Research Topic for the ParisTech/CSC PhD Program

Subfield: wetting, soft matter physics, physical chemistry

ParisTech School: ESPCI

Title: Magnetic control of wettability on superhydrophobic surfaces

Advisor(s): Etienne Barthel (https://www.simm.espci.fr/spip.php?article806 - etienne.barthel@espci.fr) in collaboration with Jérôme Fresnais (PHENIX, Sorbonne University, http://www.phenix.cnrs.fr/spip.php?article504).

Short description of possible research topics for a PhD:
Superhydrophobic surfaces attract the interest of both academic and industrial research communities for their unique self-cleaning, anti-icing, and non-wetting properties. Such surfaces combining hydrophobicity and roughness, are widely found in nature on plant leaves or animal bodies (feathers or velvets). The main drawback of these surfaces is that the roughness can be corrupted with dust, drastically reducing their durability of their wetting properties. The main countermeasure in nature consists in regeneration of the hydrophobic structures.
This is of course not possible (yet) for synthetic surfaces, **but how simple would be the life of a Lotus leaf if it could actuate the micrometric structures at its surface**? What nature cannot do, we are able to achieve through external stimulation of soft magnetic textures. In a recent PhD work, we have shown that we can control the orientation of magnetic PDMS pillars, and thereby directly act on the wetting properties of a single droplet. This result paves the way to novel surfaces with engineered wetting dynamics, by tuning surface properties, texture morphologies and stiffness, and the dynamics of the externally applied magnetic field. The present project will combine novel surface preparation, magnetic characterization and relatively simple dynamic wetting experiments to establish the surface properties. These experimental advances will form the basis of an improved understanding of the dynamic wetting on dynamic surfaces. Besides fundamental aspects, the understanding of dynamical wetting of micro- and nano-structured surfaces has numerous applications like nanofluidics, the captation of dew, the control of evaporating solutes like proteins and colloids, …

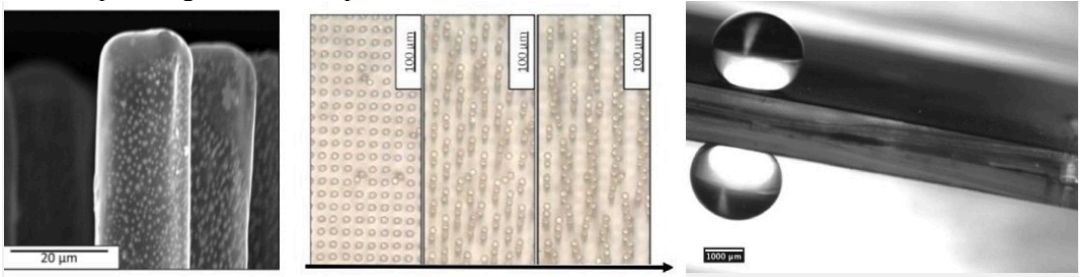

Figure: Soft magnetic pillars / magnetic interactions between pillars / controlled motion of droplet on a tilted superhydrophobic surface

Required background of the student: Interest for physical chemistry or soft matter or polymer/composites formulation – familiarity with wetting or surfaces would be a plus.
Publications of the group:
Le Digabel, J. et al., (2011) *Magnetic Micropillars as a Tool to Govern Substrate Deformations,* Lab on a Chip 11 : 2630.
Gauthier, A. et al. (2013). *Role of kinks in the dynamics of contact lines receding on superhydrophobic surfaces*, Phys. Rev. Lett. 110 : 046101.
Rivetti, M. et al. (2015). *Surface Fraction Dependence of Contact Angles Induced by Kinks in the Triple Line*, Phys. Rev. Lett. 115 : 016101.