הטכניון - מכון טכנולוגי לישראל

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הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

Lecture Hall 6, Wolfson Department of Chemical Engineering,

15th June, 2016 at 13:30

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A Simple-to-Apply Predictive Wetting Model for Textured (Rough/Patterned) Surfaces and the Role of Re-entrant Cavities

Rough/patterned/textured surfaces with nano/micro cavities that broaden below the surface – known as re-entrant cavities – can be omniphobic (macroscopic contact angle greater than 90° for both water and oils). The underlying physical principles that explain texture-driven omniphobicity have been studied extensively; however, existing models do not provide a simple procedure for predicting the thermodynamically stable and, in particular, the kinetically trapped metastable states and contact angles (for example, wetting states that involve partially-filled cavities). Recently, we have developed a simple-to-apply model that allows for predicting the metastable and the thermodynamically stable contact angles on a non-deformable textured surface consisting of axisymmetric cavities/protrusions (symmetric around the depth (vertical) axis of the cavity/protrusion). Arrays of axisymmetric cavities/protrusions are the common texture of hydrophobic surfaces, such as the Lotus Leaf.

In general, when a liquid droplet is placed on atomically smooth surface, a contact angle, θ_0, is formed along the liquid-vapor-solid rim at thermodynamic equilibrium. This contact angle is given by the Young equation. On textured surface, however, the apparent macroscopic contact angle can be significantly different; the cavities on the surface can either be fully-filled, or partially-filled by the liquid. Both wetting states – partially- or fully-filled – can occur under and/or outside (by condensation of liquid) the droplet. Importantly, the macroscopic contact angles for each state can be significantly different, and either of these states can be a transient (unstable) state, a kinetically trapped (short or long-lived) metastable state, or the thermodynamic equilibrium state. Utilizing an energy minimization approach, we derive a 'general wetting model' that (1) predicts apriori the state (partially- or fully-filled) of the cavities both under (in contact with) and outside the liquid droplet and the corresponding macroscopic contact angles on any type of textured surface; (2) allows for determination of the conditions under which metastable states exist; and (3) allows for engineering of specific nano/micro textures that yield any desired macroscopic contact angle, θ_t, for a given intrinsic contact angle θ_0. Controlling the macroscopic contact angle, whether above or below the intrinsic angle, θ_0, is desirable for many applications including non-wetting, self-cleaning and anti-fouling surfaces, or completely-wetting/spreading applications, such as cosmetics and lubricant fluids.

During the talk, our theoretical model will be presented and demonstrated by experiments.

Refreshments served at 13:15