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Dynamics of deformable sheets in extensional flow: stretching, hysteresis, and folding[1] YIJIANG YU, MICHAEL D. GRAHAM, University of Wisconsin - Madison — Applications of 2D materials such as graphene and boron nitride usually require a fluidic environment to achieve large-scale production. Those processes involve complicated fluid-structure interactions, such as stretching and folding, that have not been fully understood. We study here a continuum model of deformable sheets with disc, square or rectangular rest shapes, subjected to planar or uniaxial extensional flows. The model accounts for in-plane deformation and out-of-plane bending, and the fluid motion is computed using the method of regularized Stokeslets. In planar extensional flow, we observe for all shapes a hysteretic transition analogous to the coil-stretch transition of long flexible polymers in solution: an abrupt jump from a compact to the stretched state with a small increase in deformability. This discontinuity marks a bistable region where multiple stable steady states exist. In uniaxial extensional flow, besides a compact-stretched transition similar to that observed in planar extension, the radially compressive flow also induces interesting wrinkling and folding patterns depending on the deformability of the sheet; these affect the time dependence and final degree of stretching of the sheet, and further influence the hysteresis behavior.

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