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Linear Instability, Self-Similarity and Nonlinear Growth in Ultra-thin Wetting Films Driven by Thermocapillary Flow RYAN DENLINGER, SANDRA TROIAN, California Institute of Technology, 1200 E. California Blvd MC 128-95, Pasadena, CA — Nanoscale viscous films subject to very large thermocapillary stresses are susceptible to a linear instability resembling nanopillar arrays. The interstitial regions, which provide the fluid needed to grow these structures, are observed to undergo rapid depletion down to tens of nanometers in thickness. Previous analyses have neglected the role of van der Waals forces in these systems [1]. A linear stability analysis of ultrathin films in which the disjoining pressure is comparable to thermocapillary and capillary forces confirms that wetting van der Waals forces generate larger interpillar spacings. More importantly, however, growth beyond the linear regime is characterized by an ultra flat depletion zone. Using a combination of analytic work and finite element simulations, we have identified a self-similar regime in which finite-amplitude disturbances to this zone produce a significant non-linear response. The resulting waveform shape is indicative of a secondary growth process leading to nanopillar formation. We discuss the behavior of three distinct growth regimes characterizing initial pillar growth, depletion zone formation, and secondary pillar growth. [1] M. Dietzel and S. M. Troian, Phys. Rev. Lett. 103, 074501 (2009); J. Appl. Phys. 108, 074308 (2010)

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