Adsorption-Induced Slip Inhibition for Polymer Melts on Ideal Substrates

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In the study of capillary-driven fluid dynamics [1], relatively simple departures from equilibrium offer the chance to quantitatively model the resulting relaxations. These dynamics in turn provide insight on both practical and fundamental aspects of thin-film and near-surface hydrodynamics. In this talk, we will describe two model experiments — dewetting and capillary levelling— allowing to elucidate polymeric slip in thin polymer films. Slip is a fundamental phenomenon in fluid dynamics that governs liquid transport at small scales. For polymeric liquids, de Gennes predicted [2] that the Navier boundary condition together with the theory of polymer dynamics imply extraordinarily large interfacial slip for entangled polymer melts on ideal surfaces. By comparing two different relatively simple departures from equilibrium, we show [3] that the slip length manifested in a capillary-driven flow experiment in fact depends sensitively on the experimental configuration. A levelling experiment [3, 4] and a dewetting experiment [5] may indeed present vastly different slip boundary conditions even when the probed materials are identical and the surfaces are atomically smooth.

[1] Oron et al., Reviews of Modern Physics (1997)
[2] de Gennes, C.R. Acad. Sci. B (1979)
[3] Ilton et al, Nature Comm. (2018)
[4] McGraw et al, Physical Review Letters (2012)
[5] Bäumchen et al, Physical Review Letters (2009)

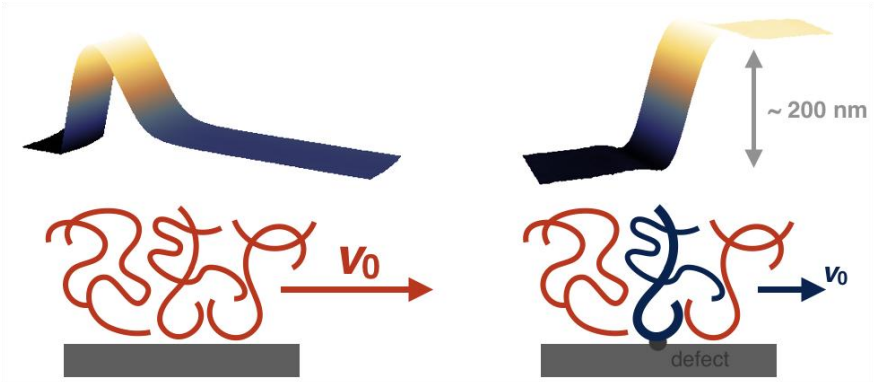

Figure 1 : Fluid velocity at the substrate can be largely impacted by the choice of capillary driving method, whether the latter is dewetting (left) or stepped-film levelling (right).