Competitive displacement of thin liquid films on chemically patterned substrates

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The lithographic, or "offset", process has been a leading printing technology for nearly 100 years, and there is currently much interest in applying it to high-speed patterning in non-traditional applications such as microelectronics. To prepare the process for such applications, gaps in our fundamental understanding of how liquids behave on chemically patterned printing plates must be filled. Motivated by this need, we study the behavior of the interface between stratified thin liquid films bounded by parallel solid surfaces and subject to spatially varying van der Waals forces which drive dewetting. The lubrication approximation is applied to obtain a single nonlinear evolution equation which describes the interfacial behavior. The time until film rupture occurs is found be strongly dependent on the length scale of chemical patterning, an effect that is relatively independent of changes in the remaining problem parameters such as viscosity, interfacial height, interfacial tension, and the magnitude of van der Waals attraction. The mechanisms underlying the rupture time behavior are also explored in detail, uncovering a possible mechanism for how one liquid may become emulsified into the other.

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