"Afraid of getting wet? Use of (Super)hydrophobic surfaces in Digital Microfluidics"

Prashant Agrawal, Oleschuk Group

A superhydrophobic (SH) surface, characterized by a water contact angle of >150° and a sliding angle <10°, is resultant of significantly stronger cohesive forces of the resting liquid compared to weak adhesive forces with the surface material.

Digital microfluidics is a discipline in which liquids of very small volume (from microliters to picoliters) are actuated, mixed, merged, split, and/or analysed on uniquely engineered devices. The two most important ways SH surfaces have aided digital microfluidics is via facilitating magnetic actuation of droplets and formation of microarrays. SH surfaces offer low frictional forces between a liquid droplet and the surface itself, allowing for actuation using minimal force. In this DMF approach, the magnetically susceptible material is added to the liquid to be manipulated. This makes it possible to manipulate the liquid droplet using an external magnetic field. The magnetically susceptible materials employed in this process can be ferrofluids, paramagnetic salts or superparamagnetic particles. The increase in research surrounding more advanced superhydrophobic surfaces has led to the development of SH materials with patterned wettability. Droplets have the ability to wet and be pinned to the hydrophilic patches for small volume deposition and droplet anchoring, respectively.

This talk will examine the synthesis and use of hydrophobic and superhydrophobic coatings for different droplet operations and analytical applications. In particular, we examine the magnetic actuation performance of aqueous droplets on Ultra-Ever Dry, (a commercial coating), fluorine-containing and environmentally friendly “fluorine-free” SH PPM surfaces and explore multiplexed magnetic actuation to conduct a quantitative DNA assay. Secondly, we demonstrate biologically-driven magnetic actuation (BDMA) using magnetotactic bacteria (MTB) to both transport of droplets along various trajectories and sequentially merge and mix multiple droplets. A microfluidic system for magnetic actuation of aqueous as well as organic droplets on slippery liquid-infused porous (SLIPS) surfaces is proposed. The final part of this talk will touch upon the use of patterned hydrophobic PPM surfaces to conduct a “higher throughput” ice recrystallization inhibition assay.