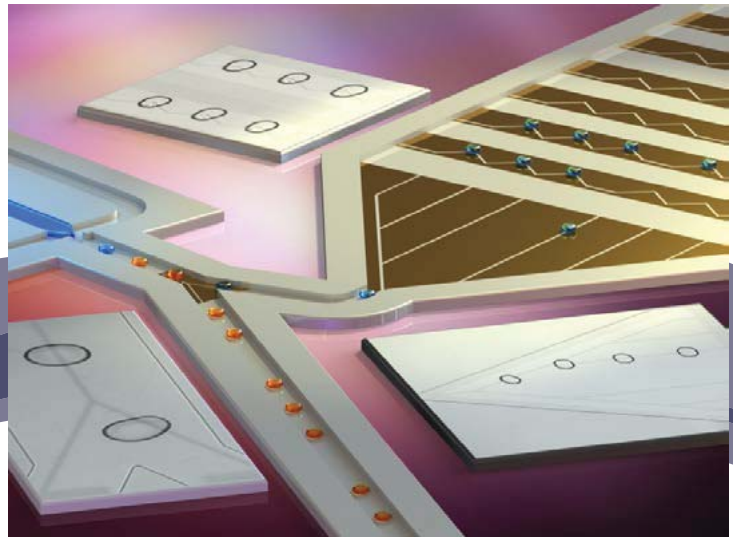
Controlling drop dynamics by electrically tunable energy landscapes



Prof. Frieder Mugele

Physics of Complex Fluids, MESA+ Institute for Nanotechnology, University of Twente, Enschede (The Netherlands)

Wednesday, October 21, 2015 9:00am - 10:00am
The Donnelly Centre, Yip/Friesen Red Seminar Room
160 College Street

ABSTRACT: Drops are frequently used as containers and reaction vessels in microfluidic applications. The dynamics of such drops are governed by the balance of conservative driving forces, inertia, and viscous dissipation. Electrowetting and related electrostatic trapping mechanisms provide a versatile tool to generate tunable energy landscapes that allow for precise control of the motion of liquid drops and the flow of solute within the drop. In this lecture, I will discuss a number of examples that illustrate the physical principles controlling the mobilization and the motion of drops on electrically functionalized surfaces. First, I will discuss the principle of electrically controllable drop traps for sliding drops on an inclined plane and the subtle balance between inertial and viscous forces in enabling drop trapping[1]. This method is applied to control the motion of drops in a hybrid continuous flow microfluidic device with electrically functionalized side walls to trap, sort, and store drops[2,3]. In the final example, I will show how inertia can be used to generate well-controlled vigorous flow fields[4,5] within evaporating drops that eventually lead to a novel method of sample preparation for MALDI-MS leading to substantially enhanced sensitivity[6].

REFERENCES:

1. t Mannetje, D. et al. Trapping of drops by wetting defects. Nature Communications 5, doi:10.1038/ncomms4559 (2014).
2. de Ruiter, R. et al. Electrostatic potential wells for manipulations of drops flowing through microchannels. Lab Chip DOI: 10.1039/c3lc51121a (2014).
3. Pit, A. M. et al. High-throughput sorting of drops in microfluidic chips using electric capacitance. Biomicrofluidics 9, doi:10.1063/1.4928452 (2015).
4. Mampallil, D., van den Ende, D. & Mugele, F. Controlling flow patterns in oscillating sessile drops by breaking azimuthal symmetry. Applied Physics Letters 99, 154102, doi:10.1063/1.3645621 (2011).
5. Mugele, F., Staicu, A., Bakker, R. & van den Ende, D. Capillary Stokes drift: a new driving mechanism for mixing in AC-electrowetting. Lab on a Chip 11, 2011-2016, doi:10.1039/c0lc00702a (2011).
6. Mampallil, D., Eral, H. B., van den Ende, D. & Mugele, F. Control of evaporating complex fluids through electrowetting. Soft Matter 8, 10614-10617, doi:10.1039/c2sm26103k (2012).