Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Buckling of thin viscous sheets with inhomogenous viscosity under extensional flows SIDDARTH SRINIVASAN, Harvard University, ZHIYAN WEI, Stanford University, L MAHADEVAN, Harvard University — We investigate the dynamics, shape and stability of a thin viscous sheet subjected to an extensional flow under an imposed non-uniform temperature field. Using finite element simulations, we first solve for the stretching flow to determine the pre-buckling sheet thickness and in-plane flow velocities. Next, we use this solution as the base state and solve the linearized partial differential equation governing the out-of-plane deformation of the mid-surface as a function of two dimensionless operating parameters: the normalized stretching ratio α and a dimensionless width of the heating zone β. We show the sheet can become unstable via a buckling instability driven by the development of localized compressive stresses, and determine the global shape and growth rates of the most unstable mode. The growth rate is shown to exhibit a transition from stationary to oscillatory modes in region upstream of the heating zone. Finally, we investigate the effect of surface tension and present an operating diagram that indicates regions of the parameter space that minimizes or entirely suppresses the instability while achieving desired outlet sheet thickness. Therefore, our work is directly relevant to various industrial processes including the glass redraw & float-glass method.

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Date submitted: 30 Jul 2016 Electronic form version 1.4