186c Competitive Displacement of Thin Liquid Films on Chemically Patterned Substrates

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Lithographic printing is a technologically important but poorly understood process in which one thin liquid film displaces another on a chemically patterned substrate. In order to gain a fundamental understanding of this process, the lubrication approximation is applied to obtain a one-dimensional nonlinear evolution equation for the position of the liquid-liquid interface. Chemical patterning of the substrate is incorporated through the use of a spatially varying van der Waals potential. Both linear stability analysis and numerical simulations are performed to study the behavior of the evolution equation over a wide range of parameters. When one liquid film rests on a substrate containing a chemical pattern that it does not preferentially wet, an overlying liquid film which does wet that pattern can displace the film adjacent to the substrate and cause it to rupture. The location and speed of the rupture are found to depend on a competition between the width of the chemical pattern and the wavelength of the most dangerous mode associated with a chemically homogeneous substrate. The results also show that rupture can occur in multiple places almost simultaneously, which suggests a possible mechanism for emulsification, a phenomenon known to occur in all lithographic printing processes.