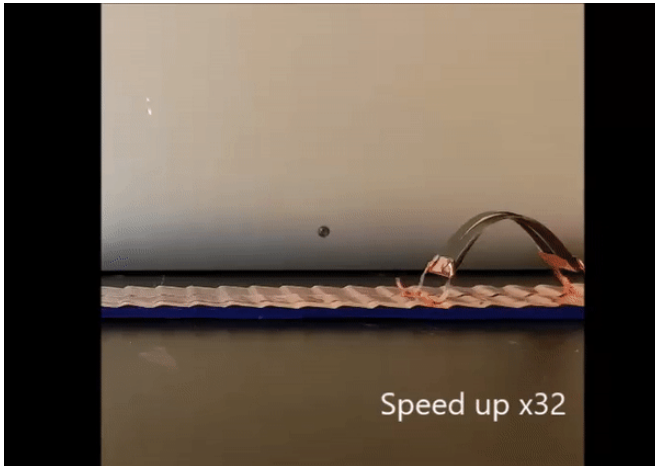


# Soft robot programmed to move like an inchworm

7 October 2019, by Liz Do



Credit: University of Toronto

Engineering researchers from the University of Toronto have created a miniature robot that can crawl with inchworm-like motion. The underlying technology could one day transform industries from aviation to smart wearables.

Professor Hani Naguib and his group specialize in smart materials. One line of their research focuses on electrothermal actuators (ETAs), devices made of specialized polymers that can be programmed to physically respond to electrical or thermal changes.

For example, an ETA could be programmed to mimic muscle reflexes, tensing up when cold and relaxing when hot.

Naguib and his team are applying this technology to the robotics field, creating 'soft' robots that can crawl and curl. They believe these could one day replace the bulky and metal-plated bots found in [manufacturing industries](#).

"Right now, the robots you'll find in industry are heavy, solid and caged off from workers on the

factory floor, because they pose safety hazards," explains Naguib.

"But the manufacturing industry is modernizing to meet demand. More and more, there's an emphasis on incorporating human-robot interactions," he adds. "Soft, adaptable robots can leverage that collaboration."

Although [responsive materials](#) have been studied for decades, the team has discovered a novel approach to programming them, resulting in the inchworm motion demonstrated in a paper recently published in *Scientific Reports*.

"Existing research documents the programming of ETAs from a flat resting state. The shape-programmability of a two-dimensional structure is limited, so the response is just a bending motion," explains Ph.D. student Yu-Chen (Gary) Sun, the paper's lead author.

By contrast, Sun and his co-authors created an ETA with a three-dimensional resting state.

They used a thermal-induced, stress-relaxation and curing method that opens far more possibilities in shape and movement.

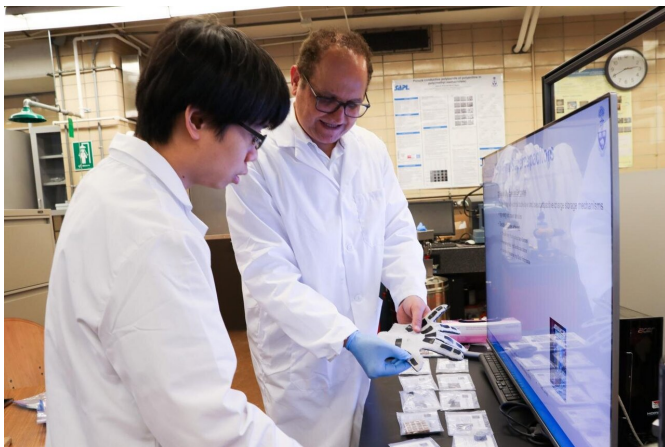
"What's also novel is the power required to induce the inchworm motion. Ours is more efficient than anything that has existed in research literature so far," says Sun.

Naguib says these programmable shape-shifting soft robots won't just revolutionize manufacturing industries: it could be useful in fields including security, aviation, surgery and wearable electronics.

"In situations where humans could be in danger—a gas leak or a fire—we could outfit a crawling robot with a sensor to measure the harmful environment," explains Naguib. "In aerospace, we could see

[smart materials](#) being the key to next-generation aircrafts with wings that morph."

[10.1038/s41598-019-47949-0](https://doi.org/10.1038/s41598-019-47949-0)



Provided by University of Toronto

PhD candidate Yu-Chen (Gary) Sun and Professor Hani Naguib are designing soft robots and wearable devices with smart materials that physically respond to electro-thermal changes in the environment. Credit: Liz Do

Though he points out it will be some time before the world sees morphed-wing aircrafts, the most immediate impact will be seen in wearable technology.

"We're working to apply this material to garments. These garments would compress or release based on body temperature, which could be therapeutic to athletes," says Naguib. The team is also studying whether smart garments could be beneficial for spinal cord injuries.

Over the next year, Naguib's team are focused on speeding up the responsive crawling motion, and looking at other configurations.

"In this case, we've trained it to move like a worm," he says. "But our innovative approach means we could train robots to mimic many movements—like the wings of a butterfly."

**More information:** Yu-Chen Sun et al, Shape programming of polymeric based electrothermal actuator (ETA) via artificially induced stress relaxation, *Scientific Reports* (2019). [DOI:](#)

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