Instability of Confined Thin Liquid Film Trilayers with Application to Lithographic Printing

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The instability of a system in which three stratified thin liquid films are confined in a channel with parallel walls and the interior film is subject to van der Waals-driven breakup is examined in this work. We derive a model based on lubrication theory and consisting of a pair of nonlinear partial differential equations describing the position of the two liquid interfaces. A linear stability analysis is carried out to show that the effects of varying the boundary film thicknesses can be understood in terms of several known limits, including a supported monolayer, confined bilayer, and supported bilayer. Variation of the boundary film viscosities is shown in many cases to eliminate the supported-bilayer limit. The parameter regimes in which squeezing and bending modes dominate the initial growth are determined, and nonlinear simulations are used to show that the mode always switches to squeezing near rupture. It is also found that a multi-modal dispersion relation may be created by asymmetries in thickness ratio, but not viscosity ratio, even in the absence of asymmetric interfacial tensions. The model is used to estimate the size of fountain solution droplets that are emulsifed between fresh ink and residual ink in a lithographic printing nip.

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