Controlling surface coverage in patterned substrates

R. Ledesma-Aguilar*, A. Hernández-Machado, and I. Pagonabarraga
Departament de Estructura i Constituents de la Matèria
Universitat de Barcelona, Av. Diagonal 647, 08028 Barcelona

We study the dynamics of fluid thin films that spread in chemically patterned substrates under the action of gravity. It is well known that for homogeneous substrates, the front is unstable for sufficiently large driving velocities[1,2]. For hydrophobic substrates, the instability leads to the growth of fingers and consequently to poor surface coverage. This contrasts with the case of hydrophilic substrates, in which the instability leads to the growth of protrusions that saturate to a given length, a situation that does not generate dry regions. Heterogeneos surface wettability then appears as a potential way of controlling the instability and ultimately surface coverage.

By means of a 3D lattice-Boltzmann algorithm, we study the flow of thin films in cases in which substrate heterogeneity is highly asymmetrical, meaning that some portions of the substrate are hydrophilic (with a vanishing equilibrium contact angle) while some others are super-hydrophobic (where the equilibrium contact angle is beyond 120°).

We find that a rich phenomenology for the motion of the contact line arises for different wetting patterns. For situations in which the size of the hydrophobic domain allows for the destabilization of the contact line, we find that the patterned substrate can effectively suppress the instability.

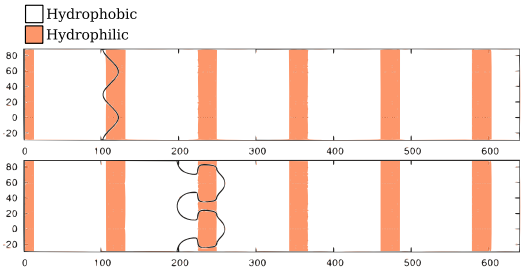

Figura 1. Contact line evolution for a thin film spreading in a hydrophobic substrate with hydrophilic patches. Interface calculated from lattice-Boltzmann simulation.

* rodrigo@ecm.ub.es

[1] F. Melo, J.F. Joanny, and S. Fauve, Fingering instability of spinning drops, Phys. Rev. Lett. **63**, 1958 (1989).
[2] J.R. de Bruyn, Growth of fingers at a driven three-phase contact line, Phys. Rev. A **46**, R4500 (1992).