

# NRI:INT:COLLAB: Soft Active Contact Pads with Tunable Stiffness and Adhesion for Customizable Robotic Grasping

CMMI 1830362



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## Problem Statement & Motivation

### Universal & Customizable Robot Grasping

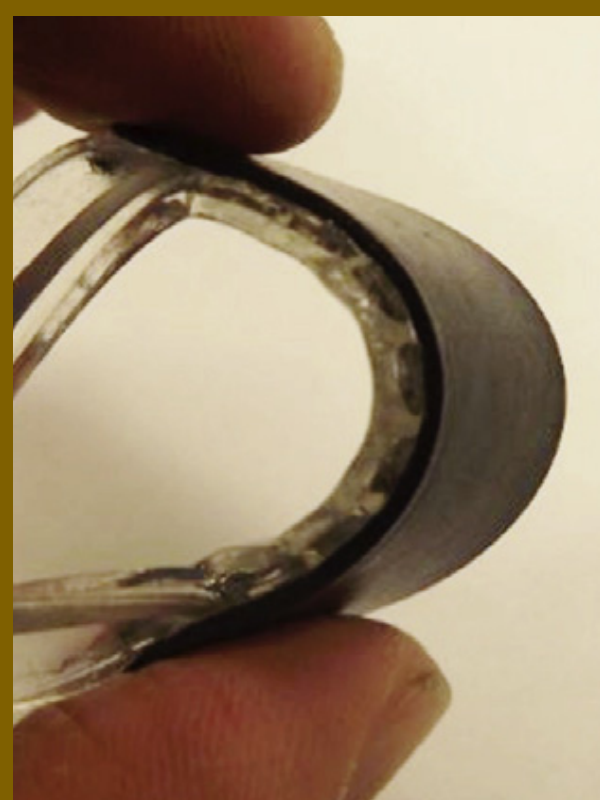
Emerging co-robotics require *universal* gripping systems that can match the versatility of natural grippers in handling a wide variety of objects.



Objects from Amazon Picking Challenge 2015 (IEEE Spectrum)

### Our Approach: Adhesion/Stiffness Tuning

- Polymer composites that dynamically change modulus in response to electrical stimulation
- Mechanisms for tuning adhesion strength of soft surfaces by modulating the subsurface stiffness



Rigidity tuning element with shape memory polymer (Wanliang Shan & Carmel Majidi)

## Proposed Methodology

### Robotic Gripper Systems

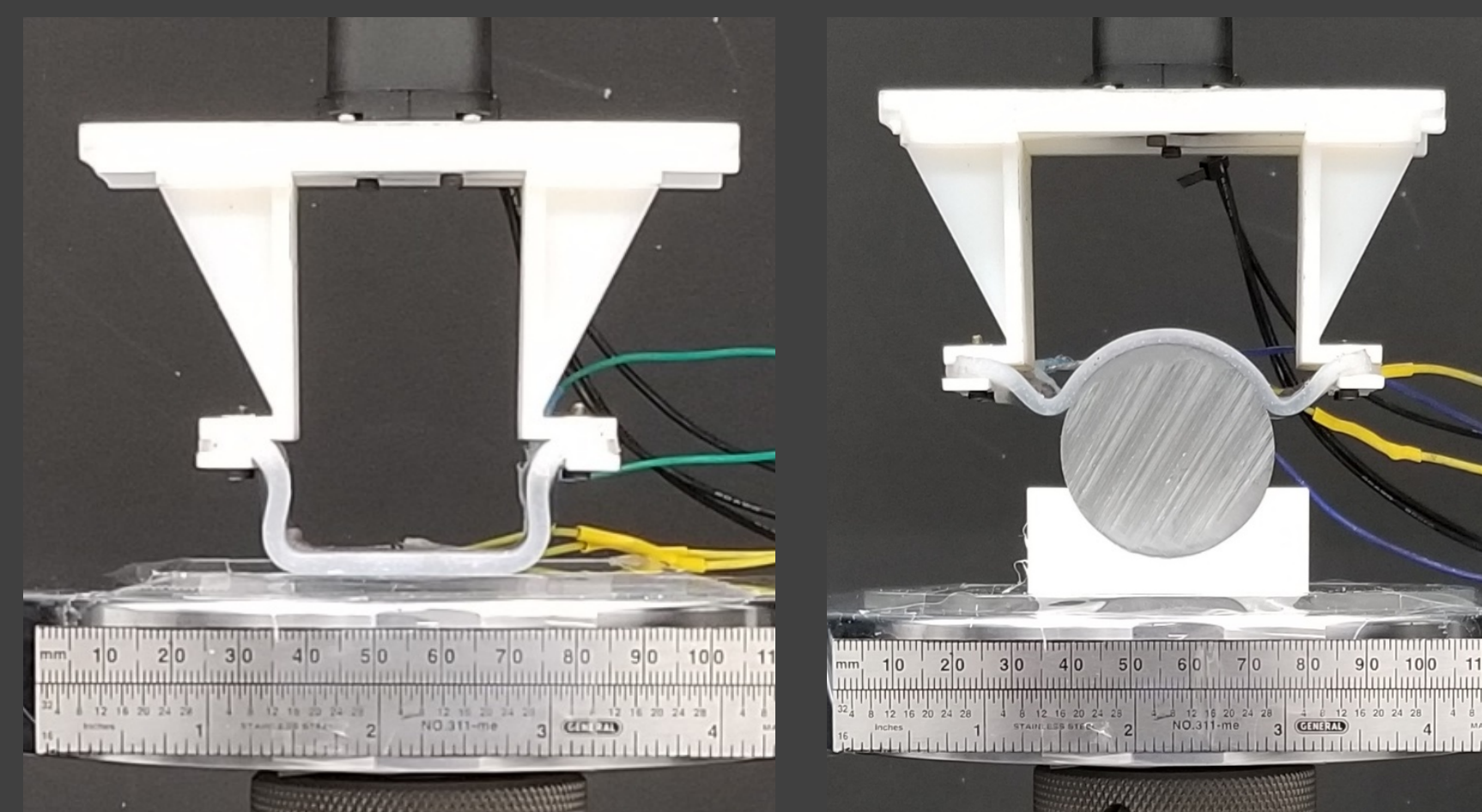
- Adhesion/stiffness-tuning contact pads mounted on robot end effector.
- Robot grasping tests performed with a conventional wide-face parallel gripper



### Sensing Skin for Monitoring Interfacial Traction

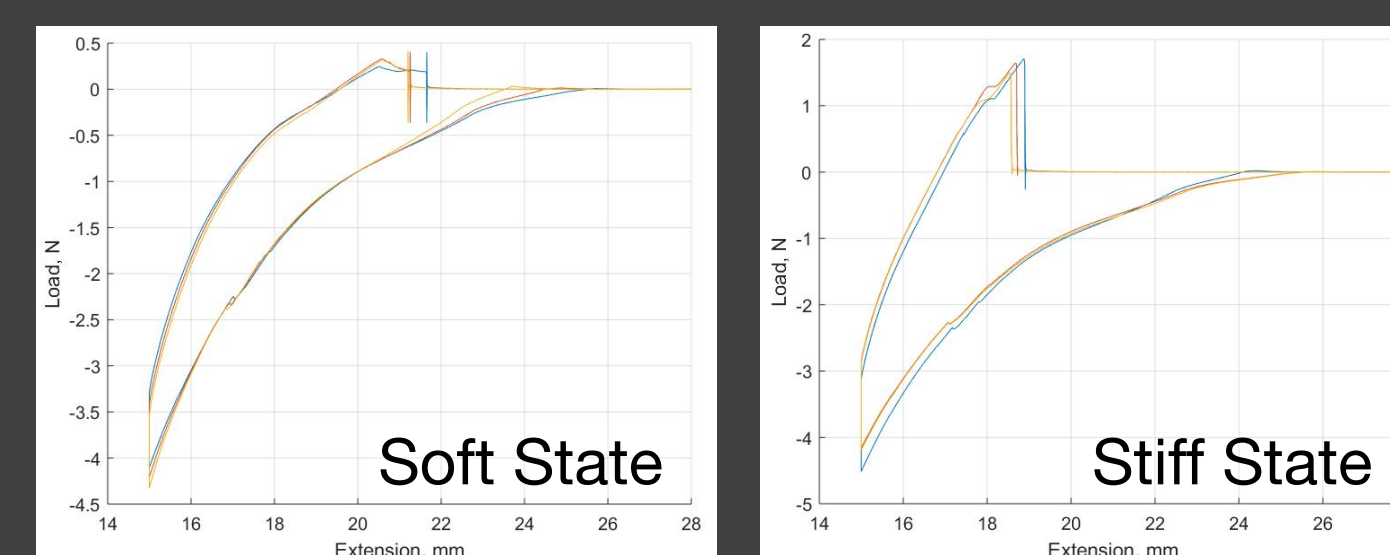
- Objects covered with a tactile skin that will map surface tractions.
- These same electronics could also be incorporated into the gripper for tactile feedback or contact pad activation

## Research Results



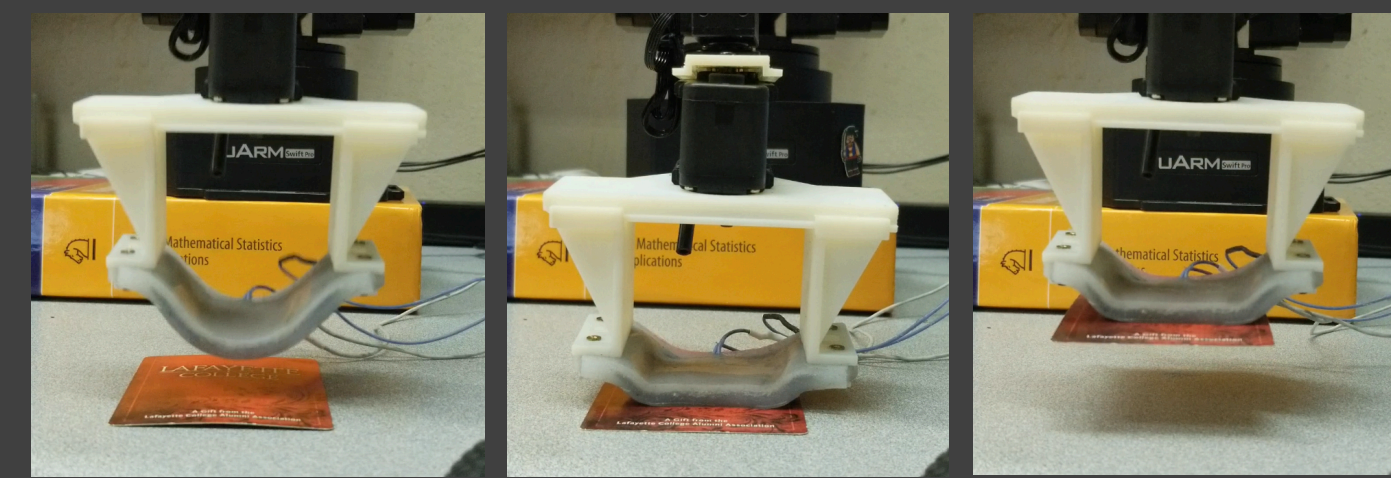
Adhesion/Stiffness-tuning material mounted to parallel plate end effector

Pull-off measurements in the soft and stiff states:

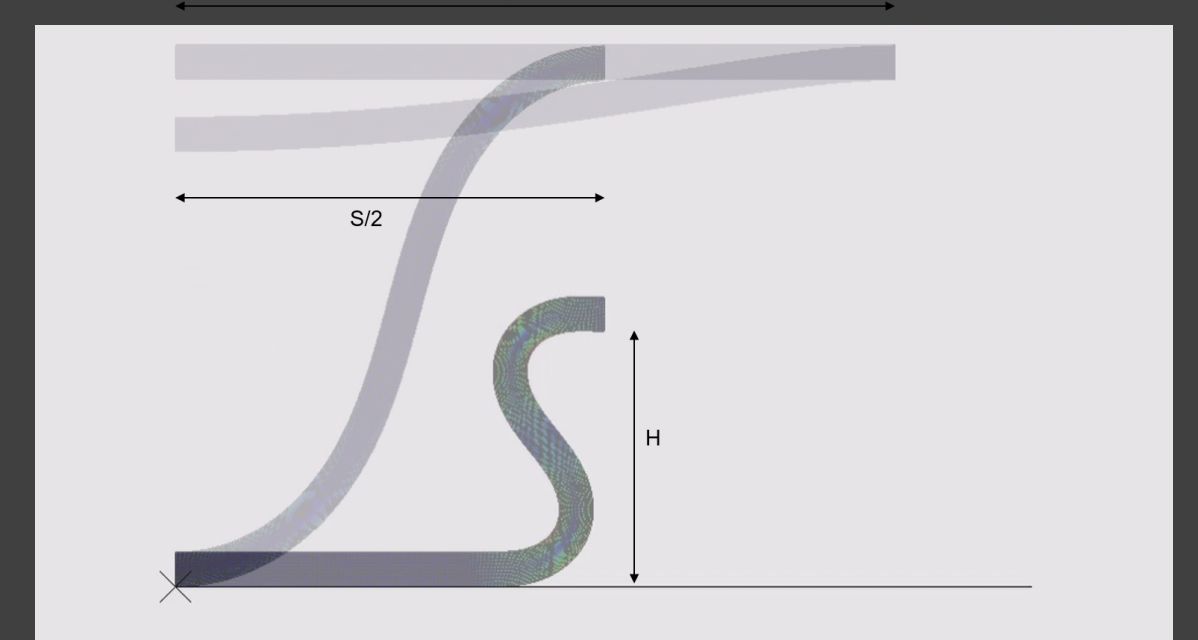
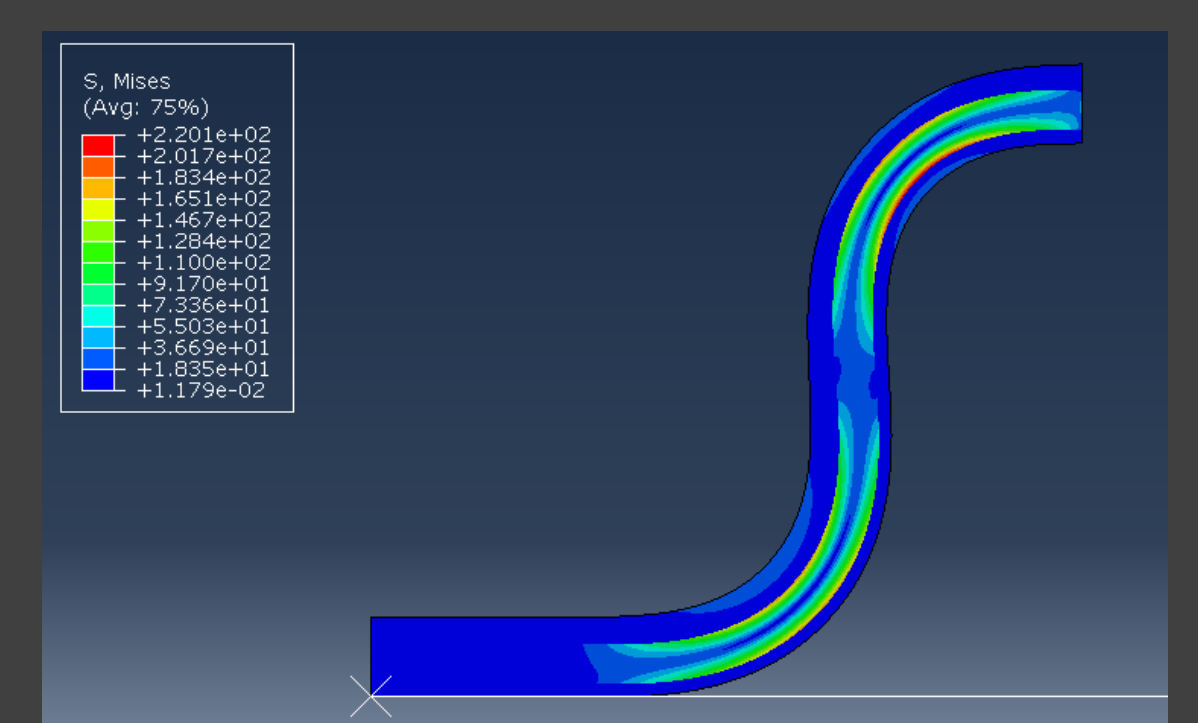


In the **soft state**, the contact pad conforms to object but has poor adhesion

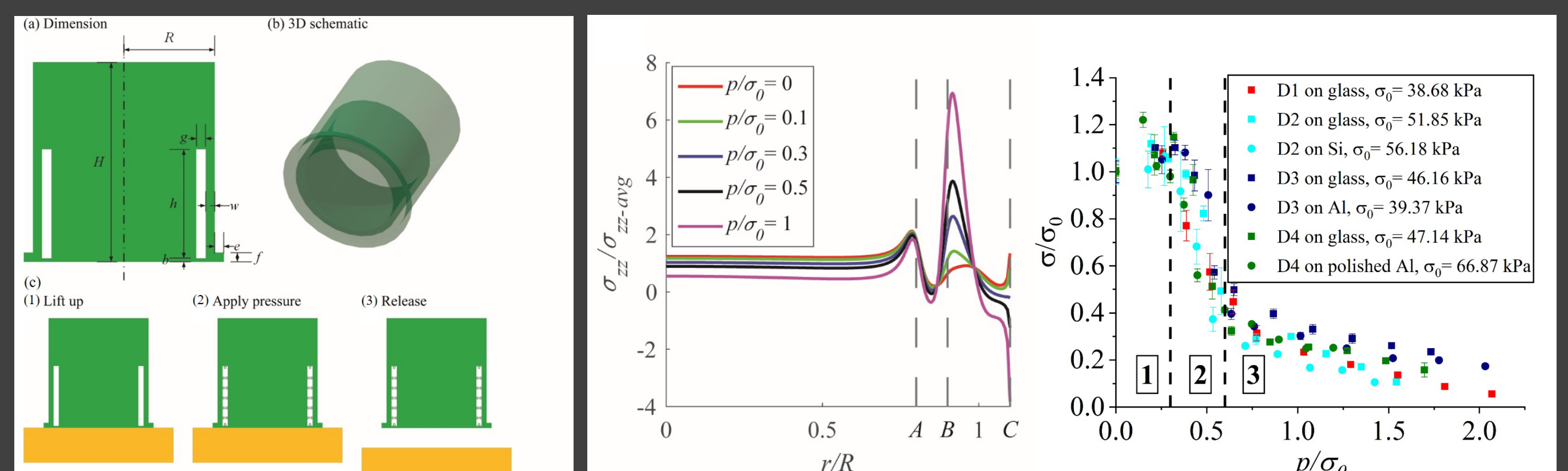
In the **stiff state**, the contact pad locks its shape and has good adhesion



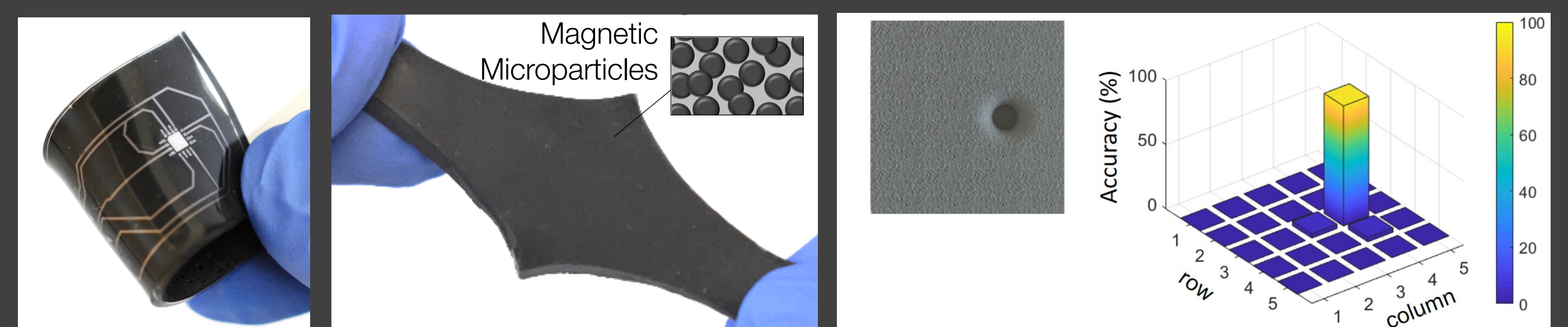
Theoretical Validation with FEA Modeling



### Adhesion-tuning subsurface pressure modulation

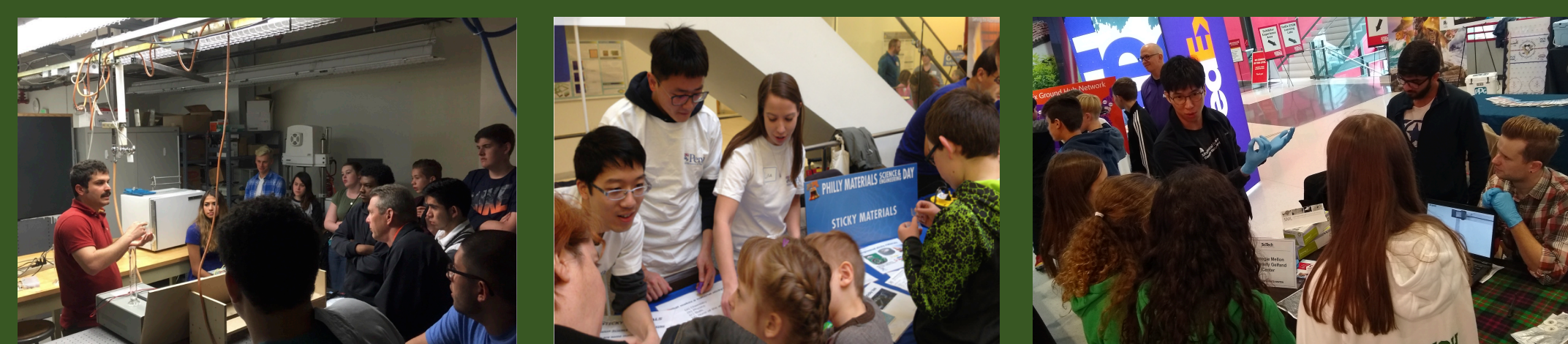


*In situ* sensing with magnetic sensing skin



Hellebrekers et al. *Advanced Intelligent Systems* (2019).

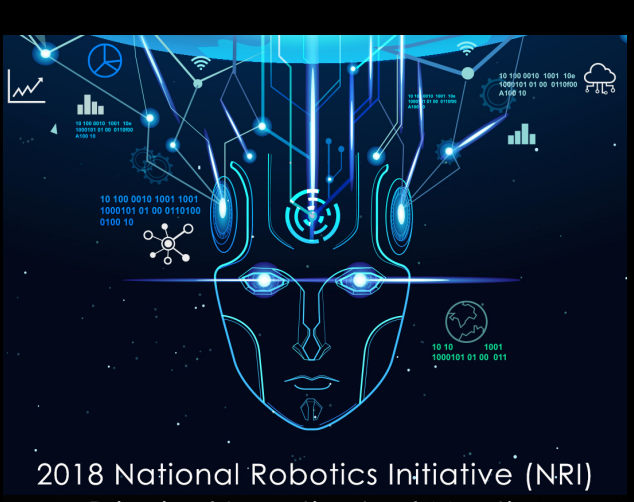
## Educational Outreach



Shan group member Amir Mohamamdi Nasab doing research project demo at Engineer's Day at UNR

Turner group members doing demo of "Sticky Materials" at Philly Materials Science and Engineering Day.

Majidi group members hosting a hands-on demo at the 2019 SciTech Festival for Pittsburgh-area middle school students



2018 National Robotics Initiative (NRI) Principal Investigators' Meeting