Using Small Molecule Absorbers To Create A Photothermal Wax Motor

Tech ID: 32723 / UC Case 2022-854-0

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	2023033258	10/19/2023	2022-854

FULL DESCRIPTION

Background

Phase change materials (PCMs) exhibit expansion upon melting. Wax motors are linear actuators that convert thermal energy to mechanical energy by exploiting the phase change behavior of wax-based PCMs that have high volumetric expansions (up to 20%). In all commercial devices the melting of wax is induced by electric heating. Photothermal heating of PCMs can also be used to generate expansion and mechanical actuation. In previous devices, photothermal actuation has relied on doping the wax with nanoparticles that absorb visible light. In these cases, the long-term stability of the wax-nanoparticle composites is compromised due to the phase separation and aggregation of nanoparticles out of the host wax.

Current Invention

Prof. Christopher Bardeen and his research team at UCR have developed a novel wax motor using small molecules that fit in the interstitial regions of the polycrystalline wax. They have identified highly soluble small molecule absorbers that can absorb light in the visible range and efficiently turn the absorbed photons into heat. The team identified three different small molecule absorbers and focused on guaiazulene (GAZ) since the GAZ absorption extends past 750 nm thereby opening up the possibility of infrared diodes as the photon source.

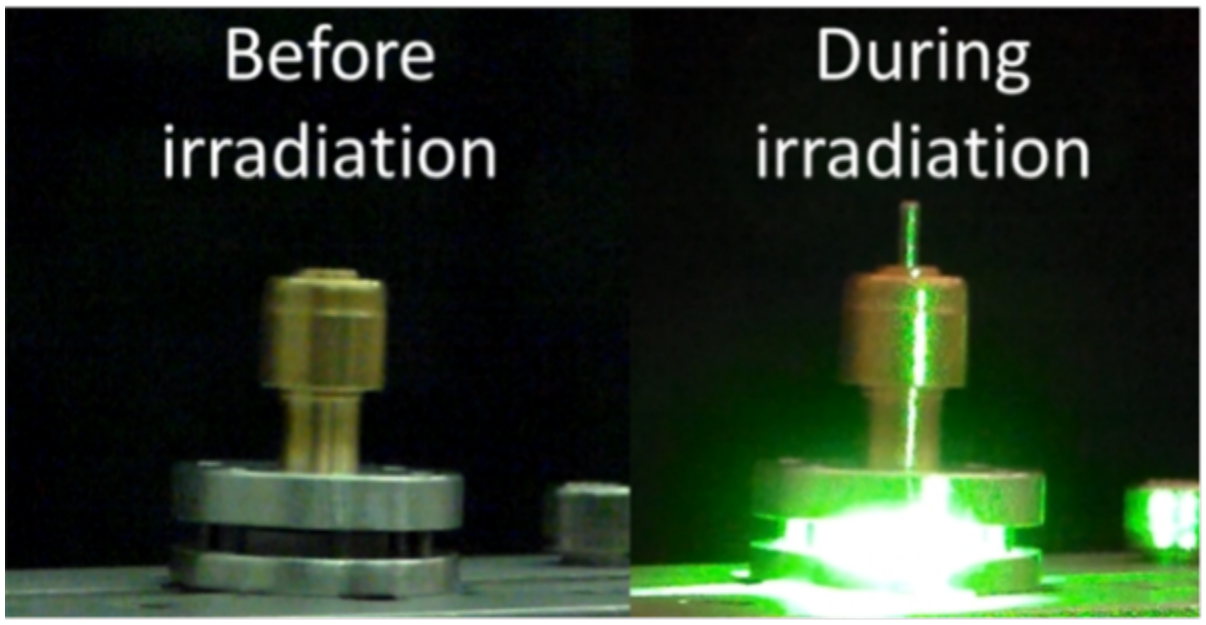

Image of the GAZ/Eicosane filled wax motor in the "off" (contracted piston) and "on" state (extended piston).

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OTHER INFORMATION

KEYWORDS

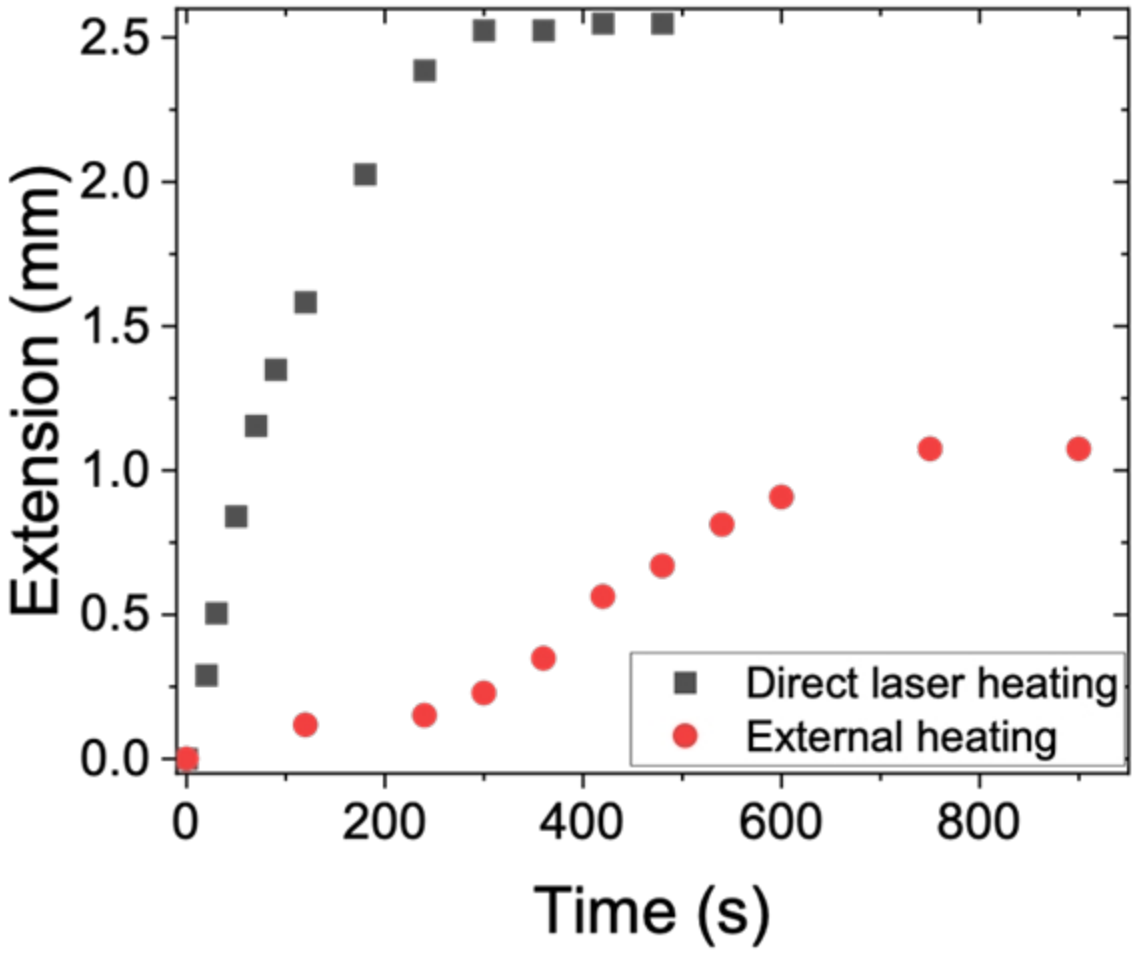
Actuators, Light powered actuators, Photothermal actuators, Photothermal agents, Small molecule, Wax actuator, Wax motor

CATEGORIZED AS

- **Engineering**
  - Engineering
- **Materials & Chemicals**
  - Chemicals
- **Transportation**
  - Aerospace
  - Automotive

RELATED CASES

2022-854-0



Graph comparing the temporal response and maximum extension due to heating of the wax by direct exposure to light versus resistive heating of the actuator body.

ADVANTAGES

The benefits of their GAZ/Eicosane composite material are:

- Doping of the small molecule absorbers does not change the wax melting temperature.
- The molecular absorption spectrum extends past 750 nm, allowing the use of low-cost diode and fiber-based light sources.
- The GAZ additive is low-cost and chemically stable, resulting in repeatable mechanical extensions.
- Selective laser heating of the PCM decreases the response time and excess heat generation because the entire device is not heated, as is the case for resistive heating.
- Serves as a platform technology that paves the way to make light powered wax motors.

SUGGESTED USES

For wax motors used in:

- Aerospace fluid controls
- Thermostatic mixing valves for HVAC
- Laundry washing machines and dishwashers
- Paraffin microactuators for MEMS

STATE OF DEVELOPMENT

Lab level prototype built and tested. The team is interested in collaborating with industry in further development of their technology.

INVENTIONS BY PROF. BARDEEN

Please see all inventions by Prof. Chris Bardeen and his team at UCR

RELATED MATERIALS

- Using small molecule absorbers to create a photothermal wax motor

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