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Drops in Motion: Microfluidics Based on Switchable Wettability

Modern concepts in microfluidics are largely based on the manipulation of discrete amounts of fluids in the form of individual drops embedded into a second immiscible fluid medium. Owing to the large surface-to-volume ratio wetting plays a crucial role in these systems. As a consequence, achieving active control of surface wettability has become a paradigm in drop-based microfluidics. Electrowetting (EW) is arguably the most versatile and robust tool in this context allowing for switching of contact angles by more than 90°, perfectly reversibly for hundreds of thousands of times. In this lecture, I will explain the basic principles of electrowetting and discuss a number of physical principles that are relevant for applications. Examples will include the control of contact angle hysteresis by means of AC electrowetting and enhanced mixing in sessile drops achieved by a periodic modulation of the contact angle. Furthermore, I will discuss some basic concepts related to the stability of superhydrophobic surfaces and demonstrate their switchability by electrowetting. These experiments will reveal that the EW-driven collapse of superhydrophobic surfaces is controlled by a different mechanism than in conventional superhydrophobic surfaces. Finally, I will discuss a novel approach to microfluidics integrating the advantages of pressure-driven microfluidic devices with the exquisite control over individual drops of EW-driven systems. I will present a specific example of microfluidic drop generation in a microfluidic flow focusing device with EW-capability.

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