

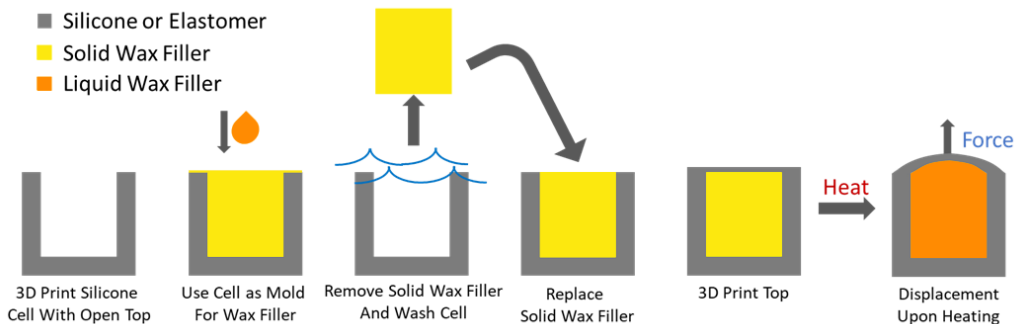
## 3D Printed Thermally-Activated Flexible Wax Actuators

### Invention Summary

This versatile method, based on 3D printing, allows for fast prototyping of thermally actuated flexible wax actuators.

### Technology Overview

Wax actuators convert thermal energy to mechanical energy as a wax substance within the actuator expands. In general they are used for applications requiring highly reliable, short stroke and high power density movements. We present a method for producing 3D printed wax actuators.



#### Inventors:

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#### Patents:

Provisional Filed

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#### Cornell Reference:

D6760

Our process (shown above) produces a sealed wax-filled cell, composed of a semi-rigid chamber and covered by a flexible elastomeric membrane. This device concentrates and focuses the force of the expanding wax in the desired direction.

By using 3D printing, as opposed to traditional manufacturing processes, the time required to make a prototype can be drastically reduced. This allows for rapid testing and iteration through potential designs-- without incurring the tooling costs associated with traditional manufacturing processes. While 3D printed actuators have been an area of active development, to-date only weak polymer actuators, small displacement piezoelectric actuators, and pneumatic actuators have been produced with 3D printers.

### Potential Applications

- Rapid prototyping of wax actuators
- Soft robotics
- Automation
- Microfluidics
- Soft electronics
- Valves and O-rings for aerospace applications
- Temperature regulation systems for greenhouses, appliances, HVAC and automotive applications
- Highly reliable short stroke and high power density applications

### Advantages

- Metal-free design usable in environments with high magnetic fields such as MRIs
- Allows a user to test a design for a new actuator at a significantly lower cost
- Soft structure can be integrated into soft-robotics
- 3D printing allows for many diverse material combinations and geometries

### Publications

- Lipton, Jeffrey I., et al. "[3D Printable Wax-Silicone Actuators](#)". *2014 Annual International Solid Freeform Fabrication Symposium, Austin, TX, August 2014.*