Robotic crystals that walk n' roll

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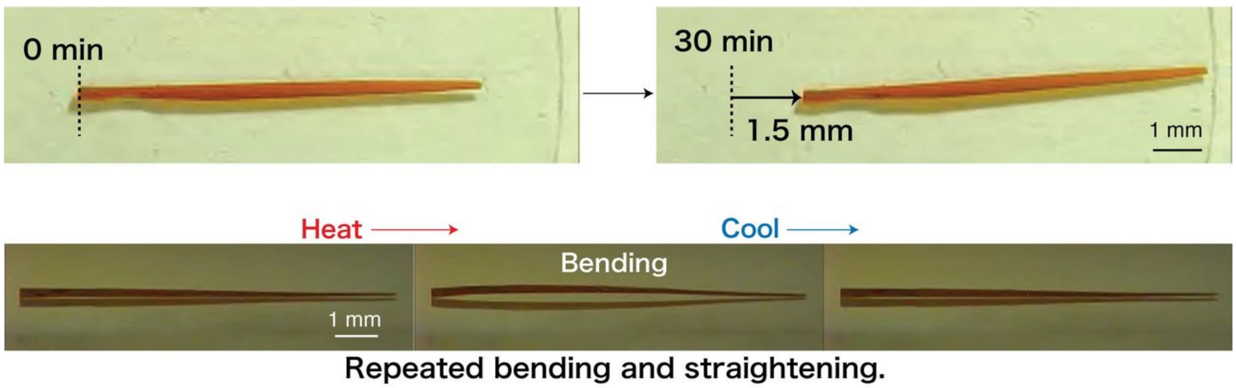


Inchworm-like walking. Credit: Waseda University

Scientists at Waseda University may have come a step closer to innovating soft robots to care for people. Its material, however, is something you may have never expected.

They have developed robotic crystals that walk slowly, inchworm-style, and roll 20,000 times faster than their walking speed. These autonomously moving, organic crystals have great potential as material for soft robots in the future, especially in the medical field.

"The crystals are flexible, durable and lightweight," says Hideko Koshima, a visiting professor at Waseda's Research Organization for Nano & Life Innovation. "They could possibly be used as material for microrobots which transport substances in the microscopic region, for instance, carrying egg cells for infertility treatment or conducting invasive surgery." Their study was published in *Nature Communications* on February 7, 2018.

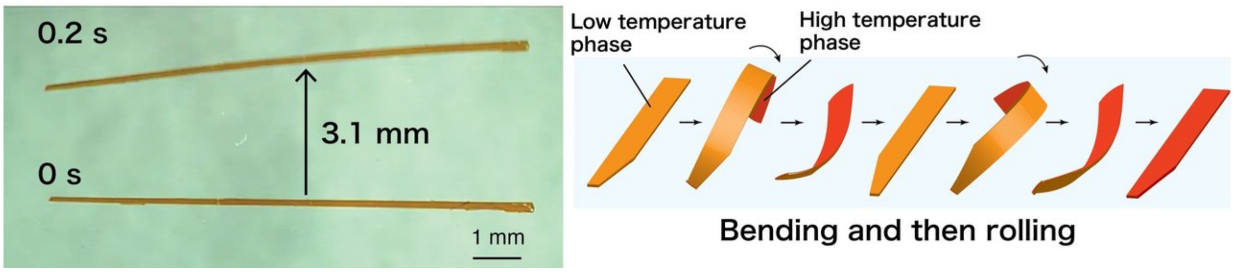
Crystals are expected to play an important role as locomotive material for soft robots with mechanical motion via bending and expansion/contraction. However, more variety in movements is sought.

Previously in 2016, Koshima's research group reported that chiral azobenzene crystals bend with exposure to light. During this investigation, the crystals were found to undergo phase transition at 145°C without fracturing, even after repeated heating and cooling. Based on these findings, they designed the robotic crystals demonstrating two modes of locomotion: walking and rolling.

Using an infrared thermography camera and a digital optical microscope, the group observed that thin, long plate-like crystals with thickness gradient in the longitudinal direction walked slowly like an inchworm through repeated bending and straightening under heating and cooling cycles near the transition temperature on a hot plate, moving 1.5mm in 30 minutes. On the other hand, thinner, longer plate-like crystals with width gradient rolled 3.1mm in 0.2 seconds, accelerated by tilted bending then flipping, under only one process of heating and cooling.

"The driving force behind the walking and rolling locomotion was generated from the unsymmetrical shape of the crystals," Koshima explains.

Although further study is required to control the direction and speed of the robotic crystals for practical applications, this finding opens a door to a new field of crystal robotics, and on a larger scale, brings us a step closer to addressing issues related to population aging.



Fast rolling locomotion. Credit: Waseda University

"Currently, robots are rigid and heavy, making them unsuitable for daily interaction with humans," points out Koshima. "Our crystals could be used as a new kind of material for soft robots with improved safety and comfort. As our society ages, we must consider the symbiotic relationship between humans and robots, since robots may look after people, including the elderly, in the near future." Koshima is now attempting to produce robotic crystals which undergo phase transition at a much lower temperature.

More information: Takuya Taniguchi et al, Walking and rolling of crystals induced thermally by phase transition, *Nature Communications* (2018). DOI: 10.1038/s41467-017-02549-2

Provided by Waseda University