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Reconfiguring and Actuating Liquid Metals, Gels, and Polymers

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This talk will describe efforts in our research group to control the shape and function of soft materials (liquid metals, polymers and hydrogels) for applications that include reconfigurable electronics, soft robots, and self-folding origami. The research harnesses interfacial phenomena, micro fabrication, patterning, and thin films. The talk with discuss the underlying fundamental science that enables the following:

1. Shape reconfigurable liquid metal alloys based on gallium. The metal is a liquid at room-temperature with low-viscosity (water-like) and can be micromolded due to a thin, oxide skin that forms rapidly on its surface. The metal can be patterned in a number of ways including injection into microchannels or by direct-write 3D printing. Recently, we discovered that the oxide may be the best surfactant ever reported and can be removed or deposited using electrochemistry in electrolyte as a new method to control and reconfigure the shape of the metal.

2. Self-folding polymers sheets that change shape in response to light. These sheets are a form of shape memory polymers that are compatible with 2D patterning techniques including lithography, inkjet printing, and roll to roll processing. The appeal of this work is converting 2D patterns into 3D shapes in a hands free manner.

3. New methods for actuating hydrogels by patterning ions in these gels. This reversible process can imprint topography in the hydrogel using modest voltages, tune its local mechanical properties to create physically-reinforcing exoskeletons, and generate stresses sufficient to actuate or fold hydrogels over large distances within seconds.