Climbing droplets on magnetically actuated surfaces

Bachelor project assignment

Introduction

The ability to manipulate droplets over surfaces is important for a range of applications. For example, droplets are used as mobile micro-reactors in microfluidics devices where they must be moved between various locations for various processing steps. Another example is the motion of droplets to clean surfaces: as the drops move over dirty surfaces, they take up and remove dirt particles and other debris. Various ways of moving droplets over surfaces have been invented and are being investigated [1], e.g. electrowetting in which electrode patterns on the surface actuate the droplets, or surface acoustic waves that direct droplets over surfaces by creating an internal flow in the drops. We recently have invented another cool method: by creating a small deformation on the surface, the local contact angle of a droplet can be changed, so that it starts moving. This surface deformation can be induced by actuating a structured magnetic surface using a simple magnet. The big advantage of this approach is that the movement is realized in a 'soft' manner, meaning no strong electric field or highly disturbing flow is imposed on the content of the droplets, and that is beneficial for biological applications.

Project

The aim of this project is to show the capability and versatility of the method. We have already shown proof-of-principle of the effect, but the motion of the drops is still slow, and the effect is not sufficiently quantified. This can be improved by optimizing the design of the surface and the magnet, with respect to the droplets to be manipulated. You will be working on the design, fabrication and testing magnetically actuated surfaces to obtain enhanced motion of droplets, demonstrated and quantified by moving the droplets up a tilted slope. This requires designing and realizing an appropriate magnetic field, designing the inner structure of the surface, fabricating the structures using microfabrication techniques in the Microfab/lab, and setting up and carrying out the 'climbing droplet' experiments. Depending on the project time and capacity of the student, theoretical and numerical modelling on the deformation of the surface structure can be performed for further optimization.

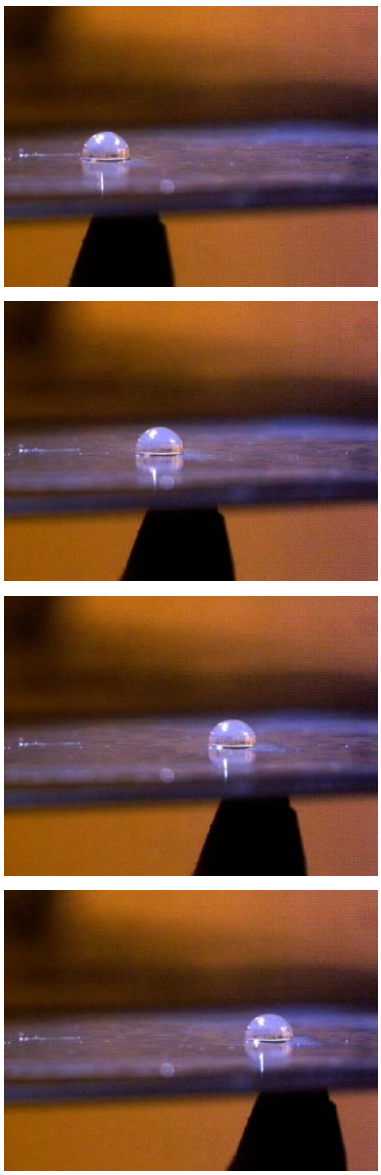

Figure 1: Proof-of-principle: a water droplet on a deformable magnetic surface, moves over the surface due to the deformation of the surface that is caused by a simple magnet that is moved underneath the surface.

[1] A. Pit et al. (2015) Micromachines 6, 1768–1793

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