Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Stretching of viscous sheets including axial and transverse viscosity variations BENOIT SCHEID, SEAS, Harvard University, SARA QUILIGOTTI, BINH TRAN, RENE GY, Saint-Gobain Recherche, HOWARD STONE, SEAS, Harvard University — We study the stretching of a Newtonian liquid sheet under the influence of strong viscosity variations. Such a flow is encountered in film casting processes where viscosity variations are usually induced by temperature gradients, not only along the stretching coordinate but also across the film thickness. We therefore derive a generalized extensional flow model accounting for an arbitrary two-dimensional distribution of the viscosity in the sheet. Stationary solutions and their stability (usually referred to as draw resonance) are then investigated for various situations. In the case of in-plane viscosity variations only, the system is more unstable (stable) if the viscosity increases (decreases) in the flow direction. In the case of transverse viscosity variations only, the system is more unstable (stable) if the viscosity is constant on one surface and larger (smaller) on the other surface. When the two destabilizing situations are combined, it is found that the critical draw ratio can be significantly below 20.18, i.e. the value for constant viscosity. Draw resonance instability is therefore shown here to be very sensitive to the two-dimensional viscosity distribution in the film.

Howard Stone
SEAS, Harvard University

Date submitted: 27 Jul 2007 Electronic form version 1.4