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Capillary Leveling of a Free-Standing Film MARK ILTON, MILES COUCHMAN, Department of Physics & Astronomy, McMaster University, Hamilton, Ontario, Canada, MICHAEL BENZAQUEN, THOMAS SALEZ, PCT Lab, UMR CNRS 7083 Gulliver, ESPCI ParisTech, PSL Research University, Paris, France, PAUL FOWLER, Department of Physics & Astronomy, McMaster University, Hamilton, Ontario, Canada, ELIE RAPHAËL, PCT Lab, UMR CNRS 7083 Gulliver, ESPCI ParisTech, PSL Research University, Paris, France, KARI DALNOKI-VERESS, Department of Physics & Astronomy, McMaster University, Hamilton, Ontario, Canada — Capillary leveling has previously been used as a sensitive probe for nano-rheology in supported films. Using atomic force microscopy, we have observed the surface tension driven leveling of a step in viscous free-standing polystyrene films. We find that the step evolves to a self-similar profile with a width that scales with the square root of time. Film mobility is found to depend linearly on the film thickness. The scaling is fundamentally different from the capillary leveling observed in supported films (Poiseuille flow) because there is no shear of the fluid at the free surfaces (plug flow). The results agree with the lubrication approximation of Stokes equation with two shear-free boundaries. Free-standing capillary leveling provides a new tool to study glassy dynamics and molecular confinement in a free-standing geometry, as well as strong slip dynamics in the idealized limit of plug flow.

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