ΕΘΝΙΚΟ ΜΕΤΣΟΒΙΟ ΠΟΛΥΤΕΧΝΕΙΟ
ΣΧΟΛΗ ΧΗΜΙΚΩΝ ΜΗΧΑΝΙΚΩΝ

ΕΠΙΤΡΟΠΗ ΣΕΜΙΝΑΡΙΩΝ, Καθηγητής Α. Κοκόσης

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ΣΕΜΙΝΑΡΙΟ ΧΗΜΙΚΗΣ ΜΗΧΑΝΙΚΗΣ

Πέμπτη 7 Απριλίου 2011, 13:00
Αίθουσα Σεμιναρίων «Ν. Κουμούτσου»

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Switchable Superhydrophobic Surfaces

The favorable properties of the superhydrophobic state are linked to the shape and stability of liquid micromenisci spanning the gaps between adjacent posts and ridges on superhydrophobic surfaces. Yet, the shape and the stability of these micromenisci has been elusive largely due to experimental difficulties in accessing these soft and fragile buried objects. In the first part of this lecture I present a method based on optical diffraction to measure the shape of the liquid micromenisci, including in particular their maximum deflection with a resolution better than 10nm. Upon varying the both an externally applied hydrostatic pressure in the liquid bath and of an applied electric field in an electrowetting configuration, we can deflect the liquid micromenisci using external control parameters. In both cases, the deflection of the menisci can be varied reversibly provided that the applied external force does not exceed a certain threshold value. For the case of hydrostatic pressure, we find that the Laplace pressure associated with the curvature of the menisci determined from the experiments matches exactly with the applied hydrostatic pressure. The critical pressure to induce the transition to the Wenzel state agrees with the advancing contact angle on a flat part of the substrates. This confirms that the Cassie-to-Wenzel on superhydrophobic surfaces with sufficiently large aspect ratio is controlled by the depinning of the contact line from the edges of the pillars.

For superhydrophobic surfaces in an electrowetting configuration, the equilibrium shape of the liquid micromenisci is governed by the local balance of the Maxwell stress and the Laplace pressure. Since the Maxwell stress varies both as a function of the distance from the posts and as a function of the shape of the meniscus, the do not display a constant mean curvature. Beyond a certain critical voltage, the Cassie states collapses to the Wenzel state. Depending on the advancing contact angle, the transition scenario is either controlled by the same depinning mechanism as the pressure-driven decay or by an electromechanical instability. I also discuss possibilities of achieving reversible switching between Cassie and Wenzel state using suitably patterned surfaces and electrodes.