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Instability of Thin Viscous Sheets ANDREY FILIPPOV, ZHEMING ZHENG, Corning Incorporated — Thin viscous fluid flows are characterized by a small aspect ratio, i.e., the characteristic thickness is much smaller than the characteristic tangential length scale. They have been used in a variety of manufacturing applications, including curtain coating, film blowing, film casting, extrusion and optical fiber drawing. An asymptotic theory for predicting the thickness distribution and the geometry boundaries of a thin nearly planar fluid sheet and analyzing the stability of its shape is developed, where the sheet thickness and out of plane displacement are additional distributed variables along with the continuum velocities. The sheet motion in the transverse direction is described by a transient second order PDE expressing the normal momentum balance: Its analysis showed that the existence of compressive stresses inevitably leads to viscous sheet shape instability, while the corresponding stationary equation becomes of mixed type. Two practical examples involving viscous sheets have been considered: an isoviscous two-dimensional viscous sheet, which shape is unstable in the case when the compressive stress is applied by setting an obstacle to the flow at the exit end, and a 3D problem of viscous sheet redraw (constant stretching), where existence of compressive stresses leads to development of hyperbolic zones in the sheet, and the sheet shape instability develops.

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