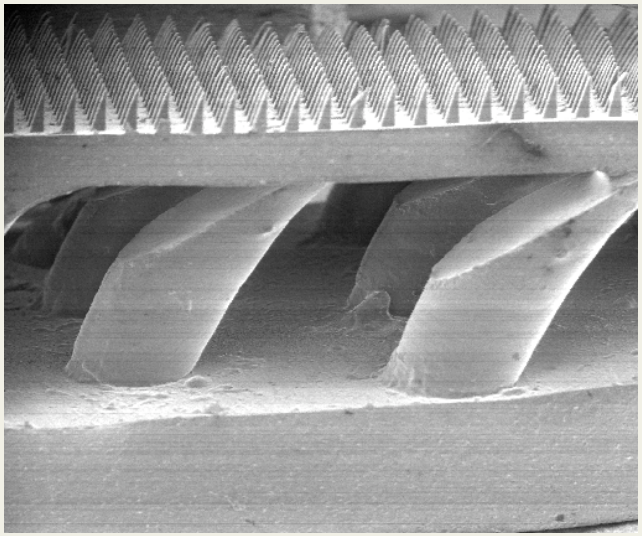
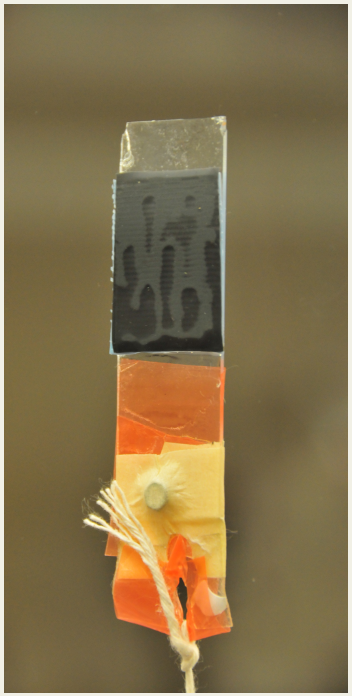
Microstructured Adhesives for Climbing Applications

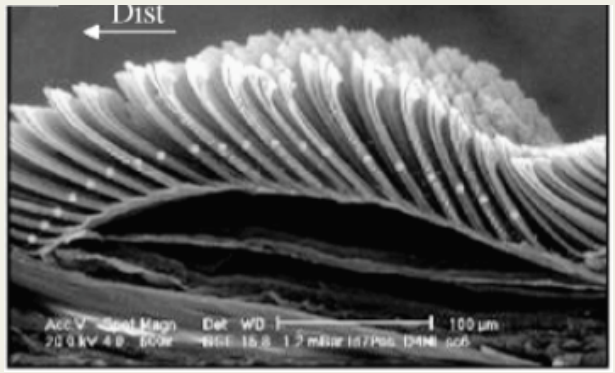




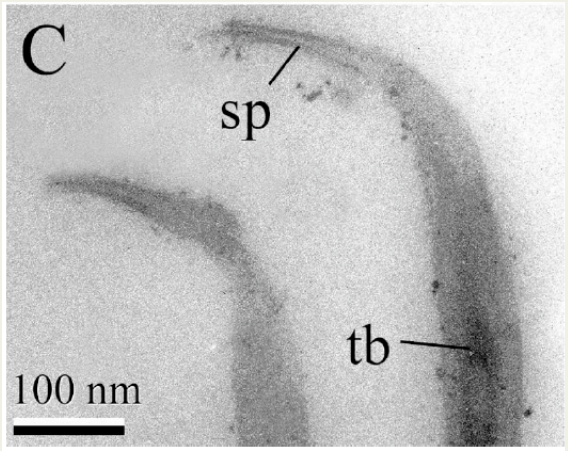
Aaron Parness, PhD Candidate,
Mechanical Engineering, Class of 2009
Mark Cutkosky, ME Faculty

Sources of Inspiration

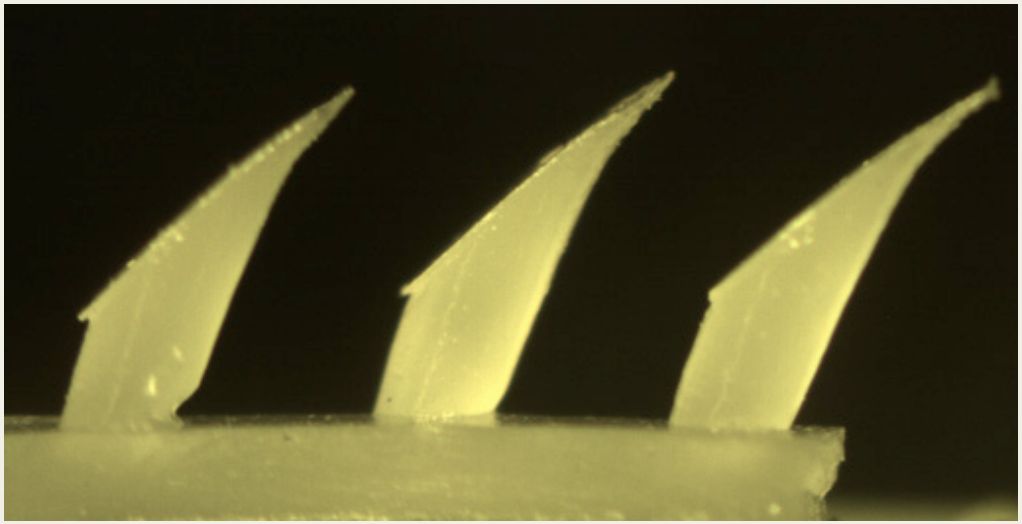
Autumn



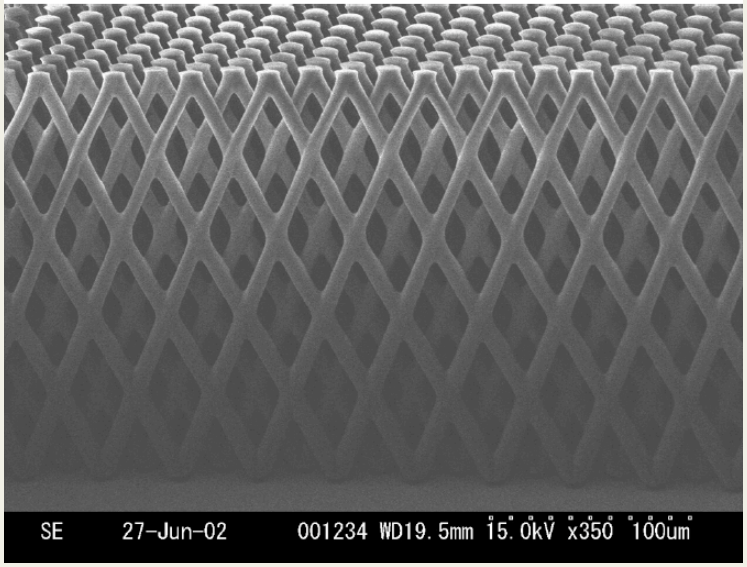
Russell, JAST, 2007



Persson, J. Chem Phys, 2003

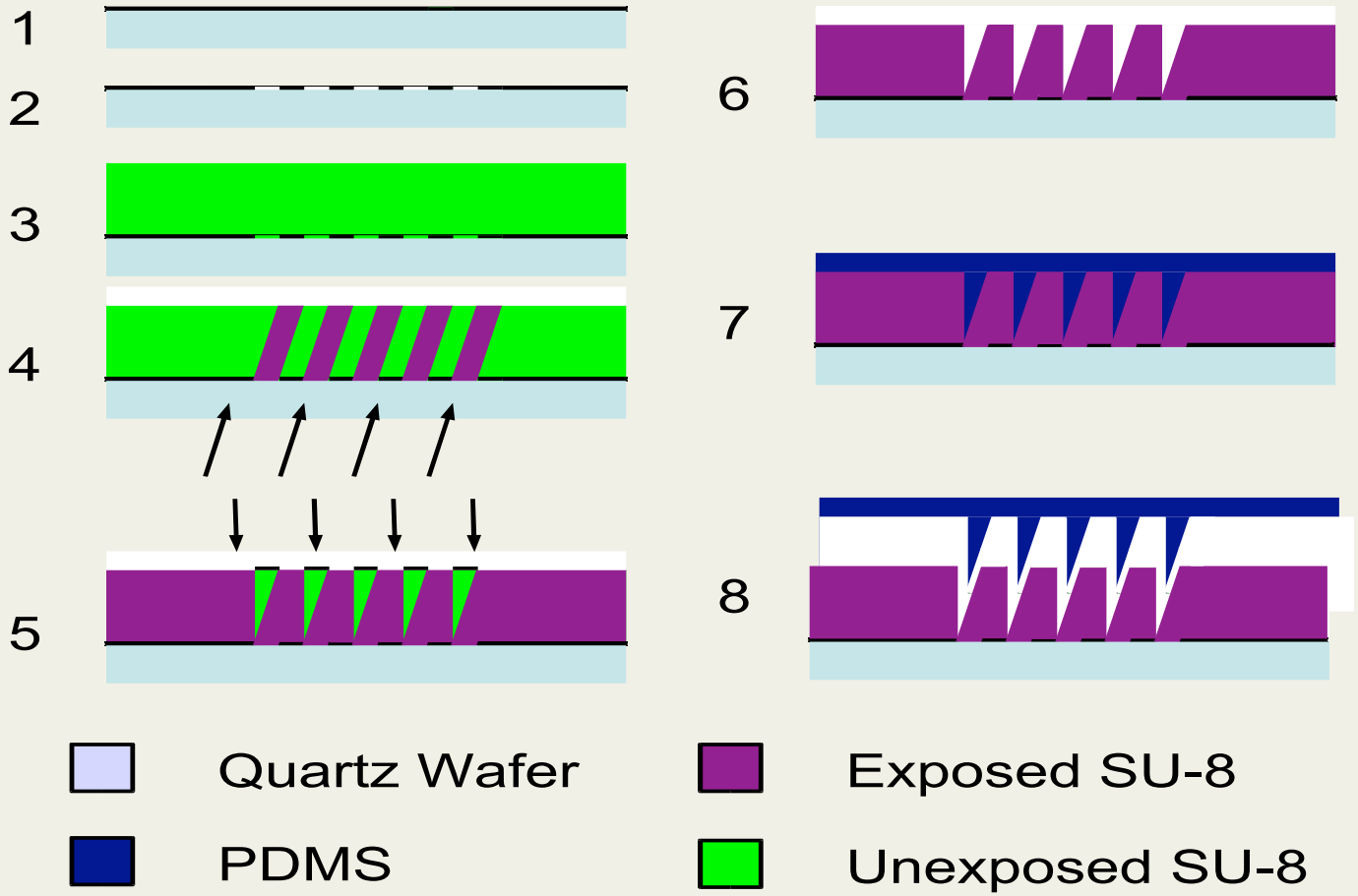


Kim et al, IEEE ICRA 2006

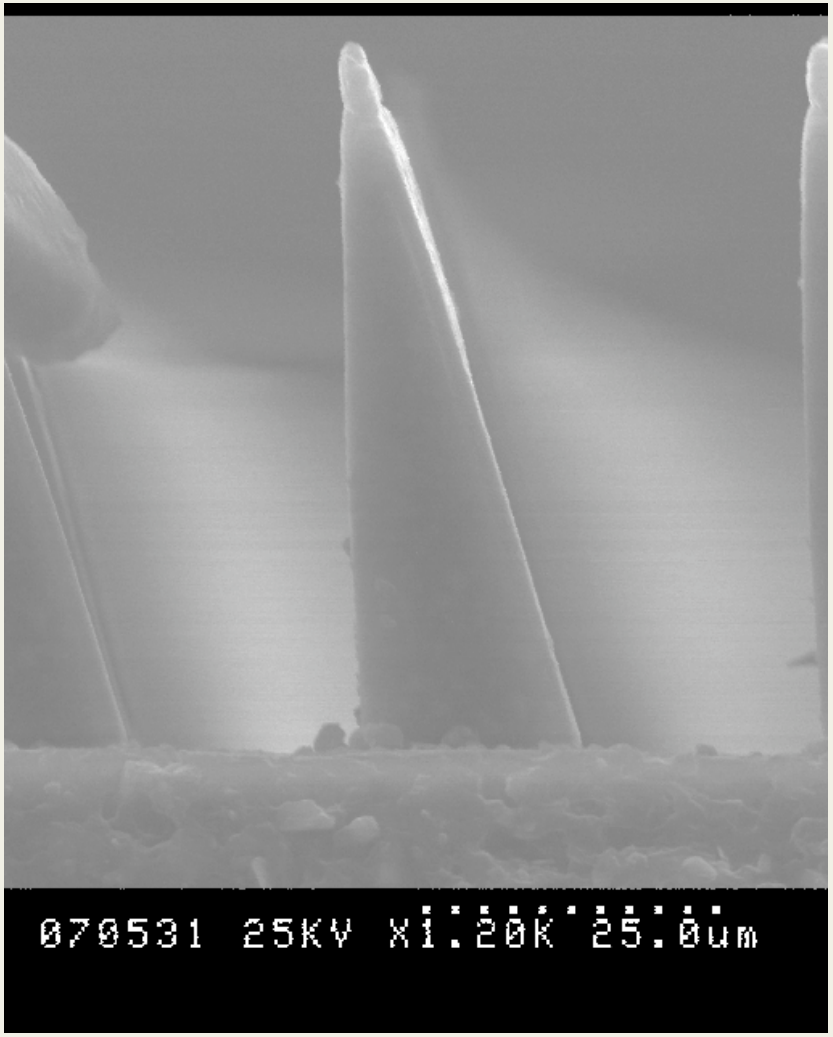


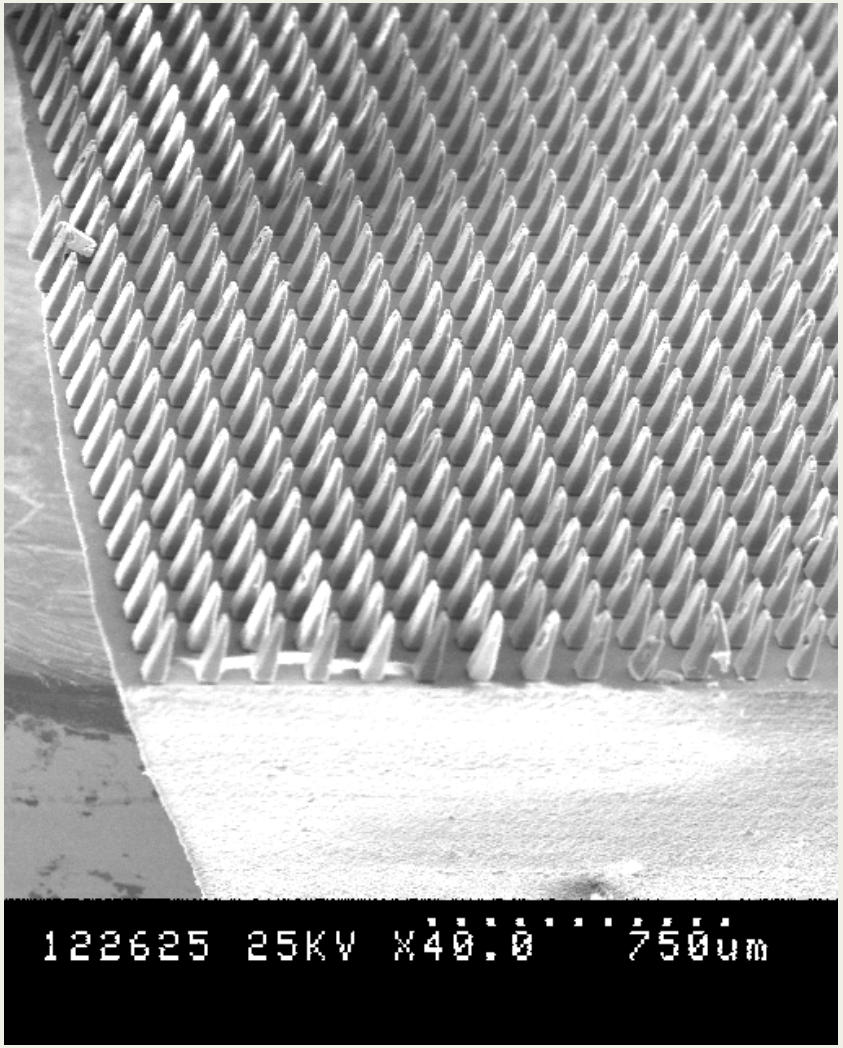
Yoon et al, JMEMS, 2003 & 2006

Wedge Fabrication Process
Two Mask Dual Angle Exposure with Alignment



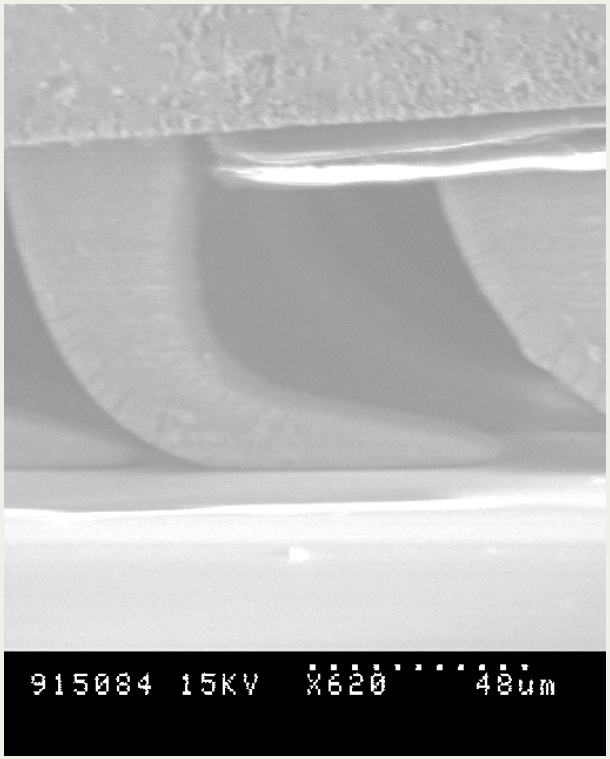
20 µm Wedge Arrays



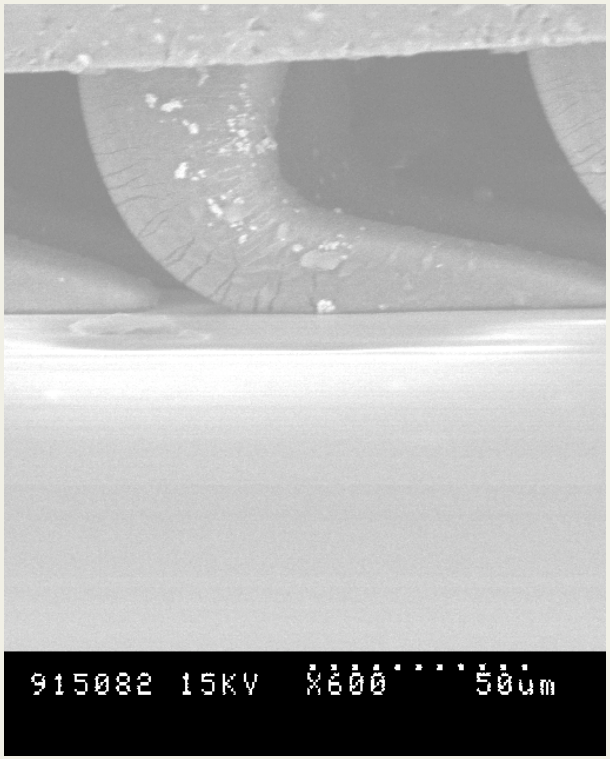


Loaded Wedges

Slightly Loaded

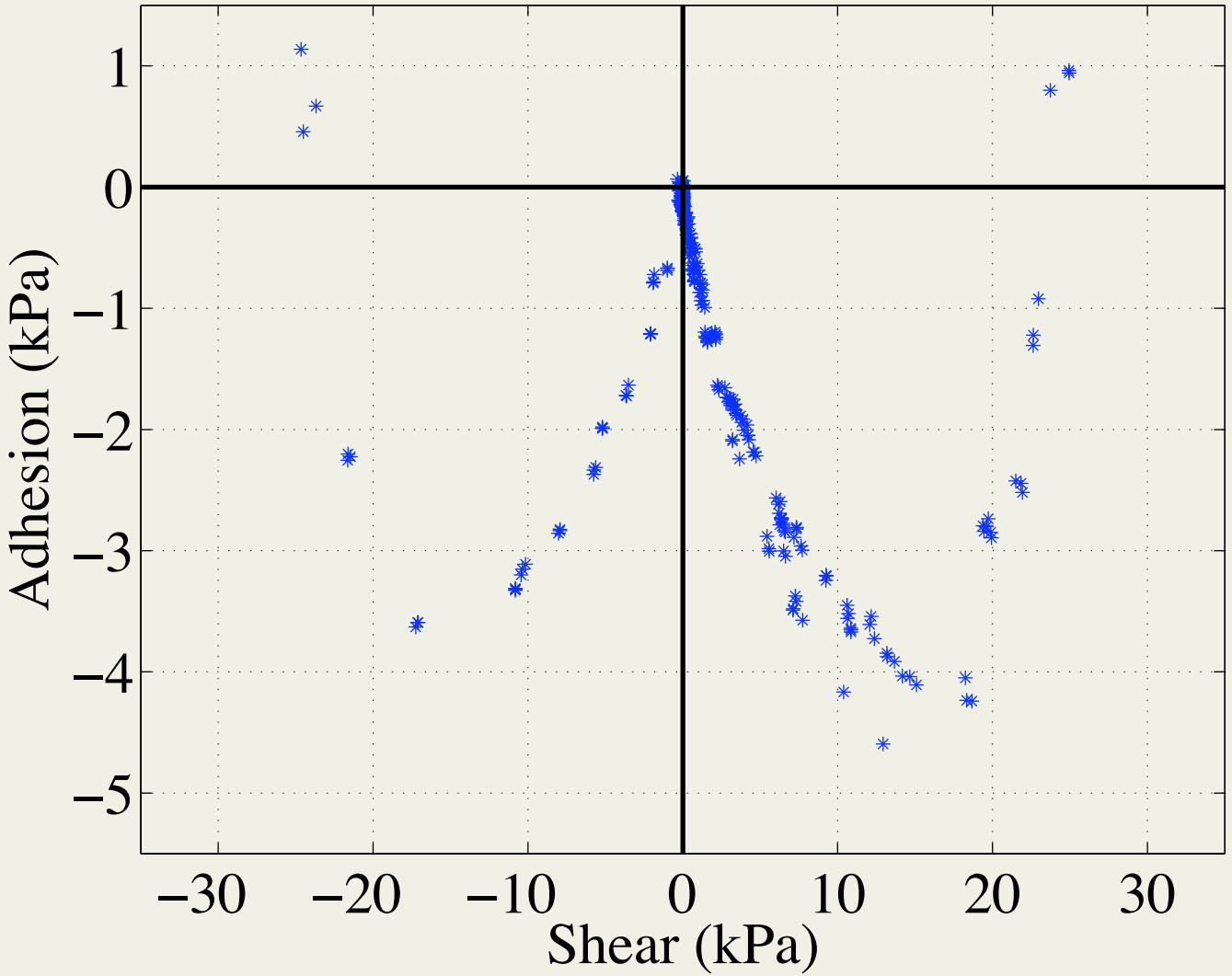


Moderately Loaded

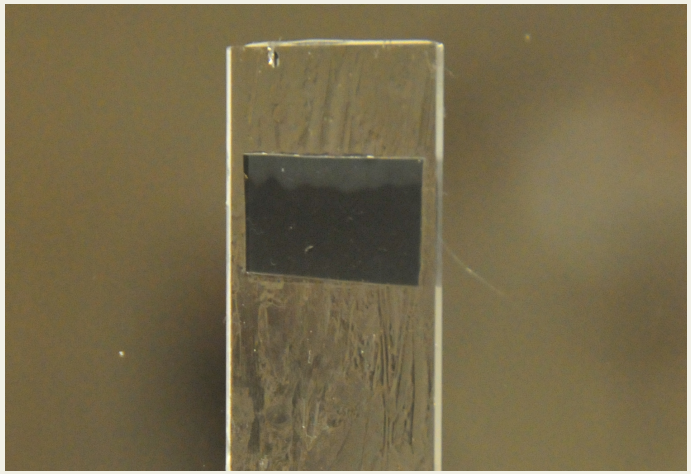


Heavily Loaded

Limit Surface Shows Shear Dependence on Adhesion

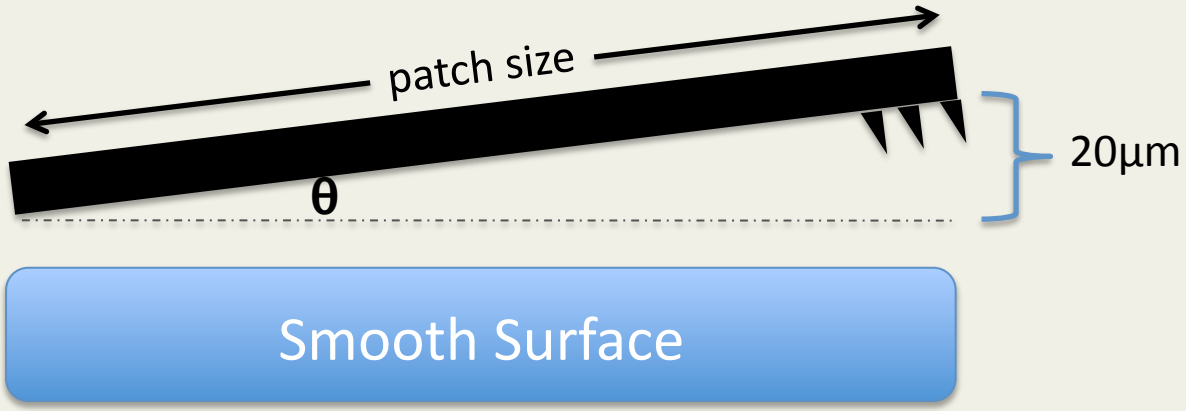


Conforming to Surfaces



Challenges with Conformation

- Alignment
- Irregularities in backing layer
- Surface roughness
- Part tolerances of robot toes

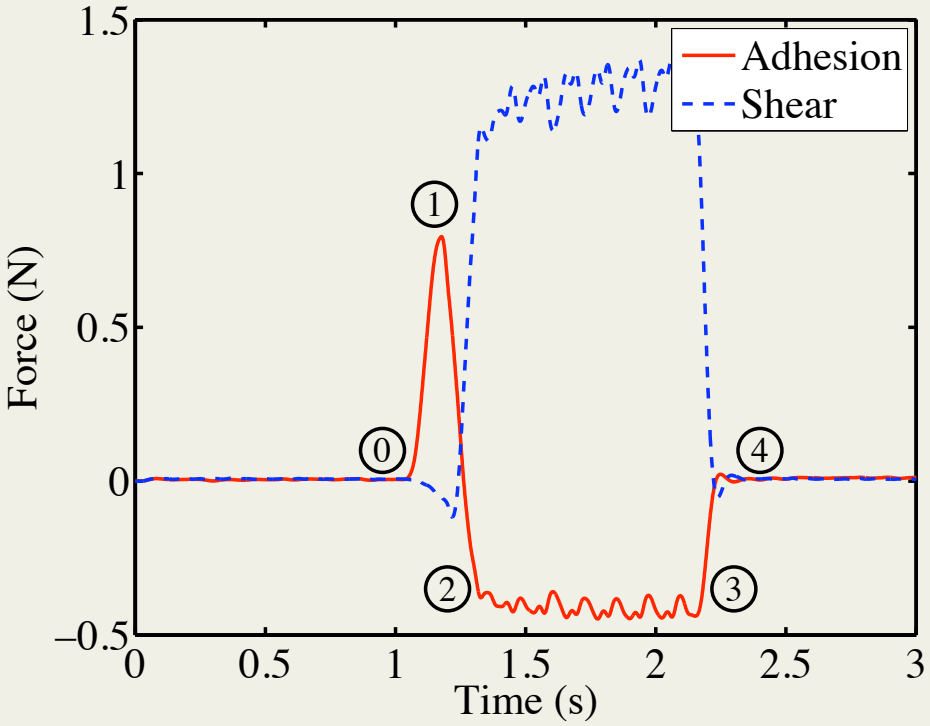


patch size	θ
200µm	5.7
1mm	1.15
4cm	0.029

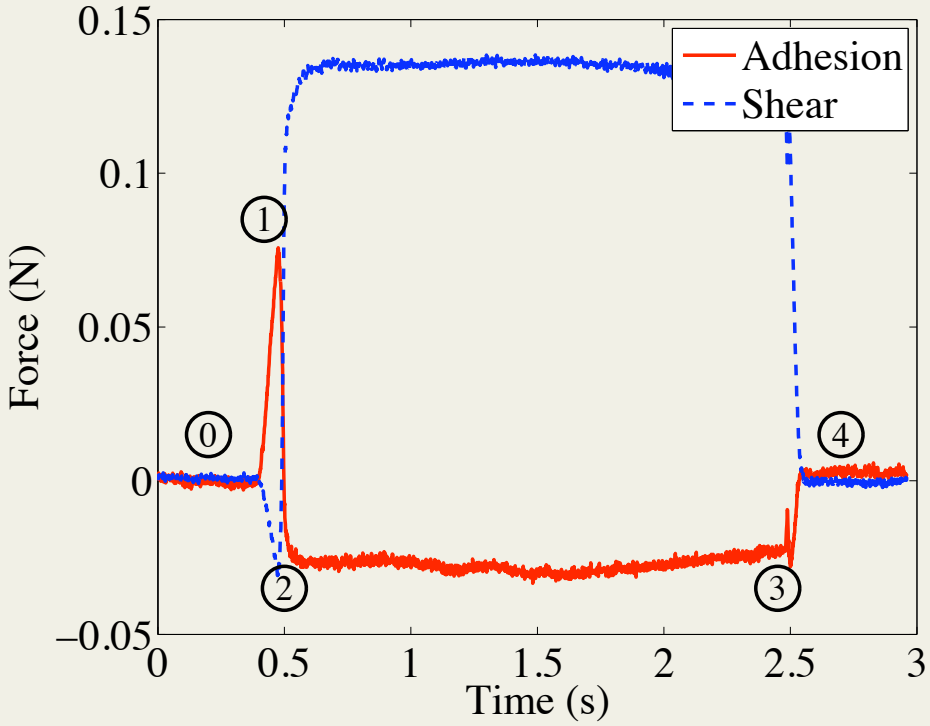
Dynamic Adhesion

The ability to maintain adhesion while failing in shear.

Microstructured adhesive

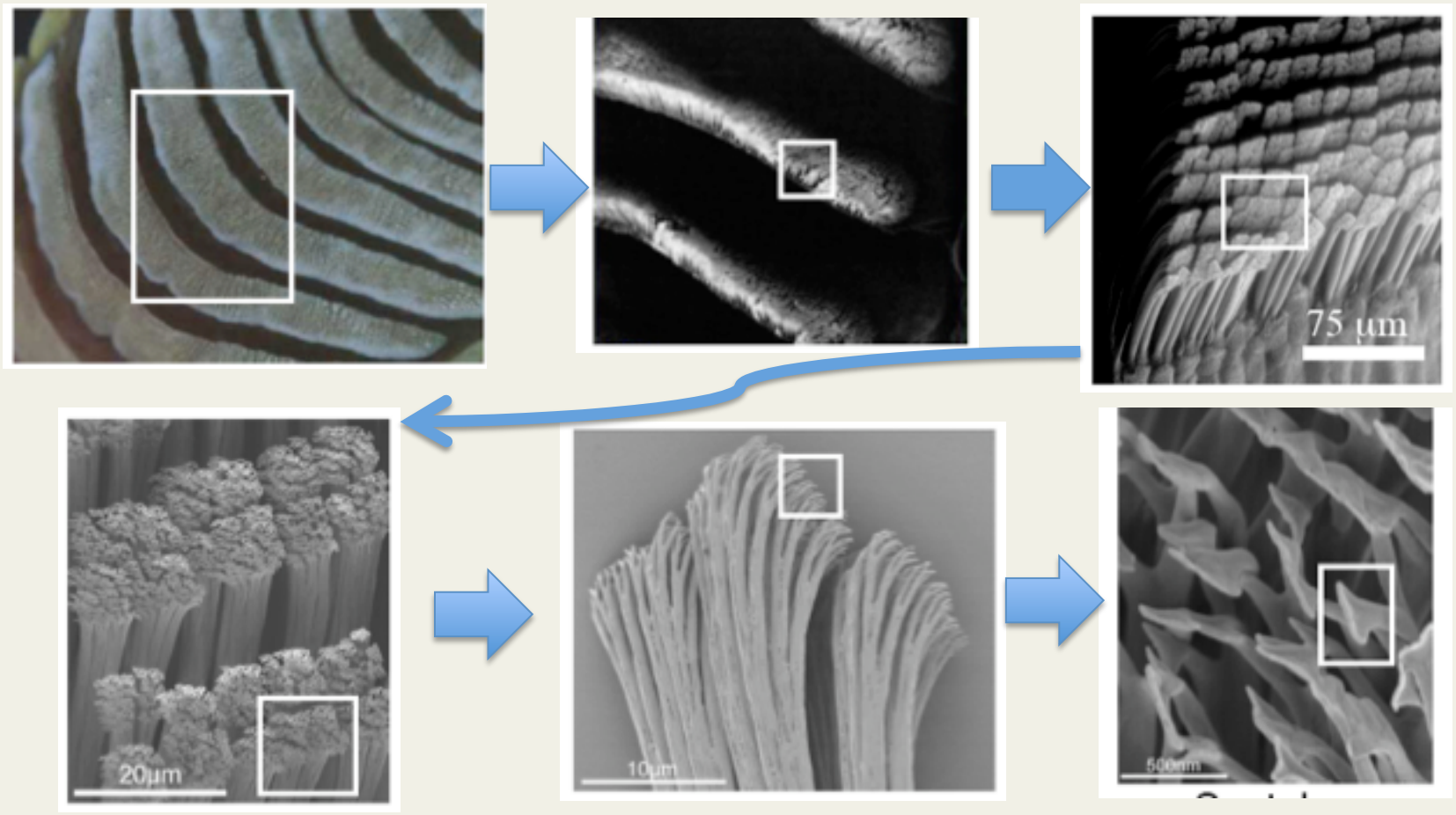


Gecko setal array

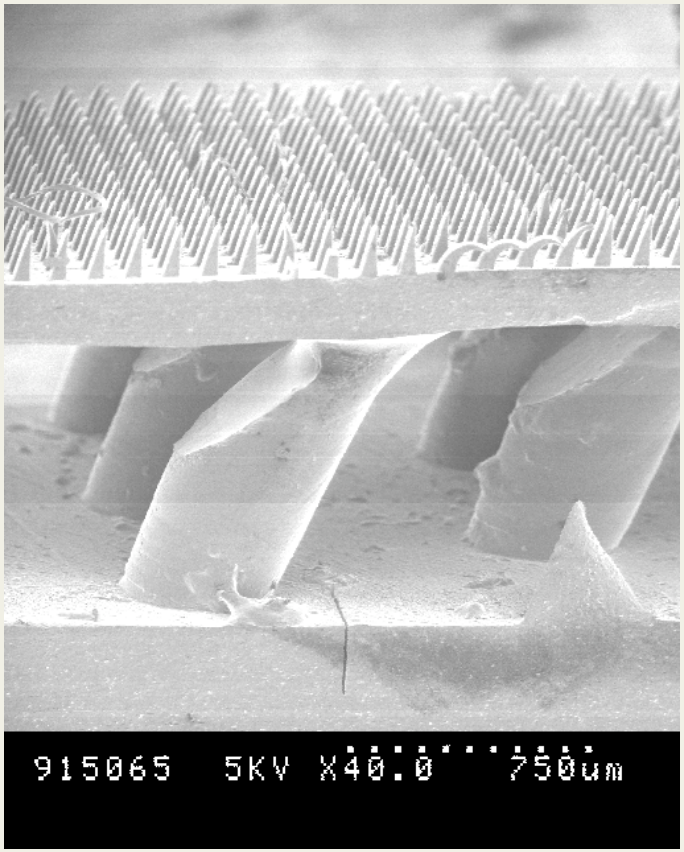


Gecko Hierarchical Adhesive Structures

Hierarchy should improve conformation to the surface while maintaining proper load distribution facilitating better performance on semi-rough surfaces and scaling to larger patch sizes.



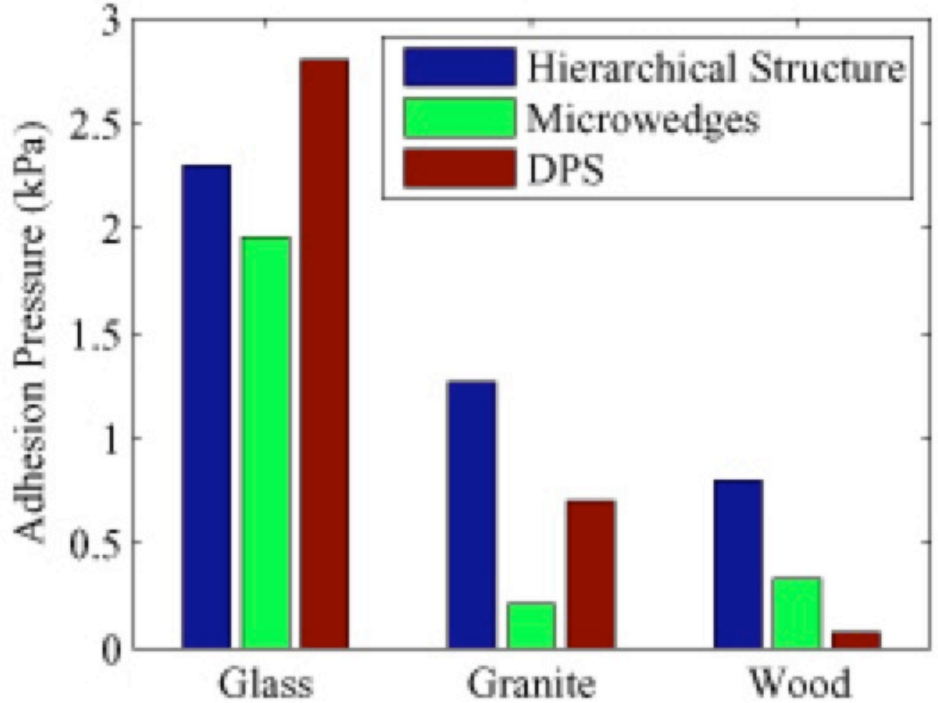
Synthetic Hierarchical Adhesive Structures Improve Performance on Roug Surfaces and Large Patch Alignment

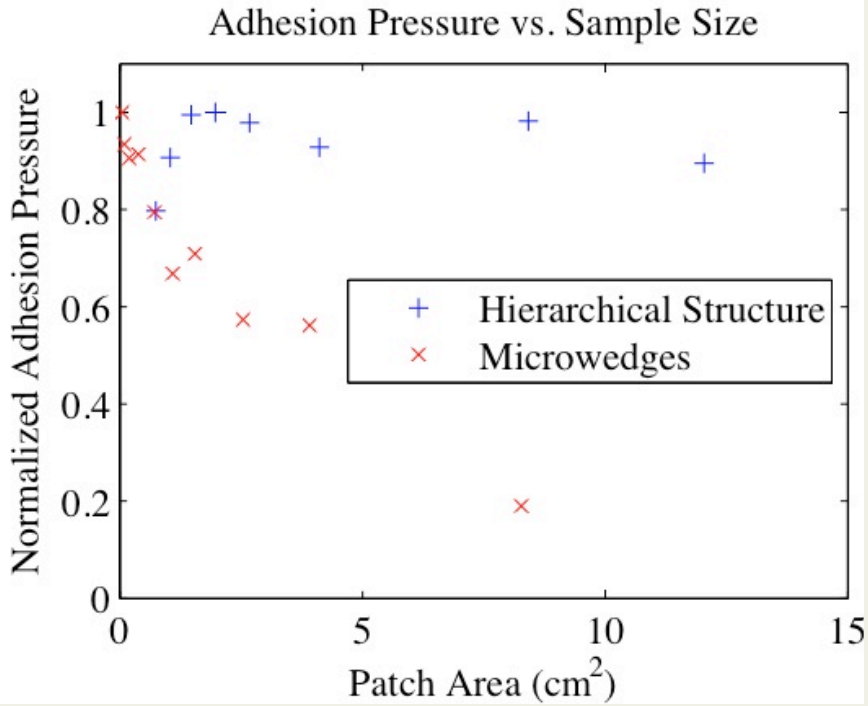


Bi-layer design allows compliance on millimeter and micrometer scales

4 by 4 inch patch holds 45 lbs!

Hierarchy Data





As predicted, improved performance on semi-rough surfaces,
and in scaling to larger sample sizes.