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Case ID:M19-296P^
Published: 3/14/2020

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Thermally Responsive Shape-Morphing Hydrogel for Soft Robotic Actuation

Background

Adaptive materials—materials able to change their properties based on certain stimuli—can provide valuable modes of actuation for many applications. Development of these materials has derived much inspiration from muscle tissue, which is robust and adaptable owing to its inherent hierarchical structure, from molecules to proteins to tissues. However, this sophistication has limited the progression of muscle-mimicking technologies. Complex motions, such as creation of a traveling wave in bulk material, require highly orchestrated localized stresses and strains while keeping volume of material at a minimum. Responsive hydrogels have been a promising area of research due to their ability to change volume by altering applied temperature, pH, lighting, or electric field. Through these volume changes, caused by absorption and release of water, motion and force can be generated. Currently, the motion achievable with soft hydrogel-based actuators are programmed into their structure and cannot be changed after manufacturing. Since these designs are not hierarchical, their versatility as building blocks for larger systems is diminished.

Invention Description

Researchers at Arizona State University have developed an adaptive material consisting of soft voxels made of novel thermally responsive hydrogels that are electronically addressable via embedded resistive joule heaters. This strategic muscle-mimicking approach resembles biological tissue more closely than current designs, allowing for future integration into more complex structures and motions. By adjusting the chemical composition of the gel, faster thermal and mass diffusion is achieved, giving faster response to stimuli.

Potential Applications

- Military, aerospace, robotics, and medicine
  - Bioinspired soft actuators
  - Adaptive materials
  - Responsive digital materials

Benefits and Advantages

- Enables electronic excitation and control of hydrogel morphing, and thus compatibility with microcontrollers and embedded systems
- Faster response of actuation
- Hierarchical approach lends flexibility to the design of larger systems

Laboratory Homepage of Professor Daniel Aukes