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Wetting simulation on rough surfaces by lattice Boltzmann method

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Surface topography; Texturation; Contact and adhesion; Simulation.

ABSTRACT

The wettability of a surface may be changed for industrial or ergonomic needs. In order to increase or decrease the wettability, there are two main approaches: modifying chemically or topographically the surfaces. This work is interested in topography of a surface which will change the wettability by impacting the spreading dynamics. Natural surfaces like ginkgo biloba leaves are good examples of complex topographical multi-scale surfaces shape (Fig. 1). On a ginkgo leaf, we can see many asperities and they are obstacles for the liquid-gas and triple line motion.

The spreading of droplets is driven by dynamic effects which have to be taken into account for multi-scaled surfaces [1]. In order to calculate the shape of a droplet on those complex substrates, the Lattice Boltzmann Method is used and coupled with the Shan-Chen Model [2] to simulate two fluids. A model of wetting interaction is developed to reach a more realistic spreading and final contact angle. Because LBM is a statistical approach of molecular dynamics, it may be possible to handle both small scale and large scale geometrical effects. Fig. 2 shows the simulation of a droplet on a one-scale squared plot shape hydrophobic surface. The interaction model includes intrinsic hysteresis of the surface [3] and free energy barrier [4].

Simulation is first tested on a smooth and flat surface and then roughness is increased to reach a multi scale rough surface. Each numerical result is compared to the equilibrium contact angle and hysteresis of a real sessile test on the corresponding substrat.

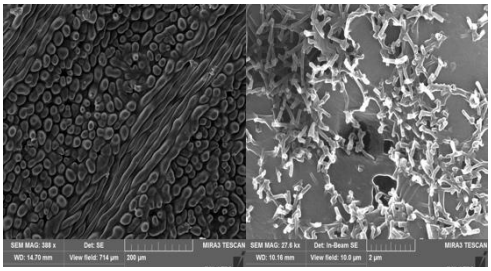

Fig. 2: Ginkgo Biloba Leaf multi-scale topography

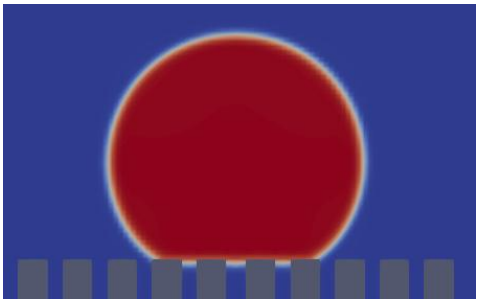

Fig. 1: Simulation of liquid (red) on a textured surface (gray)

REFERENCES

[1] Bormashenko, E., Advances in Colloid and Interface Science, 222, 2015, 92-103.
[2] Shan, X. and Chen, H., Phys. Rev., 1994, 2941-2948.
[3] Extrand, C. W., Langmuir, 22, 2006 ,7991–7999
[4] Sedev, R., Advances in Colloid and Interface Science, 222, 2015, 661-669