Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Stretch-induced compressive stresses and wrinkling in hyperelastic thin sheets RUI HUANG, University of Texas at Austin, VISHAL NAYYAR, K. RAVICHANDAR, CENTER FOR MECHANICS OF SOLIDS, STRUCTURES AND MATERIALS TEAM — Wrinkles are commonly observed in stretched thin sheets. This paper presents a study on stretch-induced wrinkling of hyperelastic thin sheets using the finite element method. The model problem is set up for uniaxial stretching of a rectangular sheet with two clamped ends and two free edges. A two-dimensional stress analysis is performed first under the plane-stress condition to determine stretch-induced stress distributions in the elastic sheets, assuming no wrinkles. As a prerequisite for wrinkling, the development of compressive stresses in the transverse direction is found to depend on the length-to-width aspect ratio of the sheet and the applied stretch. A phase diagram is constructed with a set of different distribution patterns of the compressive stress spanning a wide range of aspect ratios and up to moderately large tensile strain ($\sim$150%). Next, an eigenvalue analysis is performed to find the potential buckling modes of the elastic sheet under the prescribed boundary conditions. Finally, a nonlinear post-buckling analysis is performed to show evolution of the stretch-induced wrinkles. In addition to the aspect ratio and the applied stretch, it is found that the critical condition for wrinkling and the post-buckling behavior both depend sensitively on the sheet thickness.

Rui Huang
University of Texas at Austin

Date submitted: 26 Nov 2010 Electronic form version 1.4