Soft Strain Sensor for Human Motion Measurement

Cindy Furukawa, Mechanical Engineering
Mentor: Jiefeng Sun, Assistant Professor
School for Engineering of Matter, Transport and Energy

Research Question

How can we fabricate stretchable soft strain sensors to enable accurate measurement in a large stretchable range and dynamic motion?

Background

Wearable soft strain sensors

- Designed to be flexible and stretchable to detect strain (use of Eco-Flex 00-50 silicon)

Eutectic gallium-indium (EGaIn)

- Conductive liquid metal used to embed into wearable soft sensors

Challenges

- Ensure even distribution of LM into the channel
- Ensure proper adhesion of silicon layers without collapsing silicon channels

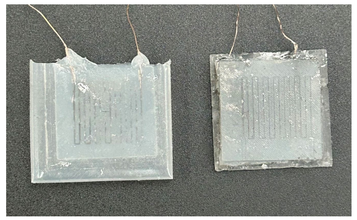

Fig 1: Channel has air pockets (Left), Channel cannot be filled all the way (Right)

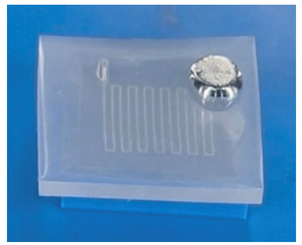

Fig 2: Filling liquid metal in channel via vacuum chamber

Design and Fabrication

- Channel dimensions: 0.2 mm (W) x 0.6 mm (H)
- Three sets of channels were created to ensure the entire channel could be filled with liquid metal

Syringe Method

- Created silicon mold with two inlets - one opening is used to inject liquid metal, one to remove the inside air
- This resulted in an uneven distribution of the liquid metal - air bubbles caused breakage

Vacuum Method

- Created a silicon mold with only one inlet and drop of liquid metal to cover inlet
- Mold was placed inside a vacuum chamber for about 30 minutes to pull out air bubbles within channel
- When pressure was released, chamber would return to atmospheric pressure and the liquid metal would fill channel

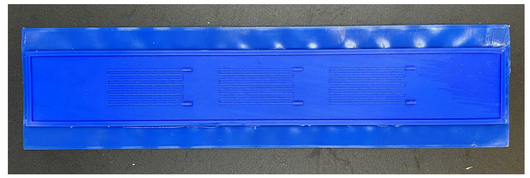

Fig 3: Final mold used to create silicon sensor

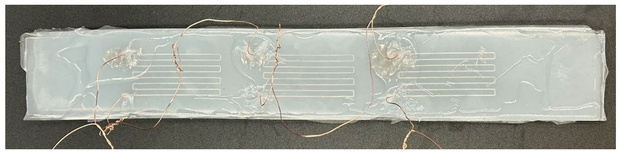

Fig 4: Silicon sensor with copper wire electrodes attached

Characterization and Results

- LCR Meter was used to measure the resistance values
- Instron Tensile Testing Machine simultaneously measured the displacement
- The three trial conducted show the similar pathway between resistance vs displacement
- The observed gauge factor was about 2.629 and was found using the equation $\frac{\Delta R}{R} = G \times \frac{\Delta L}{L}$

Fig 6: Silicon sensor tested on Instron machine (Left)

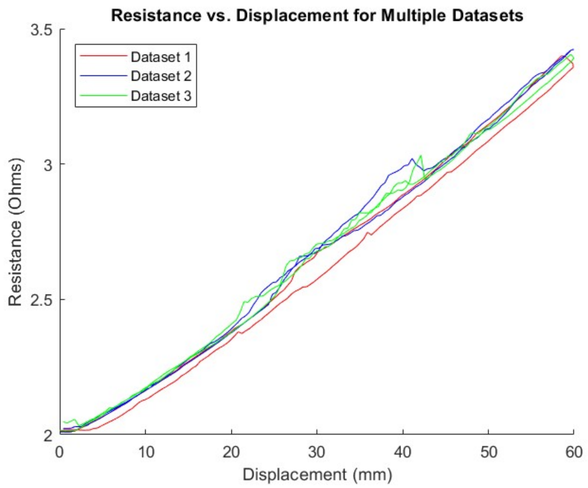

Fig 7: Resistance Readings synchronized at their respective displacement values (Right)

Acknowledgements

I would like to thank Professor Jiefeng Sun for his mentorship of this project. I would also like to thank Siva Busi and Rohan Khatavkar for their close support in making this project possible.

FURI

Robotic Acuators & Dynamics Lab

Ira A. Fulton Schools of Engineering
Arizona State University