3D Manufacturing of a Liquid Metal Microchannel for Soft Sensing and Actuation

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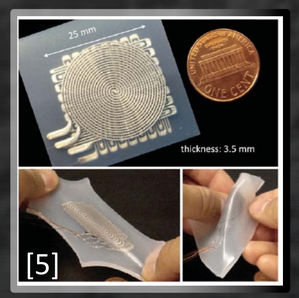
Background

- Soft smart materials with embedded liquid metal microchannels for sensing and actuation in wearable robots, exoskeletons, humanoids, and haptic devices.
- Existing methods for 2D patterns: Direct injection[1], microcontact printing[2], and direct writing[3].



Objective

To develop an automated and reliable manufacturing process to fabricate a 3D liquid metal (e.g. eGaIn) microchannels to be used in soft sensors and actuators.

Theory

Length of a microchannel used to derive necessary parameters to control setup

$$l = \sqrt{(\pi DLa)^2 + L^2}$$

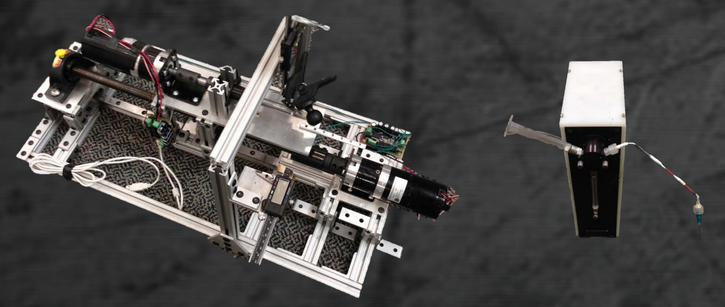
$L = axial\ length$

$a = {}^{coils}/_{unit\ length}$

$D = diameter\ of\ helix$

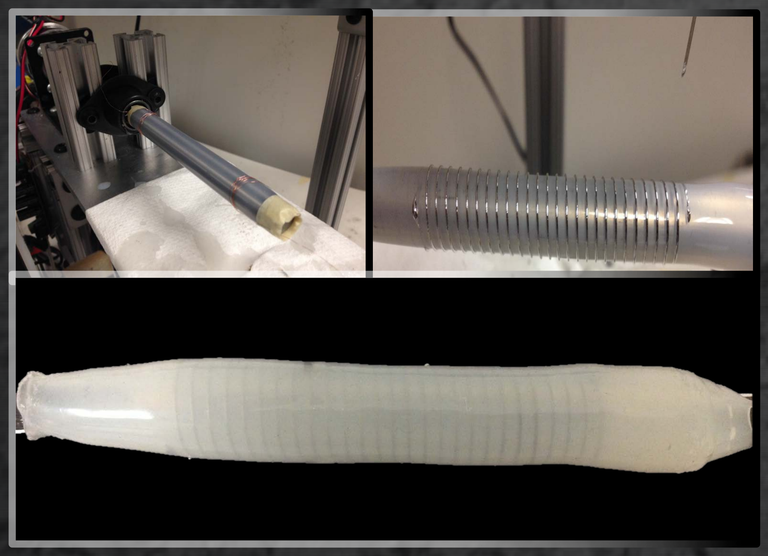
Manufacturing Setup

- Structure: 80/20 rods and ¼” aluminum plates
- Vernier calipers used as digital readouts for smoothing tool and needle position system
- Integrated with programmable Versa Pump 6 5500 Series



Manufacturing Process

A)Substrate ➔ B) EGaIn ➔ C) Substrate



Testing

Resistance increase with axial elongation

Resistance increase with radial inflation

Future Work

- Shape protection mechanism of completed EGaIn patterns
- Fine tuning of positioning parameters
- Decoupling of length and radial expansion sensing
- Multilayered patterns

References

[1] Park, Wood et al., *J.Micromech. Microeng.*, 2010
[2] Tabatabai, Majidi et al., *Langmir*, 2013
[3] Boley, Kramer et al., *Adb. Funct. Mater.*, 2014
[4] Park, Wood et al., *Bioinspiration & Biomimetics*, 2014
[5] Park, Chen et al., *IEEE Sens. J.*, 2012