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Versatile Soft Robots with Shaped Dynamics [View project](#)



Soft Manipulators with Programmable Motion using Twisted-and-Coiled Actuators

Jiefeng Sun, Ben Pawlowski, and Jianguo Zhao Tuesday, March 5th, 2019

Adaptive Robotics Lab

Department of Mechanical Engineering at Colorado State University



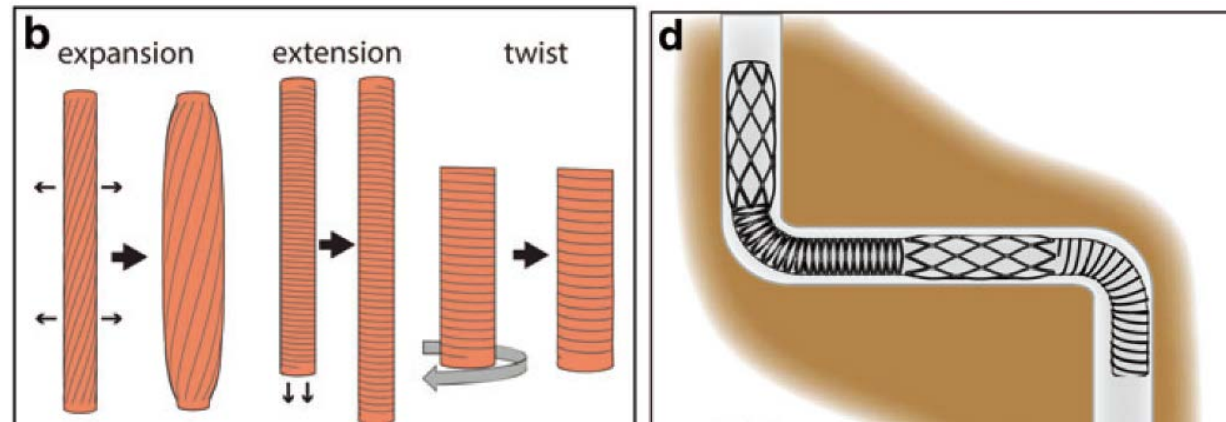
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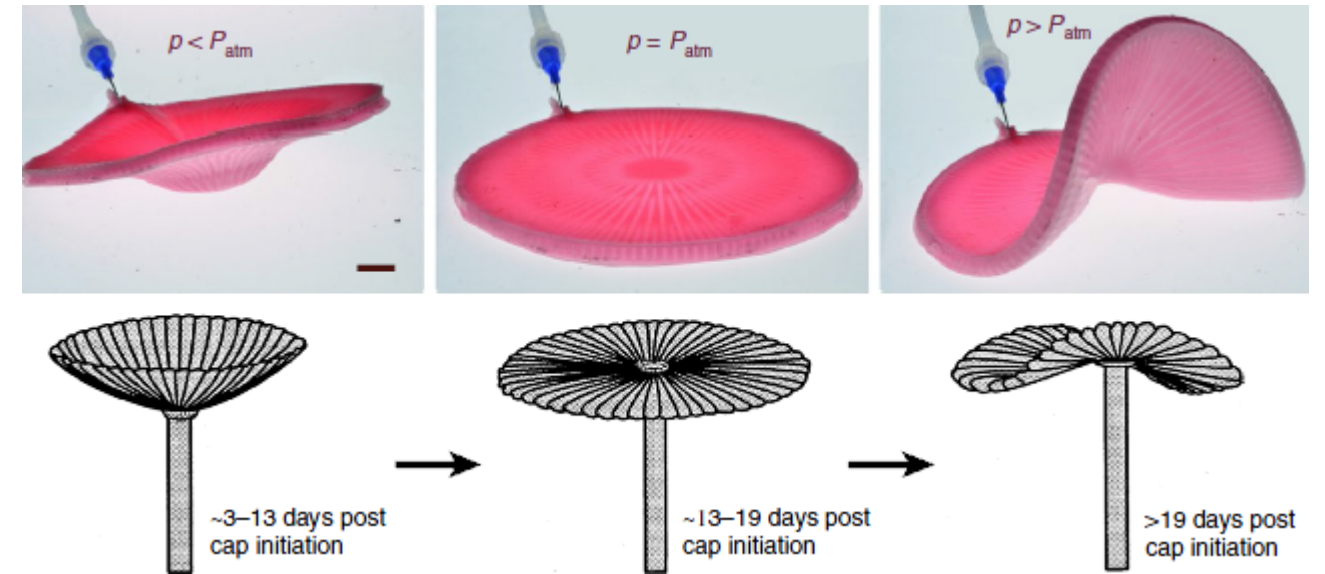
Contents

- Motivation and Introduction
- Fabrication of TCAs Enabling Soft Robots
- Versatile Preprogrammed Motions (3D Bending, Twisting)
- Combinations of Motions
- Application

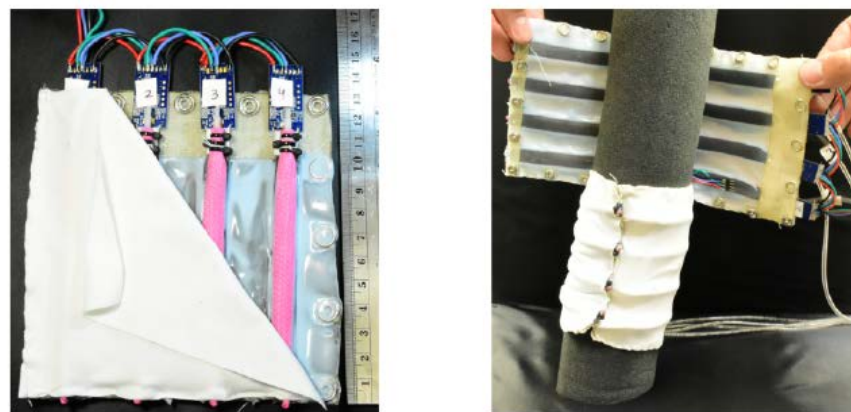
Motivation



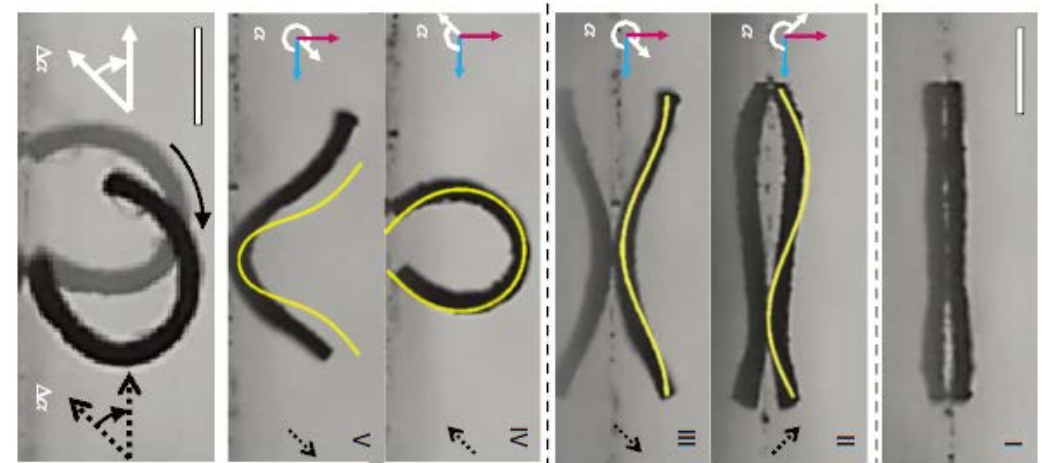
Soft Robotics. F. Connolly, et al. (2015)



Nature materials. E. Siéfert, et al. (2019)



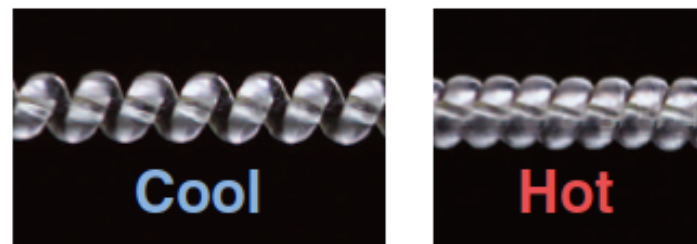
Science Robotics. J. W. Booth, et al. (2018)



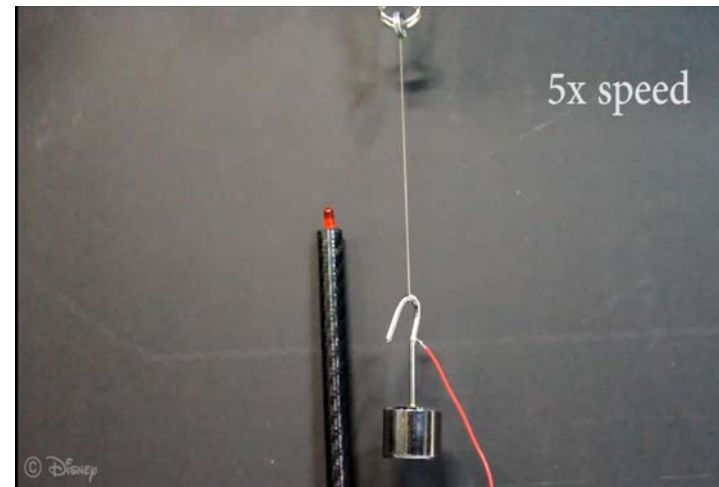
Nature. W. Hu, et al (2018)

Introduction of TCAs

- TCA



Science, C. S. Haines, et al. (2014)

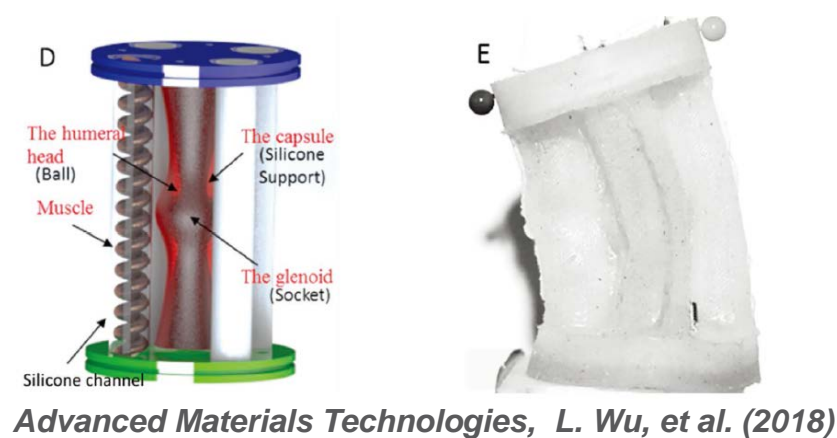


IEEE Transactions on Robotics. Yip & Niemeyer (2017)



IROS IEEE. J. Sun, et al. (2018)

- Work with a load / Pretension



Advanced Materials Technologies, L. Wu, et al. (2018)

Load

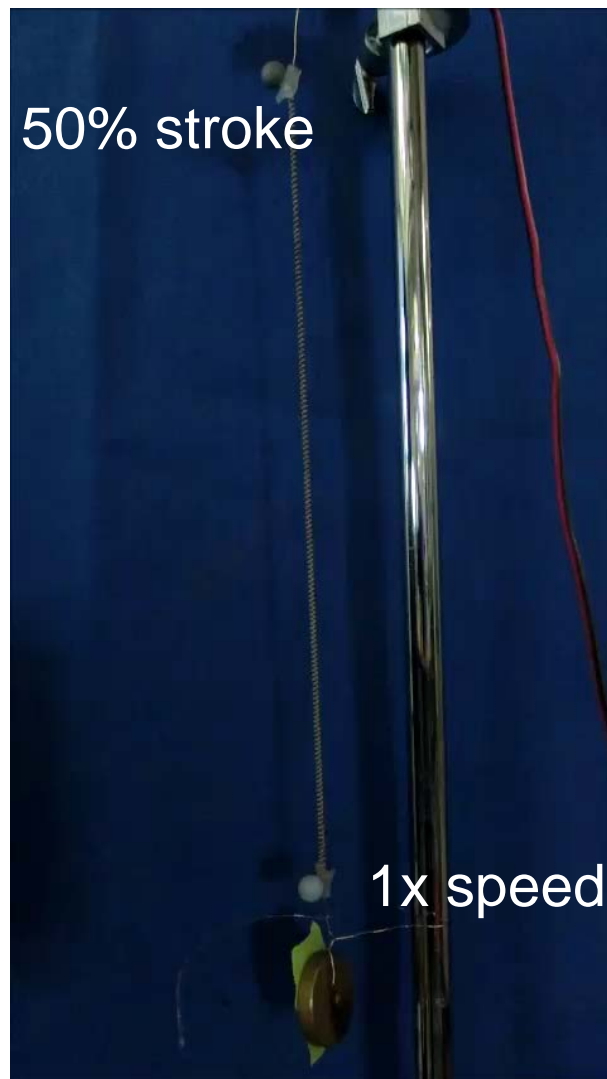
Friction

▪ Work poorly with a soft body

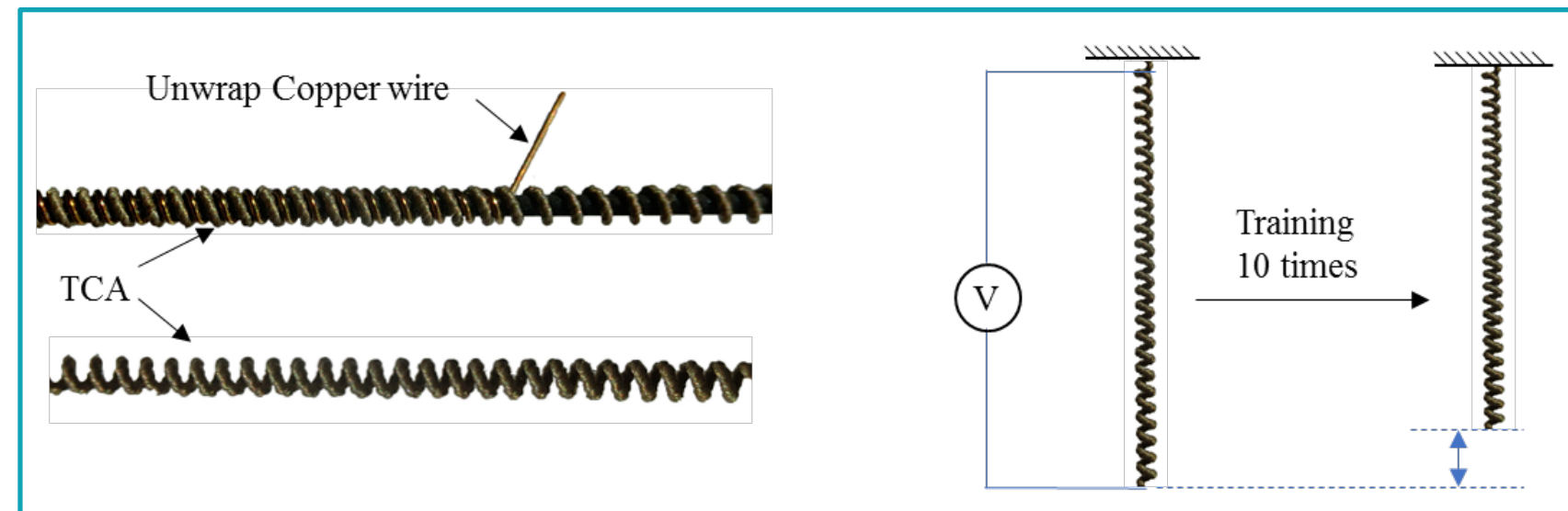
➔

+
=

Fabrication of TCAs Enabling Soft Robots



▪ Fabrication



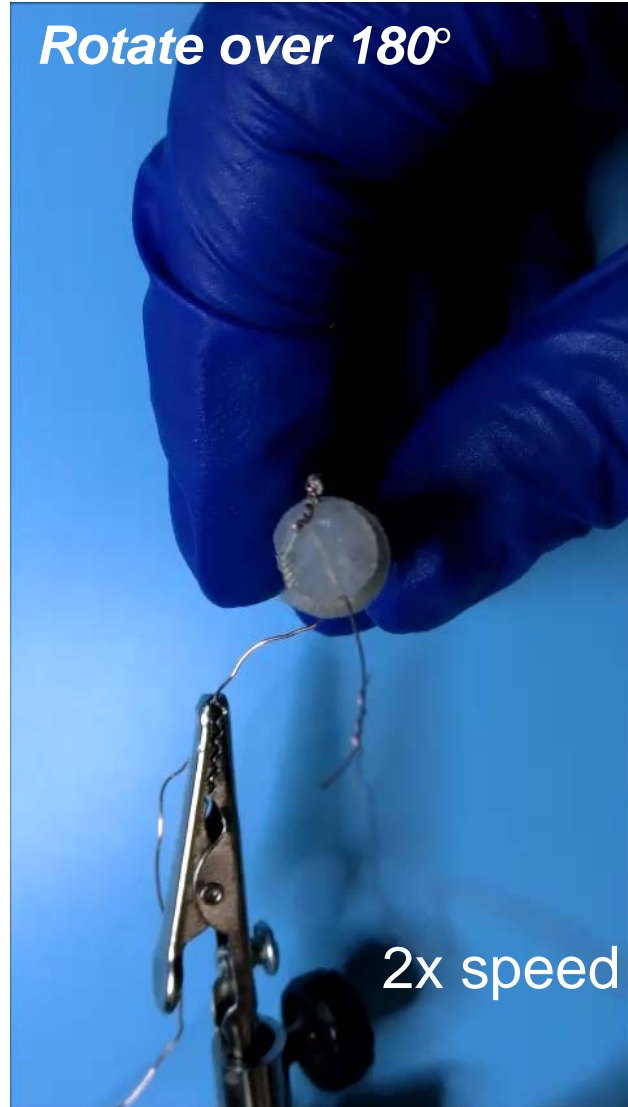
▪ Advantages

1. Faster
2. Larger stroke

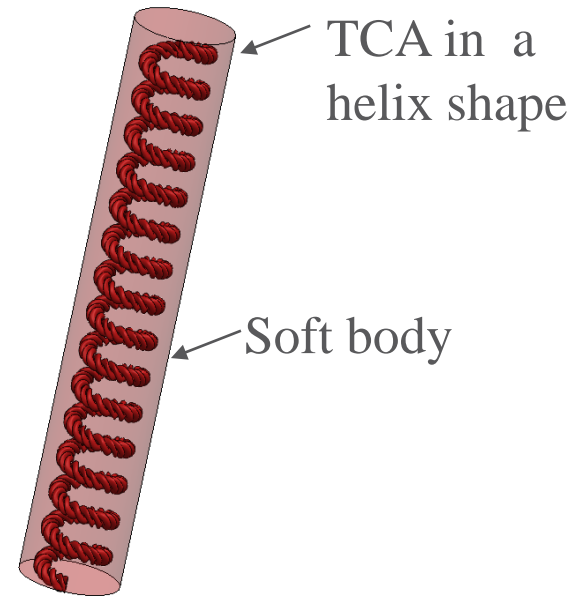


Lift up 20 g in 50 mm/s, current 1.8A

Programmed Motion - twisting

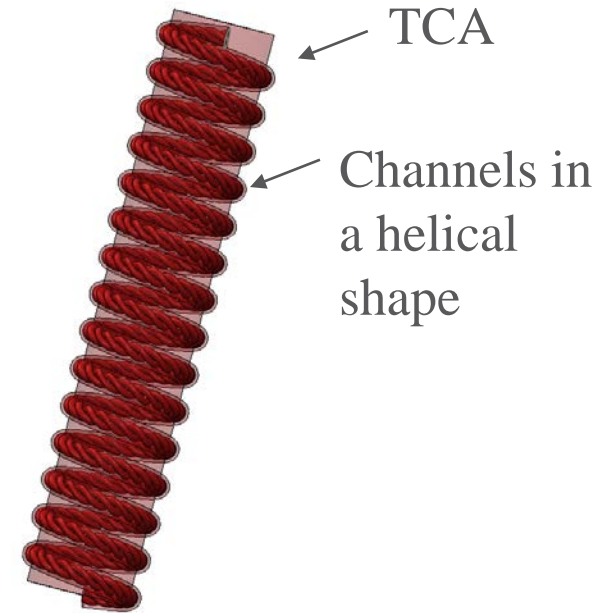


- Embedded



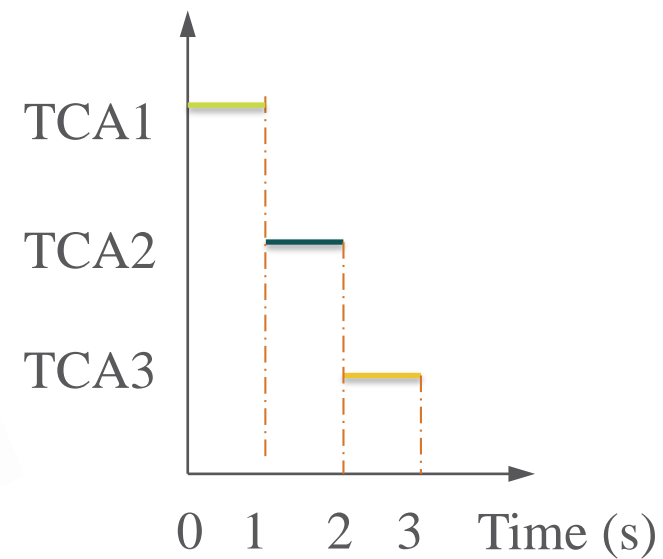
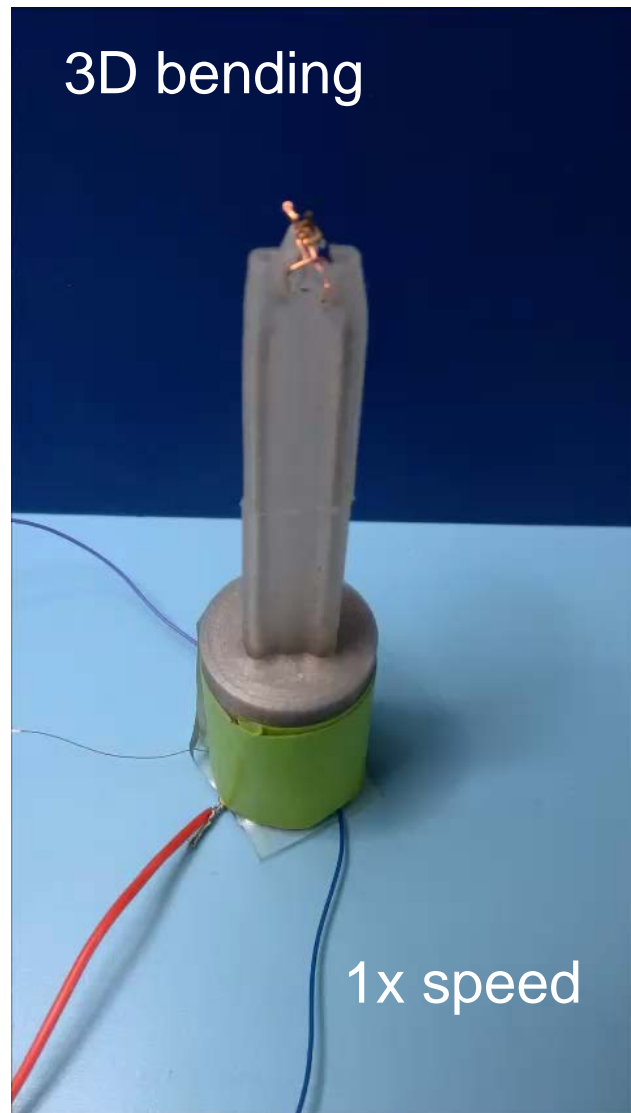
- ✓ Less deformation
- ✓ Reliable
- ✓ Regular shape

- Appended



- ✓ Larger deformation
- ✓ Faster response
- ✓ Complex fabrication

Programmed Motion – 3D Bending

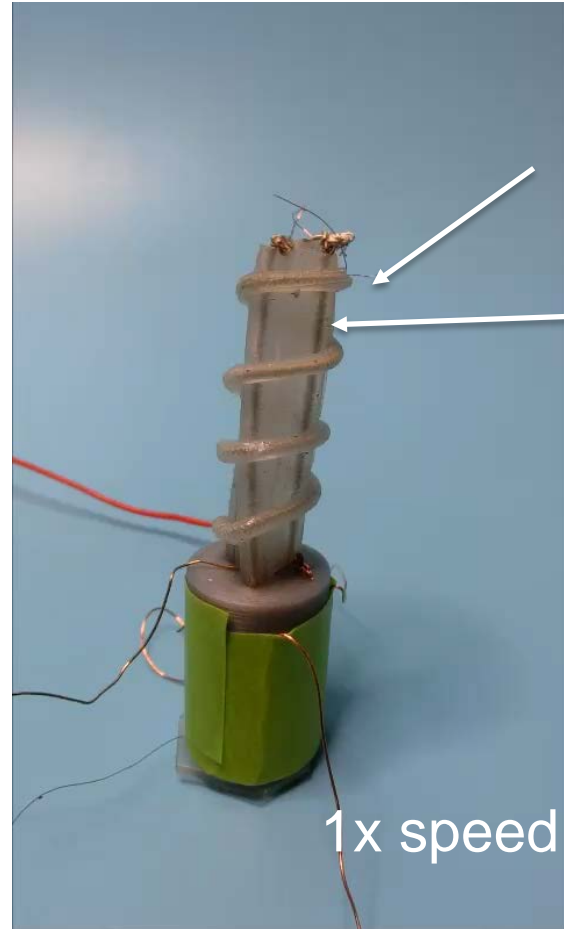


1 actuation sequence

Parameter	Value
Current	0.85 A
Power	4.5 W
Surface Temperature	56 °C
Bending Angle	90°
Actuation Time	1 sec

Programmed Motion - Combinations

- Twisting and bending in the same body

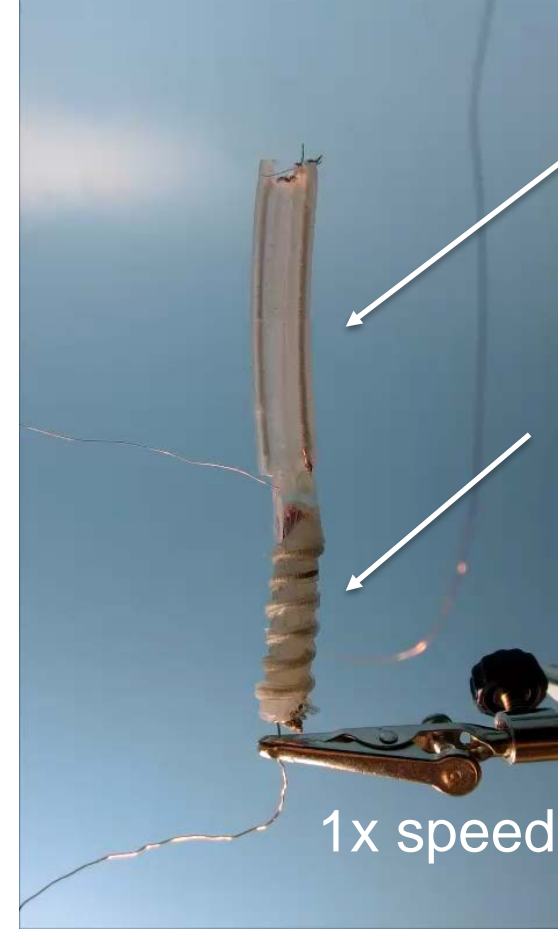


TCA in a
helix shape

3D bending
manipulator

- ✓ Compact size
- ✓ Modular design

- Twisting and bending in different bodies



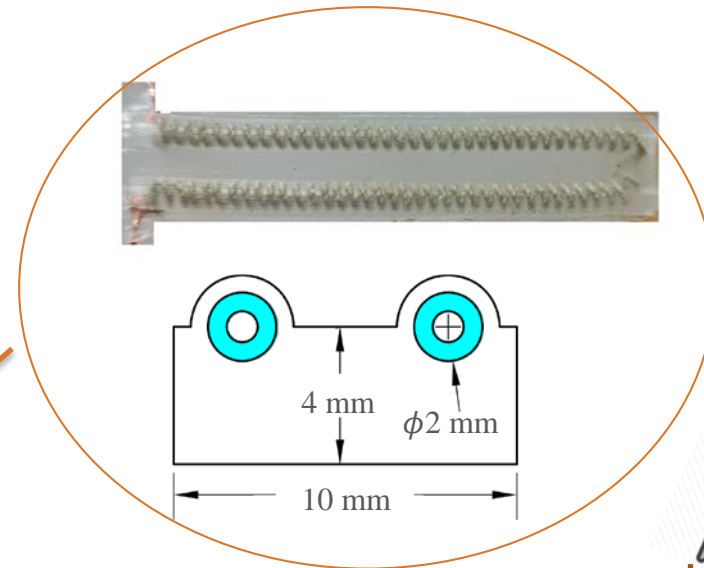
3D bending
manipulator

Twisting
manipulator

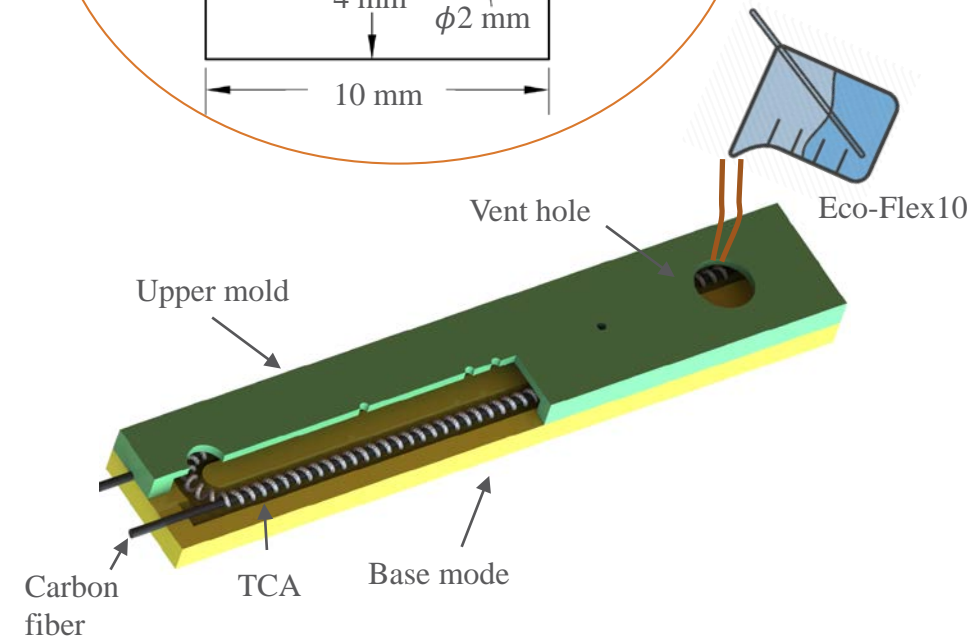
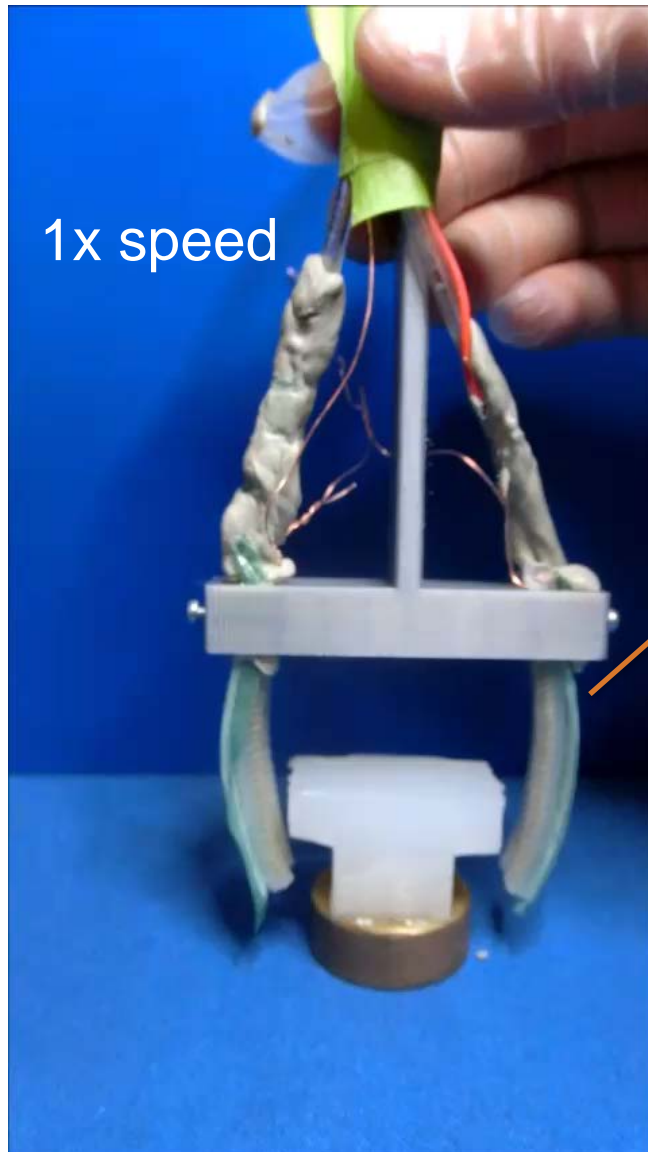
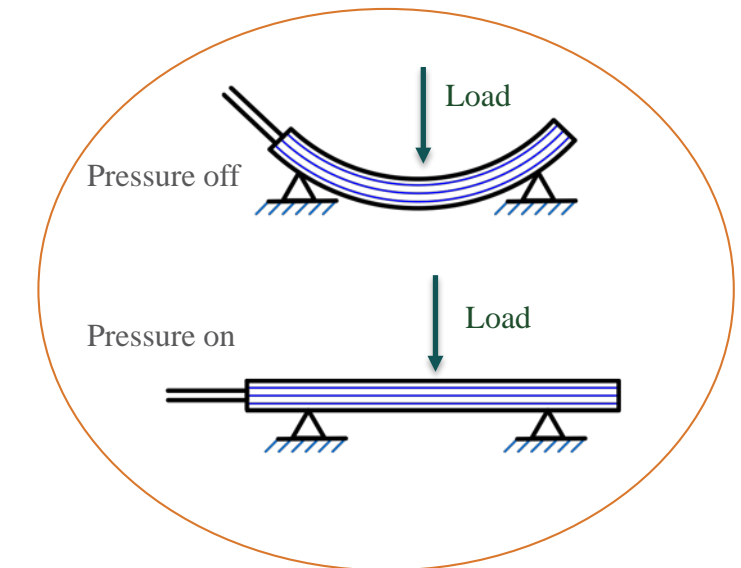
- ✓ Various motion
- ✓ Modular design

Application: Shape Morphing Gripper

- Bending manipulator



- Variable Stiffness Structure



Conclusion

- TCA: enables better soft robots, faster and larger stroke.
- Soft robots: twisting, bending and combination of motions.
- Application: 3D Shape Morphing, potentially reach any 3D shapes/configurations.



Thank You!

Q&A