Asymptotic structure of a dewetting thin liquid film: the strong slip case

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Abstract

When a thin liquid film dewets, it may form a rim which spreads outwards, leaving behind a growing dry region. For certain polymer films on coated silicon substrates, there can be significant slip at the liquid-substrate interface [1]. In this case, the structure of such a rim, formed by a viscous liquid in the limit of strong slip on a planar substrate, can be modeled by two coupled partial differential equations (PDEs) describing the film thickness and velocity [2]. Using asymptotic methods [3] we describe the structure of the rim as it evolves in time, and the spreading rate. The rim initially has a steep inner profile with a long exponential tail, but later has a more rounded shape. The film evolves with several time regimes characterised by different spreading rates. Spreading is initially at a nearly constant rate, before the film enters a regime in which the spreading rate drops, approaching the 2/3 power of time. This asymptotic description is compared with numerical solutions of the full system of PDEs.

[1] R. Fetzer, M. Rauscher, A. Münch, B. Wagner, and K. Jacobs. Slip-controlled thin film dynamics. *Europhys. Lett.*, 75(4):638–644, 2006.

[2] A. Münch, B. A. Wagner, and T. P. Witelski. Lubrication models with small to large slip lengths. *J. Engrg. Math.*, 53(3–4):359–383, 2006.

[3] P. L. Evans, J. R. King and A. Münch, Intermediate-asymptotic structure of a dewetting rim with strong slip, *Applied Mathematics Research eXpress*, 2006 Article ID 25262, 2006.