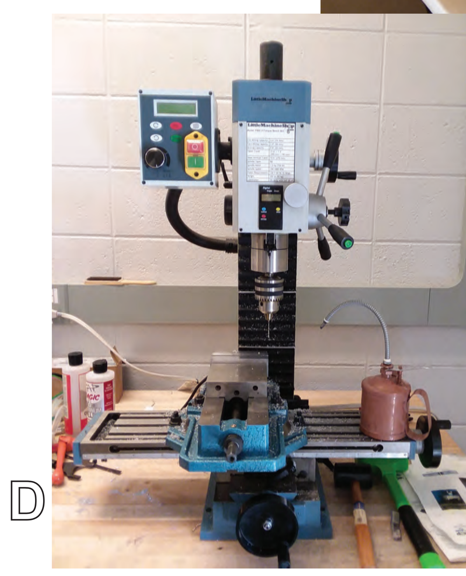
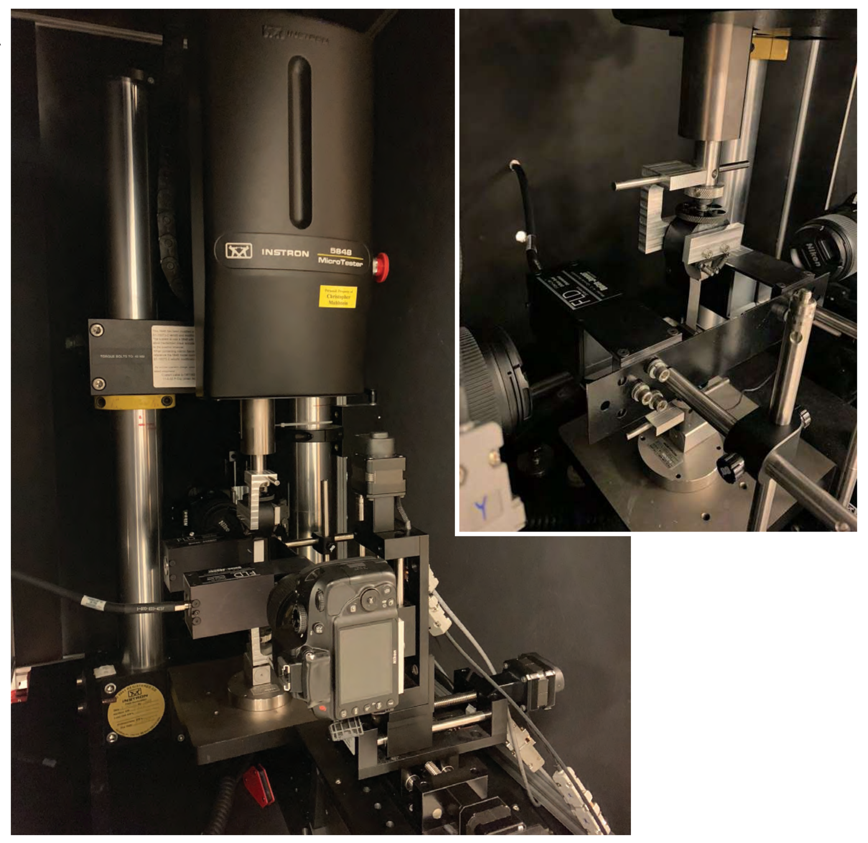
The Muhlstein Research Group

Georgia Tech

Thin flexible sheets

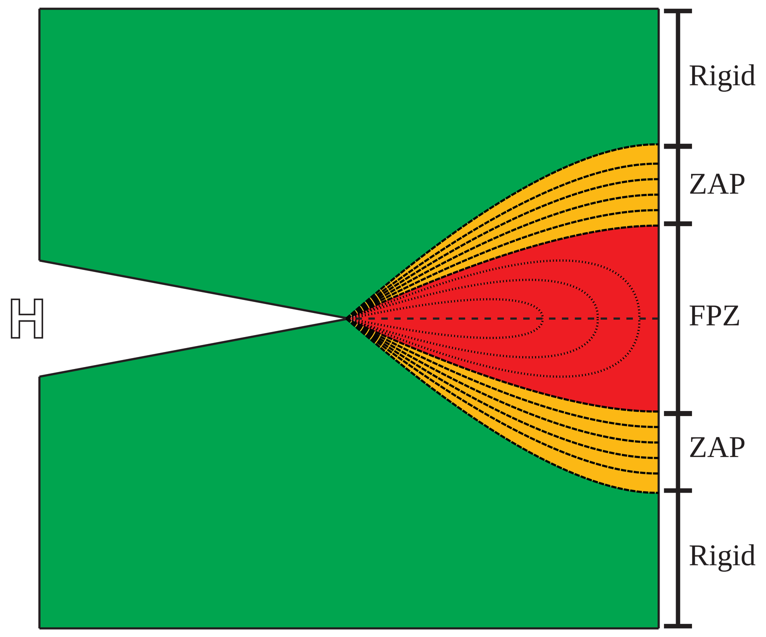
Thin flexible materials have countless cutting-edge applications: Flexible substrates for electronics, displays, or portable medical diagnostic tools: skins and control surfaces for ultra-light flying robots; or as components of laminate composites for packaging, optics, and more. The Muhlstein Group at GA Tech studies the mechanical characteristics of thin flexible sheets. Our work includes mechanical testing with optical strain measurement (A), thin sheet processing (B and C), and apparatuses and analyses built around the unique challenges of working with thin flexible systems (D).

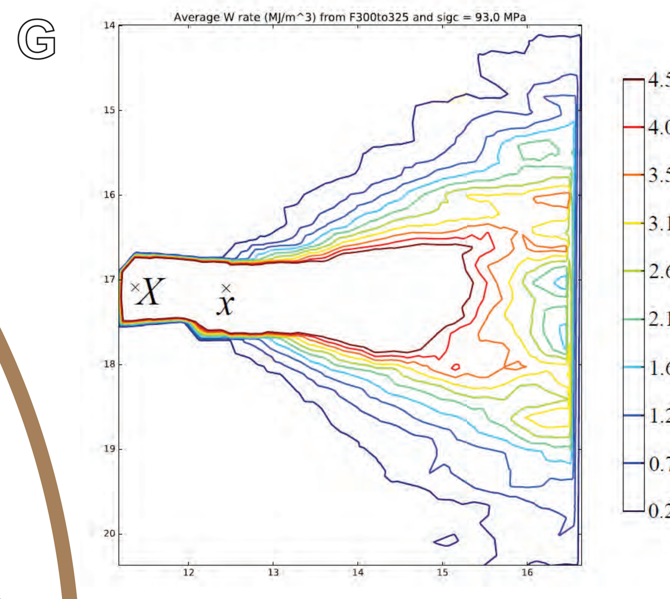


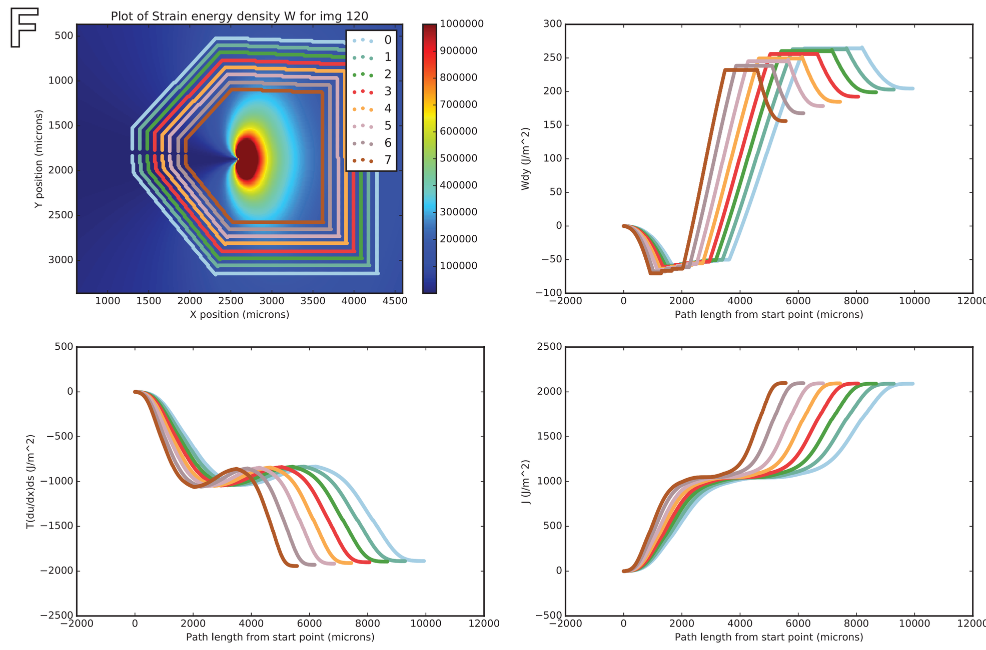


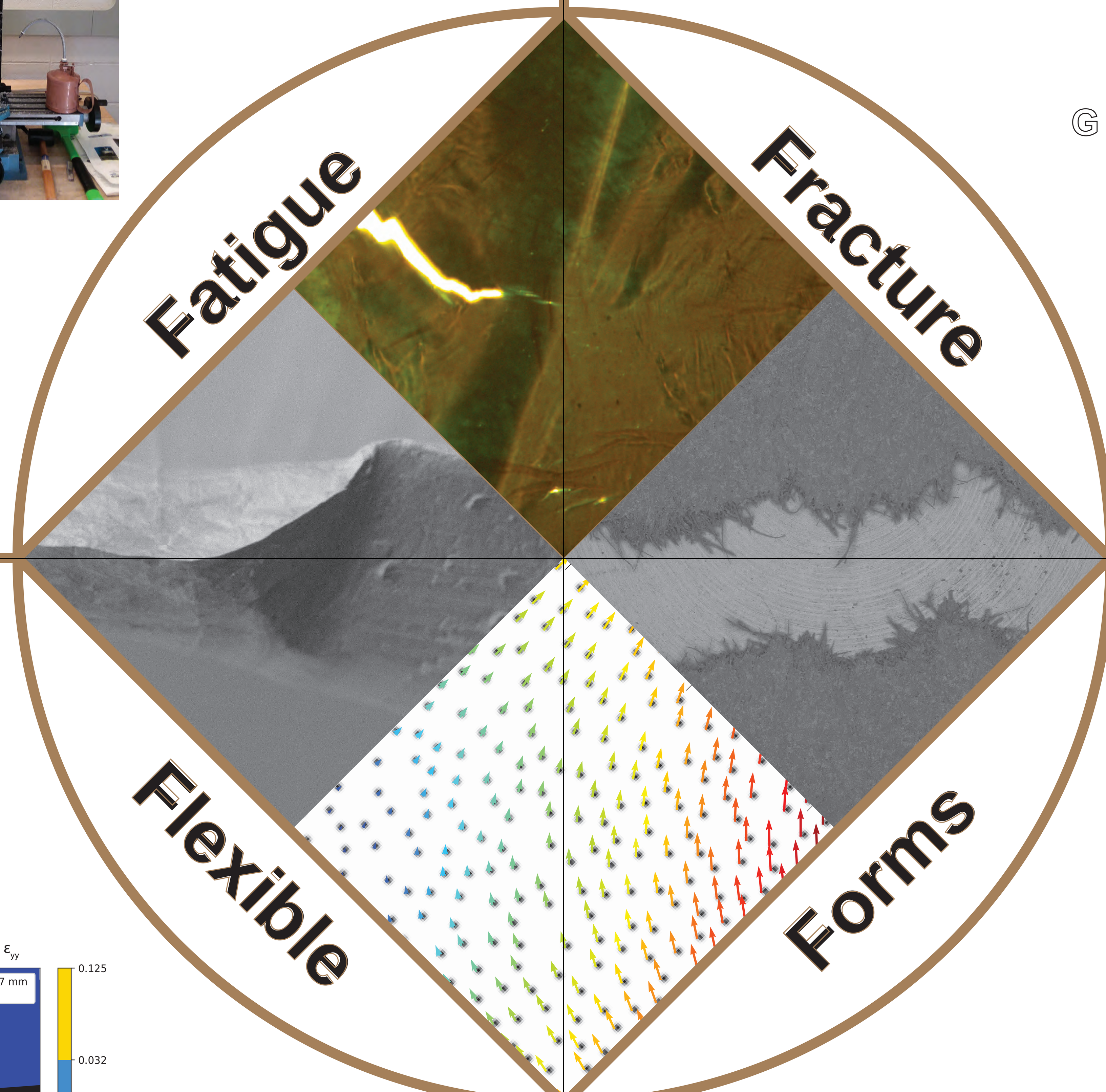
Thin metal sheet fracture and fatigue

Thin metal sheets (µm and nm scale) exhibit interesting size-dependent properties and fracture mechanisms due to the plane stress stress state, surface effects, out of plane deformation, etc. We explore the fracture characteristics 25 µm thick Al (E), evaluate metal systems using customized test systems and strain map analysis techniques such as path integrals (F & G), and illustrate zones of deformation (H).



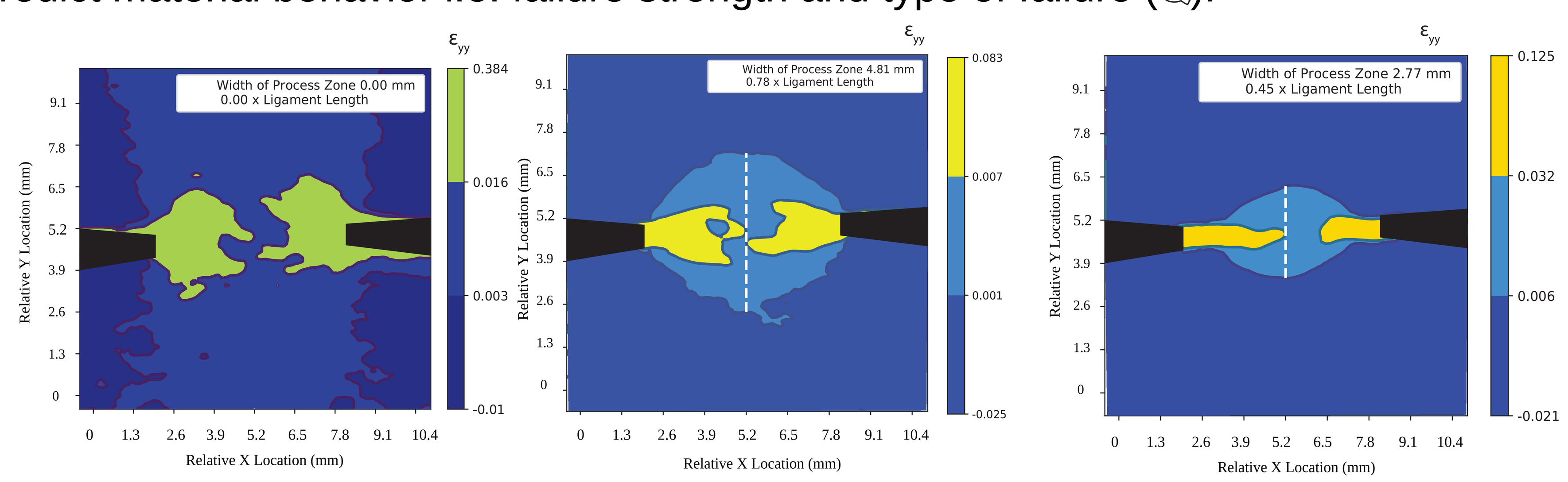


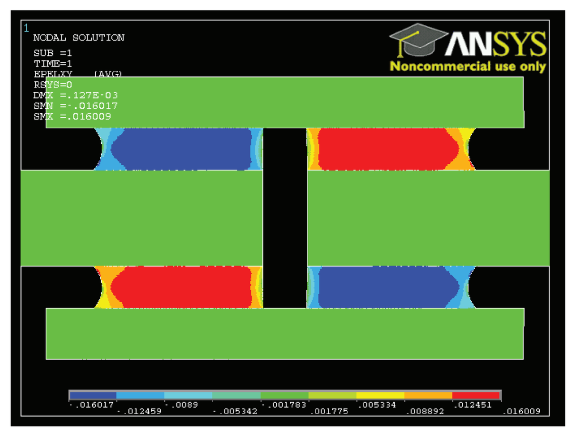


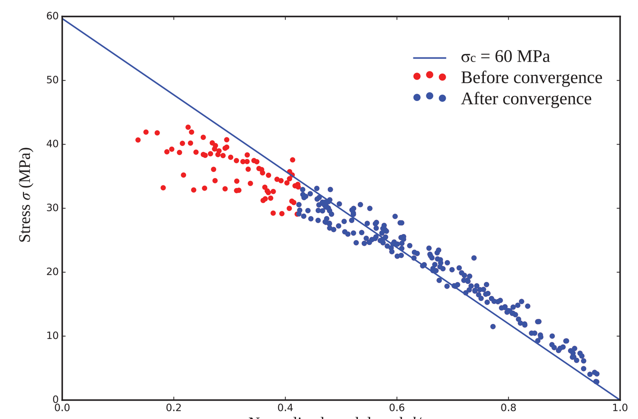


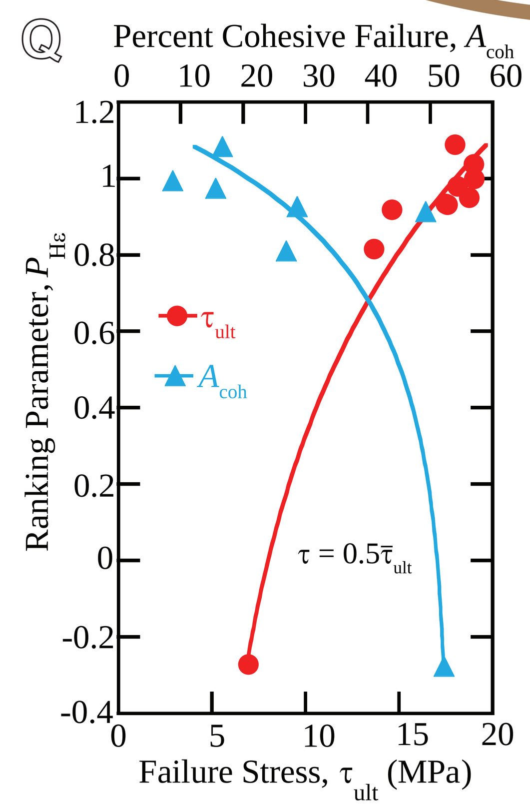
Failure prediction from strain fields

Employing a variety of data anlaysis methods creates a rich understanding of a material system. Strain map mining reveals details of strain distribution that relate microstrucure to strain evolution (N). Finite element modeling complements experimental work and aids in interpretation of experimental data (O). Comparisons between strain maps and failure statistics (P) can also be used to create charasteristic parameters and numerical models that predict material behavior i.e. failure strength and type of failure (Q).









Nonwoven fiber networks

Papers are complex polymer fiber-based composite systems which are finding new uses in energy-absorbing structures, portable medical diagnostic tools, and more. Because paper is a non-affine discontinuous material, paper defies conventiontional mechanical characterization. In addition to basic mechanical characterization and post-fracture analysis (I), we use specialized strain mining techniques. These include application of spatial statistics to strain maps (J) and direct analysis of the displacement fields (K). We also use various types of imaging techniques (L: SEM, CSLM) to characterize the structure of these complicated iber networks.