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Influence of Gas Rarefaction on Thermocapillary Flow and Instability in Confined Nanofilms NAN LIU, SANDRA TROIAN, California Institute of Technology, 1200 E California Blvd, MC 128-95, Pasadena, CA 91125 —
We have previously conducted a linear stability analysis of a fluid bilayer system sandwiched in between flat solid substrates held at different temperature [1,2]. The bilayer consists of a warm molten viscous nanofilm overlay by a cooler nanofilm of quiescent gas. Lubrication analysis showed how thermocapillary stresses along the viscous film promote formation of fluid elongations resembling nanopillar arrays no matter how small the initial transverse temperature difference. It was assumed in these studies that the rate of heat transfer through the gas layer is well described by Fourier's law of thermal conduction. For sufficiently thin gas layers, however, the mean free path for gas molecules is comparable to or can exceed the thickness of the gas layer. Collisions of the gas molecules with the cooler substrate as well as the warmer evolving viscous film can dominate intermolecular collisions in the gas film leading to temperature jump conditions first described by von Smoluchowski. In this presentation, we show how gas rarefaction effects can increase the growth rate and magnitude of the fastest growing wavelength by as much as 50% for parameter values relevant to experiment.
[1] M. Dietzel and S. M. Troian, Phys. Rev. Lett. **103**, 074501 (2009). [2] M. Dietzel and S. M. Troian, J. Appl. Phys., in press (2010).

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