Dynamics of Two Phase Fluid on Patterned Surfaces

We simulate the moving contact line in two-dimensional chemically patterned channels using a diffuse-interface model with the generalized Navier boundary condition.

The motion of the fluid-fluid interface in confined immiscible two-phase flows is modulated by the chemical pattern at the top and bottom surfaces, leading to a stick-slip behavior of the contact line. The extra dissipation induced by this oscillatory contact-line motion is fairly significant and increases rapidly with the wettability contrast of the pattern. A critical value of the wettability contrast is identified above which the effect of diffusion becomes important, leading to the interesting behavior of fluid-fluid interface breaking. Near the critical value, the time-averaged extra dissipation scales as U, the displacement velocity. By decreasing the period of the pattern, we show the solid surface to be characterized by an effective contact angle whose value depends on the material characteristics and composition of the patterned surfaces.

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