

Abstract Submitted
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Flow down an inclined plane with soluble surfactant BARRY EDMONSTONE, RICHARD CRASTER, OMAR K. MATAR, Imperial College London — We study the flow of a thin film down an inclined plane in the presence of dilute concentrations of soluble surfactant. Lubrication theory and cross-sectional averaging are used to derive a coupled set of two-dimensional (2-D) evolution equations for the film thickness and surfactant surface and bulk concentrations in the limit of rapid vertical diffusion. These equations are closed by a linear equation of state and parameterized by bulk and surface Peclet numbers, and dimensionless solubility and sorption kinetics parameters; the contact-line singularity is relieved via use of a thin precursor layer. The results of our transient growth analysis and transient numerical simulations of the nonlinear 2-D equations reveal the presence of a fingering instability that targets the thickened advancing ridge where the film adjusts onto the precursor layer. Although these fingering phenomena are present in the surfactant-free case, the presence of surfactant enhances the instability over an intermediate range of solubilities.

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