating field induces attractive interactions between particles and thus leads to the self assembly process. To control single pumps and valves individually we use optical tweezers, which can stop or slow down the motion of particle clusters. In addition to the advantage of forming large arrays of individually addressable devices, our approach allows also to scale the devices down to the nanometer range by using smaller particles.

S. Bleil, D.W.M. Marr and C. Bechinger; Appl. Phys. Lett., 88, 263515 (2006)

CPP 25.3 Thu 18:00 H37

Mesoscopic modeling of microfluidic colloidal devices — •Arthur Straube[1] and Ard Louis[2] — [1]Department of Physics, University of Potsdam, Am Neuen Palais 10, PF 601553, D-14415 Potsdam, Germany — [2]Rudolph Peierls Centre for Theoretical Physics, Oxford University, 1, Keble Road, Oxford, OX1 3NP, UK

We address the problem of microfluidic colloidal devices and focus on a peristaltic micropump and a colloidal valve, which have recently been implemented experimentally [1]. To model these microfluidic systems, we apply the method of stochastic rotation dynamics, where the motion of colloids is assumed to be imposed through the use of optical traps. We investigate the efficiency of the devices and are particularly interested in the effects of Brownian motion of the colloids. Here, we aim at answering a fundamental question of how small such a device can be made before it stops functioning.

The research is funded by DFG Priority Program SPP 1164 "Nano- and microfluidics,"(project STR1021/1-1) and partially supported by HPC-EUROPA Visitor program (RII3-CT-2003-506079).

[1]. A. Terray, J. Oakey, D.W.M. Marr, Microfluidic control using colloidal devices, Science **296**, 1841 (2002).

CPP 25.4 Thu 18:15 H37

separation of liquid mixtures on chemically patterned surfaces — •Pagra Truman, Leonid Ionov, Smrati Gupta, Petra Uhlmann, and Manfred Stamm — Leibniz Institute of Polymer Research Dresden, Hohe Str. 6, Germany

The use of chemically patterned surfaces is an interesting tool to drive liquid flow along surfaces, micro- or nano-channels. In this work we investigate novel applications of chemically patterned surfaces namely the separation of liquid mixtures. The liquid dynamics on chemically patterned surfaces is highly complex since interfacial phenomena and flow inside the liquid influence the dynamics. As a simple model liquid mixture to study fundamental aspects of this process we apply Toluene/Water mixtures to two types of surfaces: Firstly flow on surfaces with a wetting gradient is studied. Secondly flow on surfaces with an abrupt change of wettability (hydrophilic/ hydrophobic) is investigated. Wetting gradients are prepared by binary polymer brushes made of two incompatible polymers by introducing a gradient of hydrophilicity/ hydrophobicity or surface charge via variations in the grafting density. A surface with an abrupt change of wettability is fabricated by casting an expoxy resin into the cavity of a teflon block and subsequent milling. Besides presenting experimental results the perspectives to carry out such processes in confinement for applications in microfluidics systems will be discussed.

CPP 25.5 Thu 18:30 H37

Juggling with droplets: manipulation of monodisperse gel emulsions in microchannels — •Enkhtuul Surenjav, Craig Priest, Stephan Herminghaus, and Ralf Seemann — Max-Planck Institute for Dynamics and Self-Organization, Bunsenstraße 10, D-37073, Göttingen, Germany

Emulsions with a continuous phase volume fraction of a few percent only are called gel emulsions. These emulsions are topologically analogous to foam and the monodisperse compartments (droplets) assemble into well-defined arrangements. Hence, the position of a single droplet within an ensemble of droplets is fully determined while being transported through microfluidic channels. We studied the online generation, organization, and manipulation of monodisperse gel emulsions using a variety of microchannel geometries. In particular, the topological change between a zigzag structure and a bamboo structure is considered. "Passive" reorganization, based on fixed channel geometries, can be supplemented by "active" manipulation of an incorporated ferrofluid phase. A ferromagnetic continuous phase facilitates reorganization of liquid compartments on demand using an electromagnetic trigger. Moreover, coalescence between adjacent compartments of a well-defined gel emulsion can be induced via spinodal instability of their lamellae when applying an electrical potential of a few volts across a lamella. We anticipate that microfluidic processing of compartmented liquid will be well-suited for applications in combinatorial chemistry, DNA sequencing, drug screening and protein crystallizations.

CPP 25.6 Thu 18:45 H37

Atomistic simulation of nanoscale wicking — •Björn Henrich[1], Mark Santer[1,2], and Michael Moseler[1,3] — [1]Fraunhofer Institut für Werkstoffmechanik IWM, Wöhlerstraße 11, D-79108 Freiburg — [2]IMTEK-Institut für Mikrosystemtechnik, Lehrstuhl für Anwendungsentwicklung, Georges-Köhler-Allee 106, D-79110 Freiburg — [3]Freiburger Materialforschungszentrum (FMF), Stefan-Meier-Straße 21, D-79104 Freiburg

We present extensive molecular dynamics simulations of fluid propane in gold nanopores. In particular, the impregnation dynamics into a slit is investigated and compared to a continuum model, namely an extended Washburn equation which takes into account inertia, slip induced by an atomistic precursor film and the evolution of the dynamic contact angle. The latter is also extracted from stationary plug flow simulations and is found to agree with those found in the wicking simulation after a short period dominated by inertial effects.