# Development of Thermally Actuated Tunable Adhesive Structures
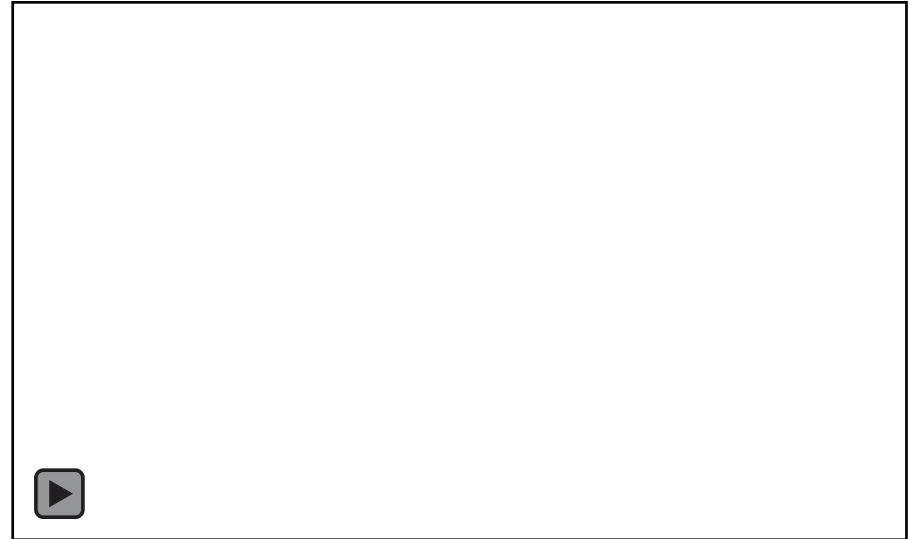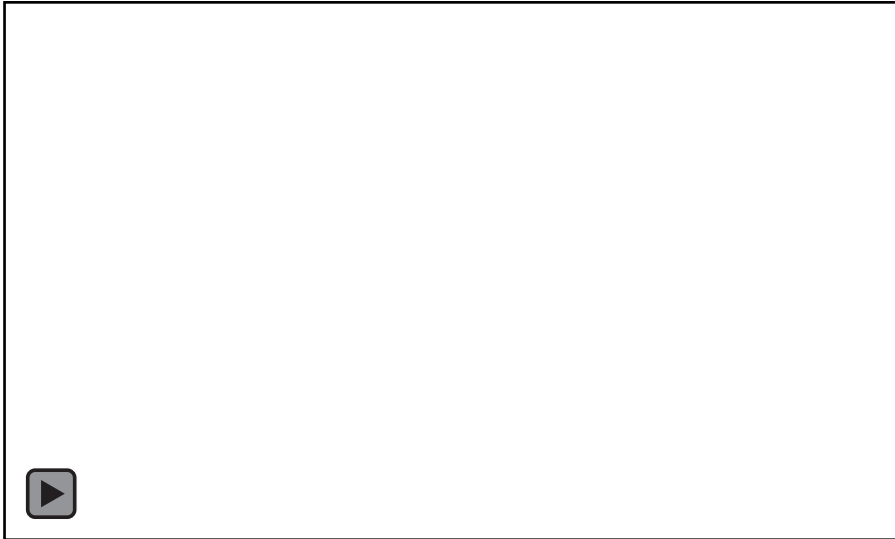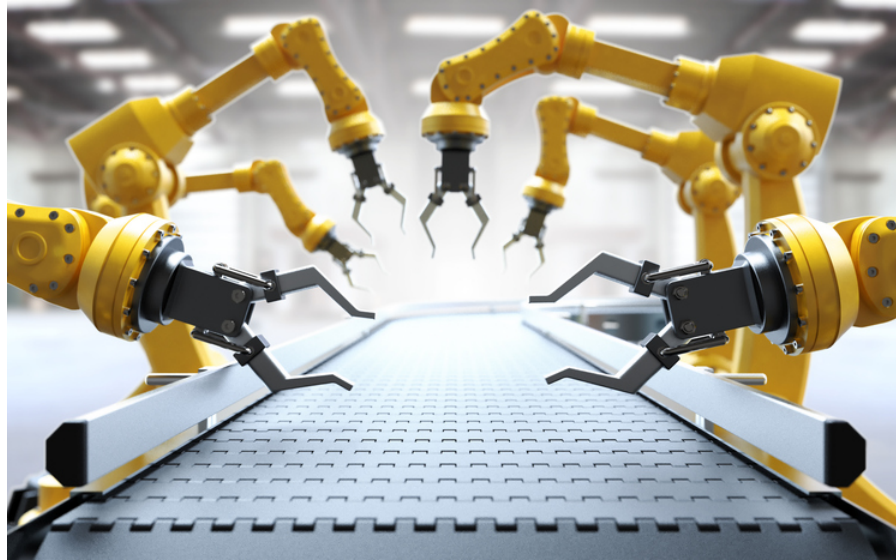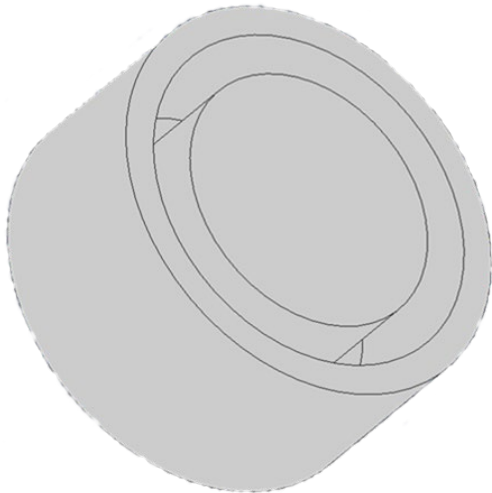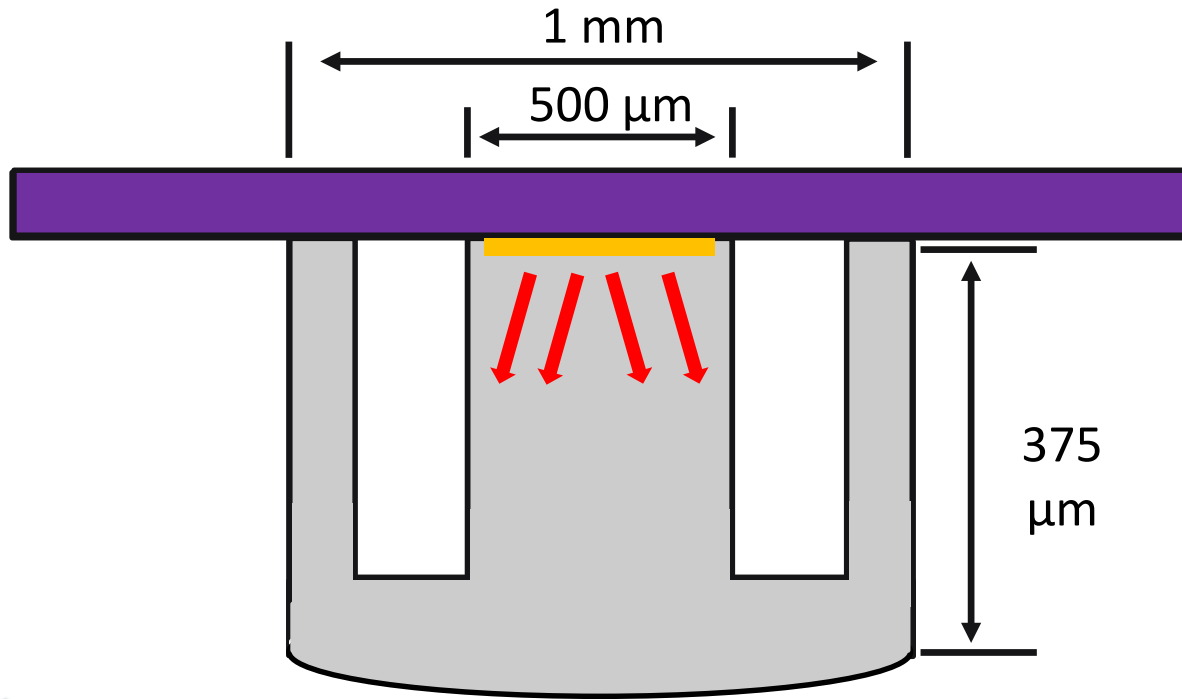
By: Joe Stage

Mentor: Aoyi Luo

Primary Investigator: Dr. Turner

# Motivation

PDMS Pillar (Sylgard 184)

Silicon Substrate

Gold Micro Heater

Induction Heating

# Pillar Fabrication via Excimer Laser Micromachining



~375μm
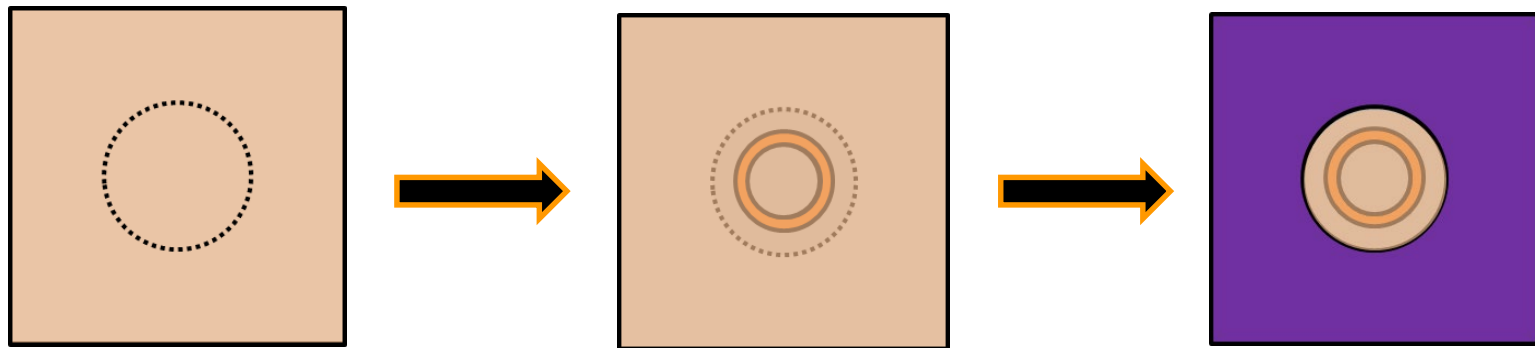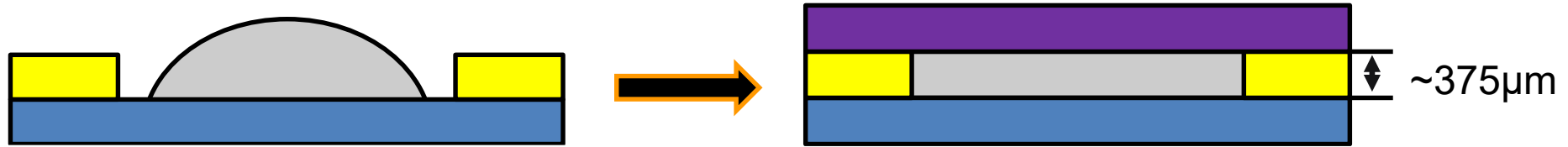
PMMA (Acrylic)

Silicon

PDMS (Sylgard 184)

Spacers

Void

Resist (LOR3A)

I

II

III

IV

V

VI

Resist (LOR3A)

Resist (S1813)

Silicon

Au

Exposed Resist

Tape

PDMS (Sylgard 184)

Silicon

Au
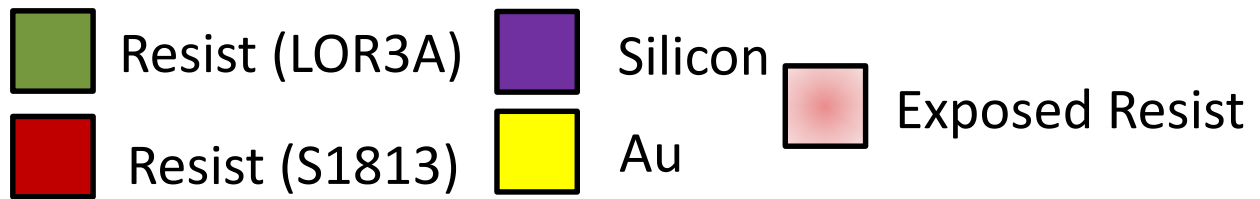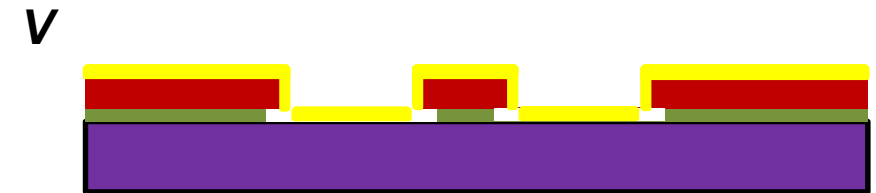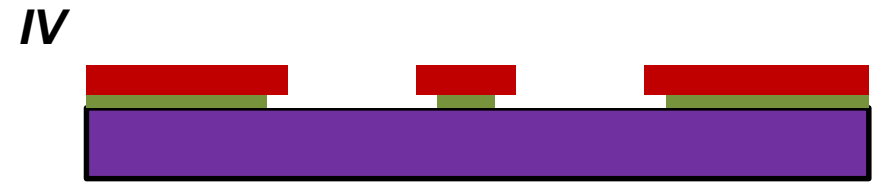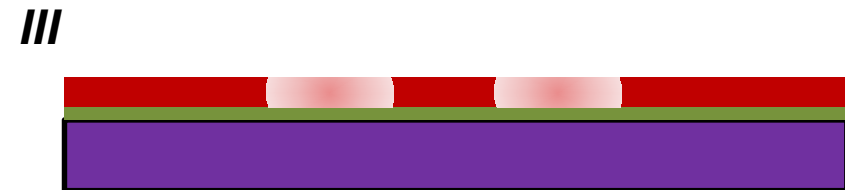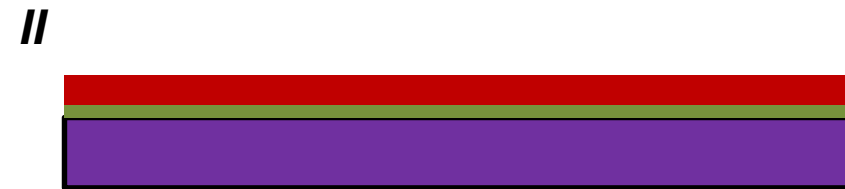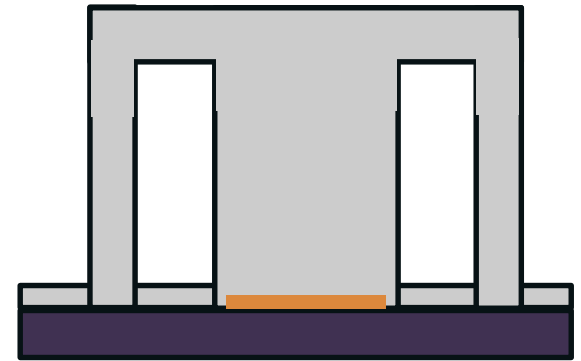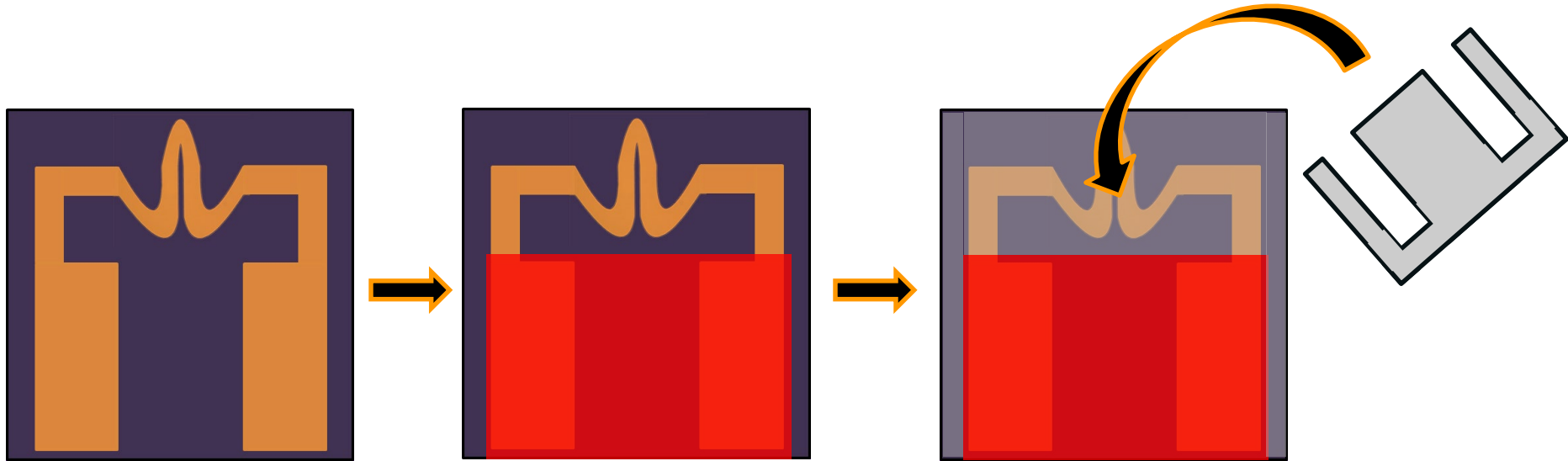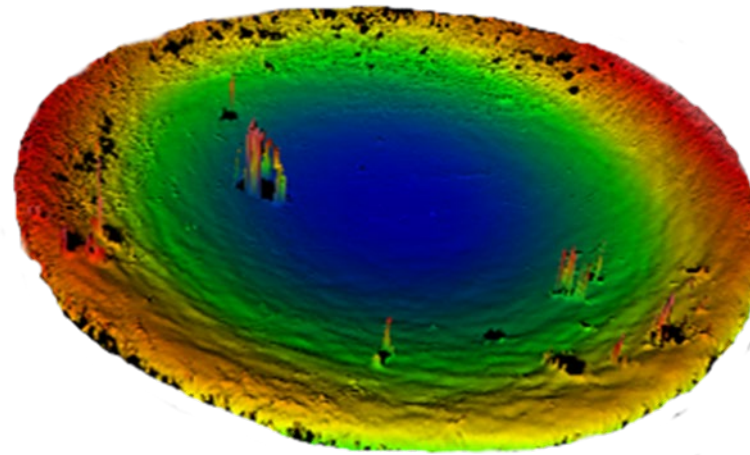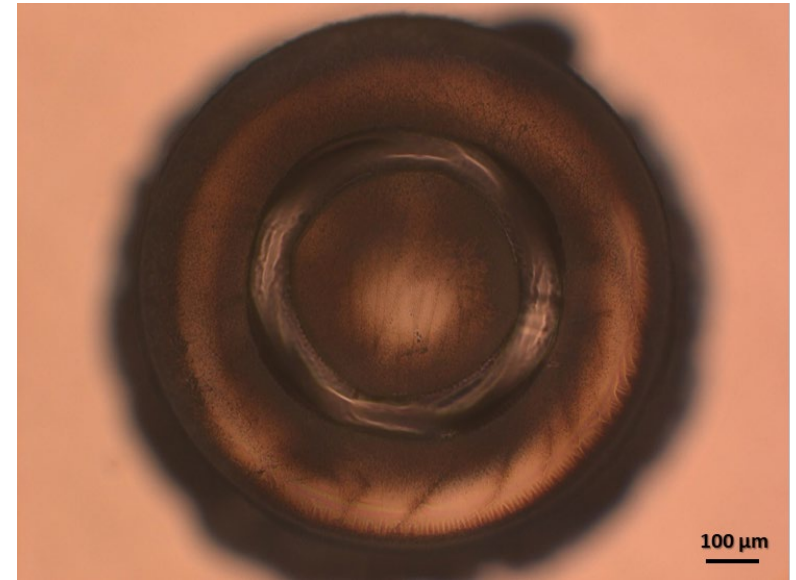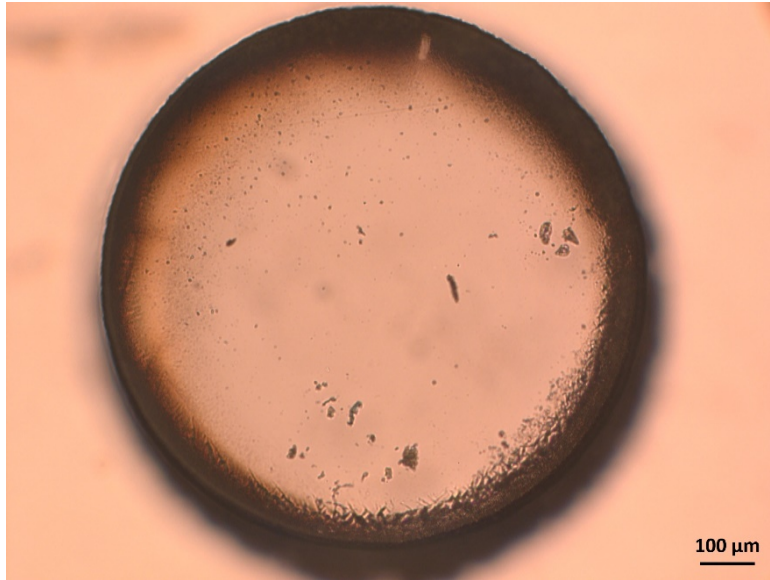
*Peak to Valley ~2μm*

# Results – Adhesive Testing


Force vs Displacement ( Structured Pillar )


Force vs Displacement ( Simple Pillar)
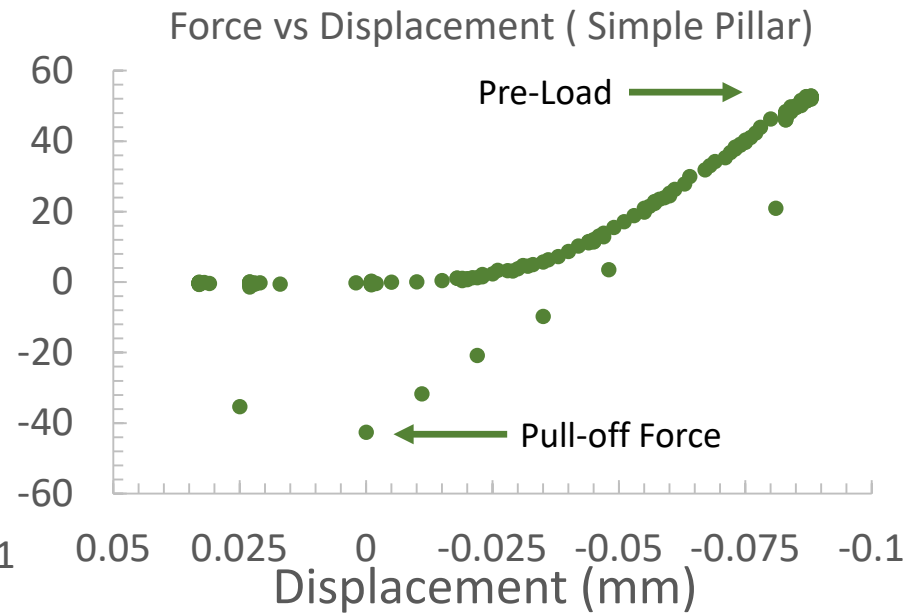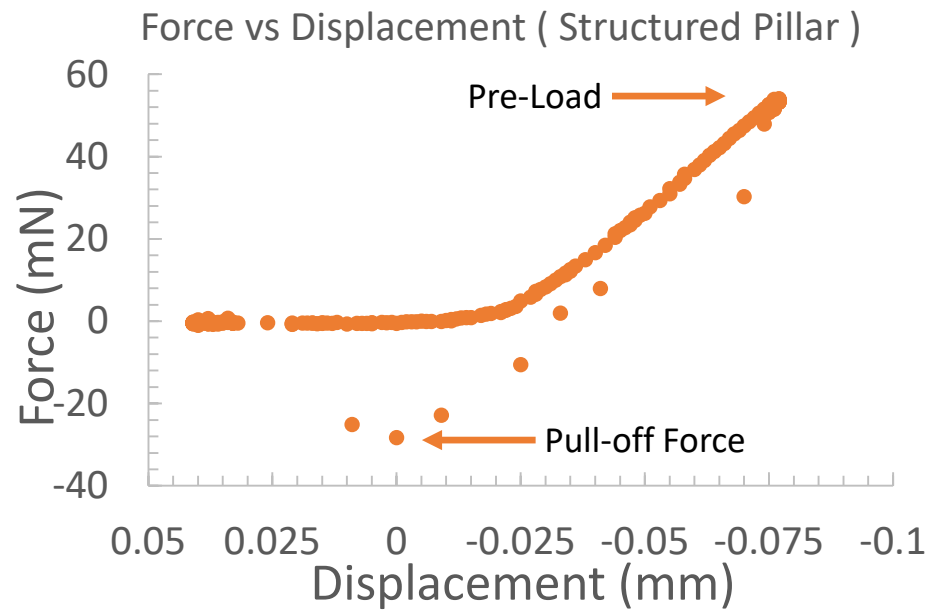

Average Adhesive Stress
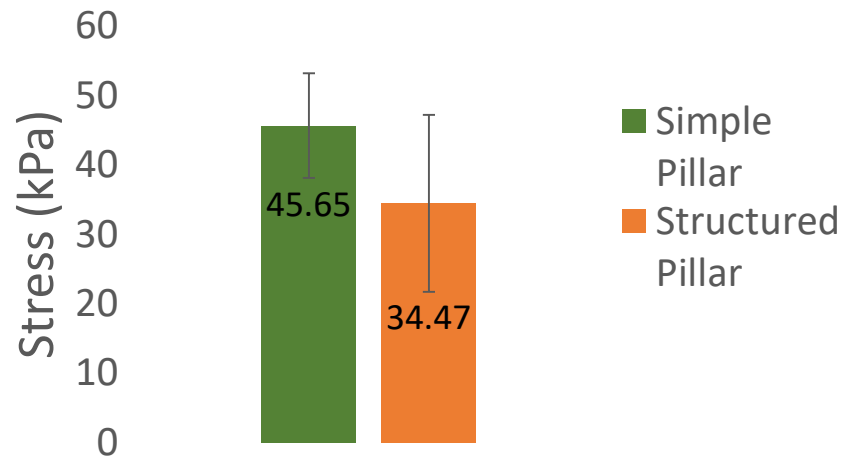
$R \approx 16\Omega$  $R \approx 6\Omega$  $R \approx 8.5\Omega$
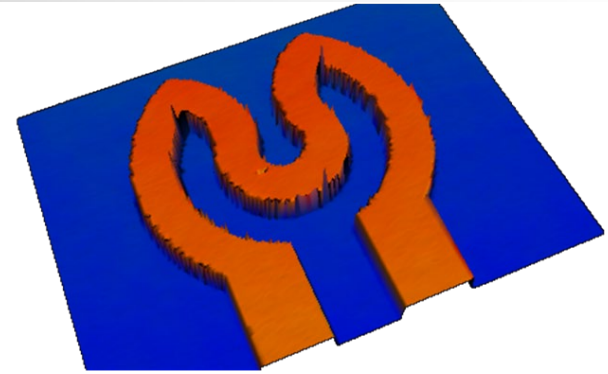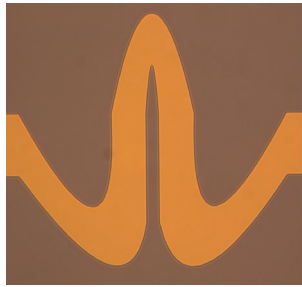
$R \approx 5.5\Omega$  $R \approx 7.5\Omega$  $R \approx 5\Omega$

- $R = \rho \dfrac{L}{A}$ , since thickness is constant, $R \propto \dfrac{L}{W}$
- Expected Currents ≈ 5mA

L = Length
W = Width
ρ = Resistivity
R = Resistance

- Still left to be accomplished
  - Integration of pillars and heaters
  - Adhesion testing of tunable adhesives
  - Fabrication method for an array rather then single pillars

# Acknowledgements

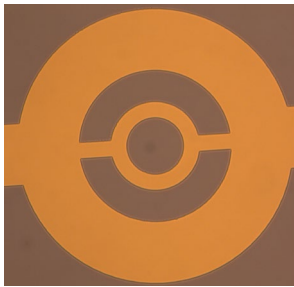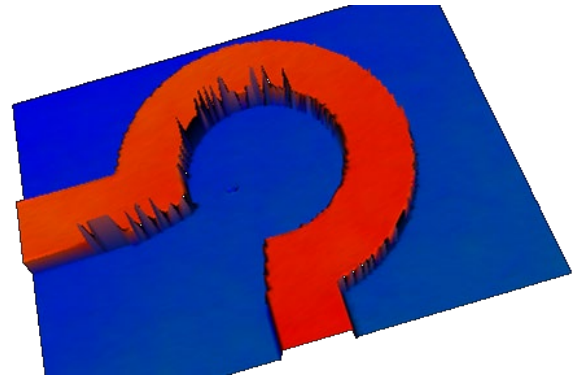- This work was performed in part at the Singh Center for Nanotechnology at the University of Pennsylvania, a member of the National Nanotechnology Coordinated Infrastructure (NNCI), which is supported by the National Science Foundation (Grant ECCS-1542153). Also, special thanks to Alexander Bennett, Ranny Zhao, Antonio Alvarez-Valdivia, and the QNF staff for their contributions to the project.