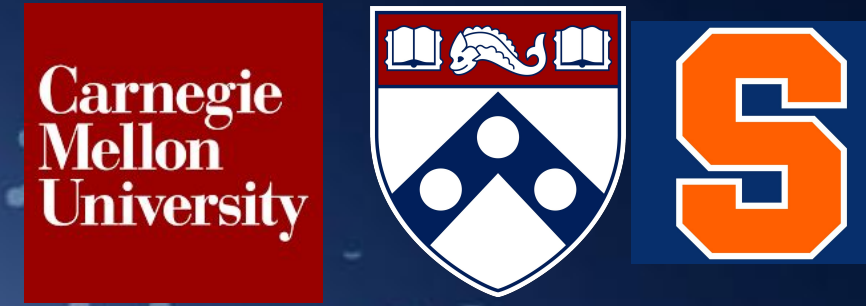


# NRI:INT:COLLAB: Soft Active Contact Pads with Tunable Stiffness and Adhesion for Customizable Robotic Grasping

Carmel Majidi (Carnegie Mellon) • Kevin Turner (University of Pennsylvania) • Wanliang Shan (Syracuse University)



Objects from Amazon Picking Challenge 2015 (IEEE Spectrum)

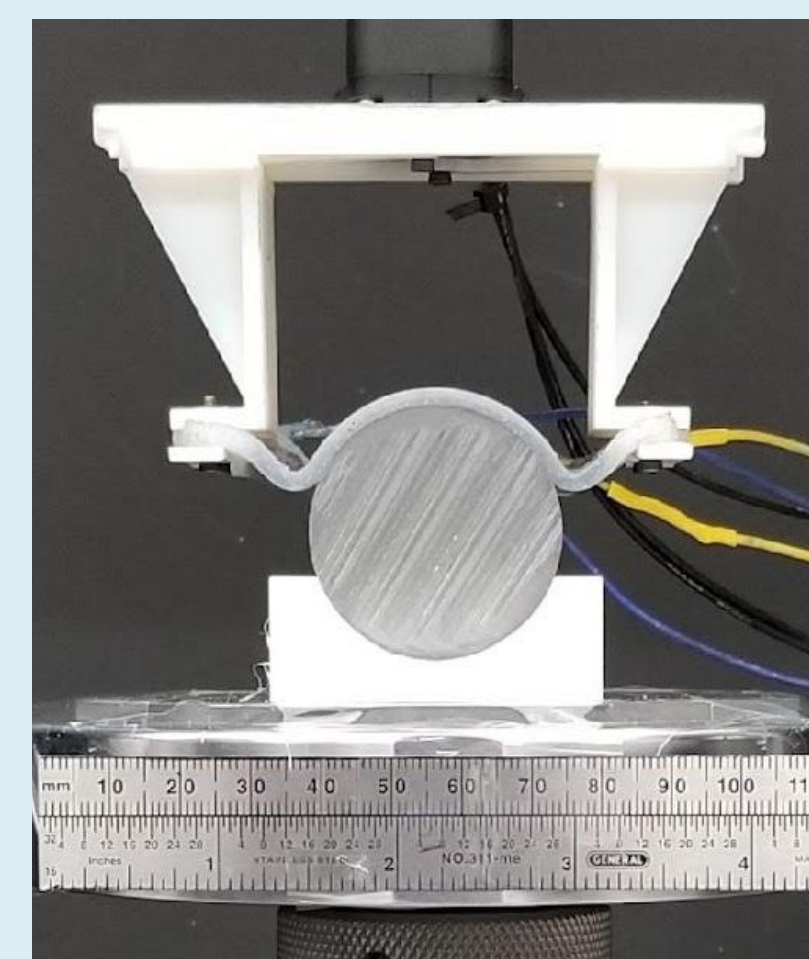
## CHALLENGE • Universal & Customizable Robot Grasping

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

Progress requires new material architectures for mechanically robust contact and detachment.

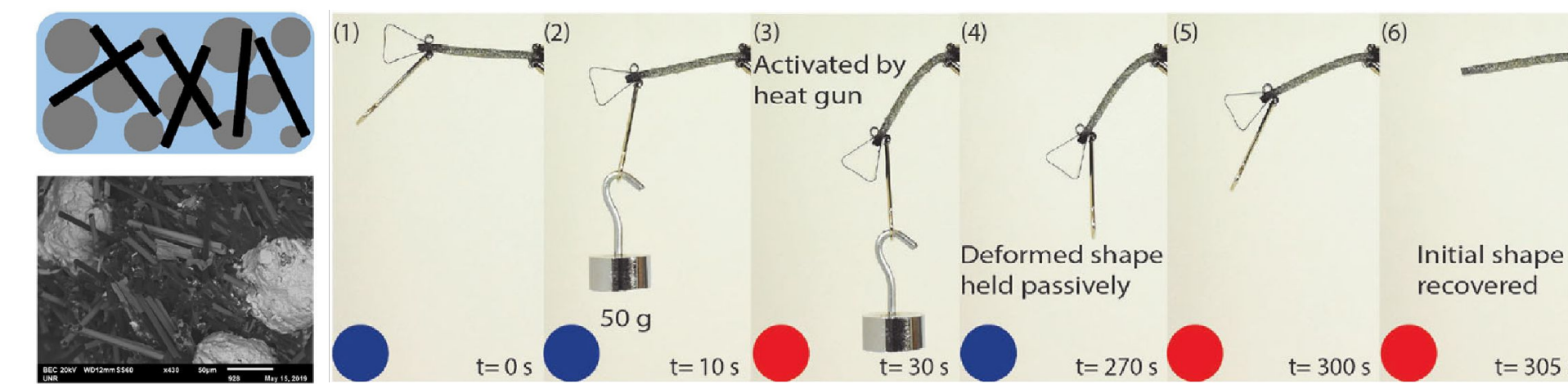
## OUR SOLUTION • Soft Active Materials capable of Dynamic Adhesion & Stiffness Tuning

- Polymer composites that change modulus and adhesion in response to electrical stimulation
- Contact pads with tunable adhesion and stiffness mounted on robot end effector.
- Robot grasping tests performed with a conventional wide-face parallel gripper
- Soft tactile skin for pressure and contact sensing



Coulson, R., Stabile, C.J., Turner, K.T. and Majidi, C., *Soft Robotics* in press (2021).

## RESULTS & SCIENTIFIC IMPACT

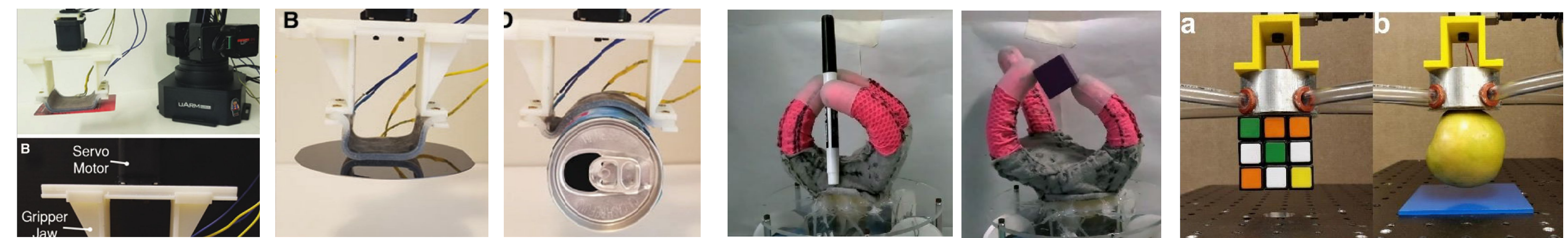
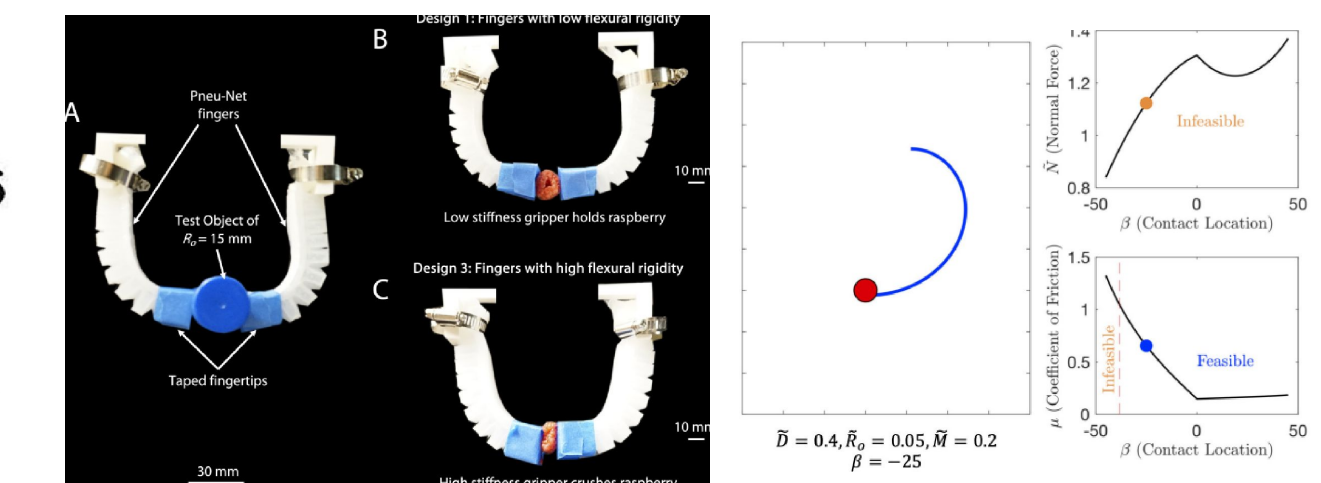
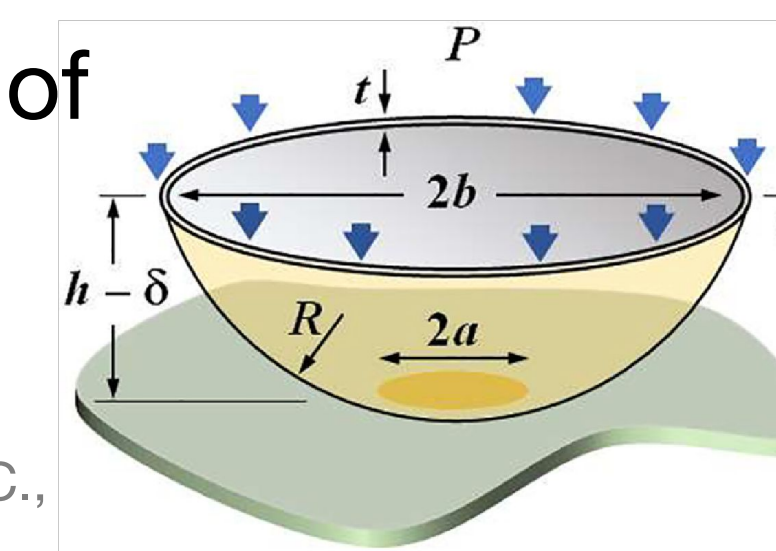


## Discovery of novel stiffness & adhesion tuning materials

Nasab, A.M., Sharifi, S., Chen, S., Jiao, Y. and Shan, W., *Advanced Intelligent Systems*, 2000166 (2020).

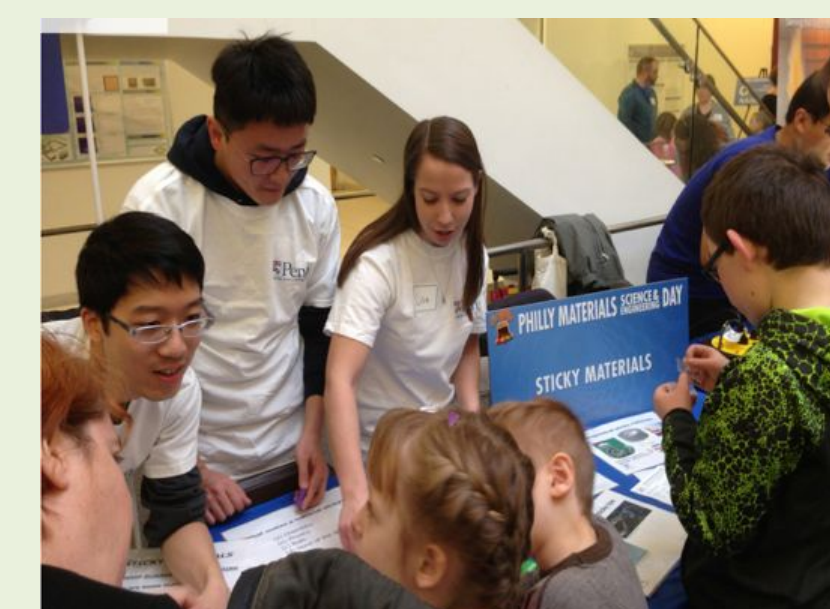
## Computational Modeling of Soft Gripper Mechanics

Zhao, C., Chen, X., Shan, W. and Wan, K.T., *International Journal of Solids and Structures*, 236, p.111351 (2022).  
Stabile, C.J., Levine, D.J., Iyer, G.M., Majidi, C., and Turner, K.T., *IEEE RA-L* (2022).



## Soft Robot Gripper Implementations with Novel Material Architectures

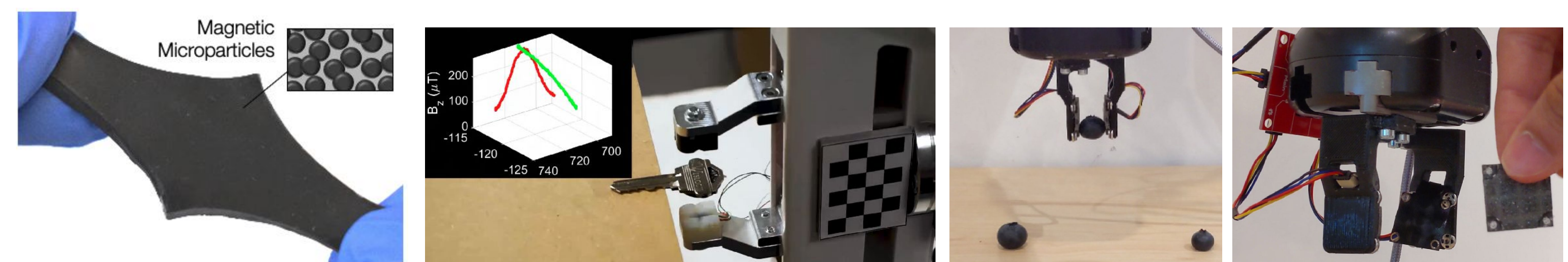
Coulson, R., Stabile, C.J., Turner, K.T. and Majidi, C., *Soft Robotics* in press (2021).  
Coulson, R., Li, C., Majidi, C. and Pollard, N. *IEEE-RAS Humanoids* (2021).  
Luo, A., Pande, S.S., and Turner, K.T. *Soft Robotics* submitted (2022).



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

## BROADER IMPACT

- STEM educational outreach at CMU/Penn/SU
- Graduate research training for seven PhDs
- Current exploration of IP licensing and commercial translation of materials technologies with companies in robotics, healthcare, and prosthetics



## Soft Magnetic Skin for Tactile Sensing and Grasp Detection

Hellebrekers, T., Zhang, K., Veloso, M., Kroemer, O. and Majidi, C., *IEEE/RSJ IROS* (2020).  
Hellebrekers, T., Chang, N., Chin, K., Ford, M.J., Kroemer, O. and Majidi, C., *IEEE RA-L*, 5(3), 3892-3898 (2020).  
Bhirangi, R., Hellebrekers, T., Majidi, C. and Gupta, A., *Conference on Robot Learning (CoRL)* (2021).