Effect of Superhydrophobic surfaces for wetting in Micro-systems

W. Li, R. Mohamadi, and A. Amirfazli

Department of Mechanical Engineering, University of Alberta, Edmonton, AB, T6G 2G8, Canada

Abstract

To develop energy efficient microfluidic systems it is important to minimize the adhesion of the liquid to the surfaces in the system. One of the proposed methods in the literature is to use superhydrophobic surfaces, i.e. surfaces with contact angles above 150 degrees (for water). However, the issue that is not generally considered in depth in literature is the role of contact angle hysteresis (the difference between advancing and receding contact angles). In other words, to have an energy efficient droplet actuation system for microfluidics it is not sufficient to use surfaces that have large contact angles, but they also should have low contact angle hysteresis (CAH). Contact angle hysteresis is a common phenomenon in wetting. It is important but difficult to theoretically investigate CAH to optimally design superhydrophobic surfaces for micro-systems. We will present a universal approach to calculate CAH based on a free energy analysis for micro-textured surfaces. Thermodynamic status of contact angles and calculation of free the energy barrier are significantly simplified by using a representative 2D model instead of a 3D model with minimum loss of generality. A pillar surface structure is chosen as a typical example (see Figure 1). It is demonstrated that this approach can predict CAH and equilibrium contact angles that are consistent with predictions of Wenzel’s and Cassie’s equations. This approach can also provide a criterion for transition between noncomposite and composite structures (i.e. free spreading of liquids on a surface or achieving minimum contact area between a liquid drop and surfaces in a channel). Recent experimental results for wetting of superhydrophobic surfaces will also be discussed.

Keywords: Micro-texture; Contact angle; Super-hydrophobic surface; Wetting

Figure 1. Schematic of a typical microtextured surface produced by lithographical methods (pillar surface structure).