Detection of methanol using a soft photonic crystal robot

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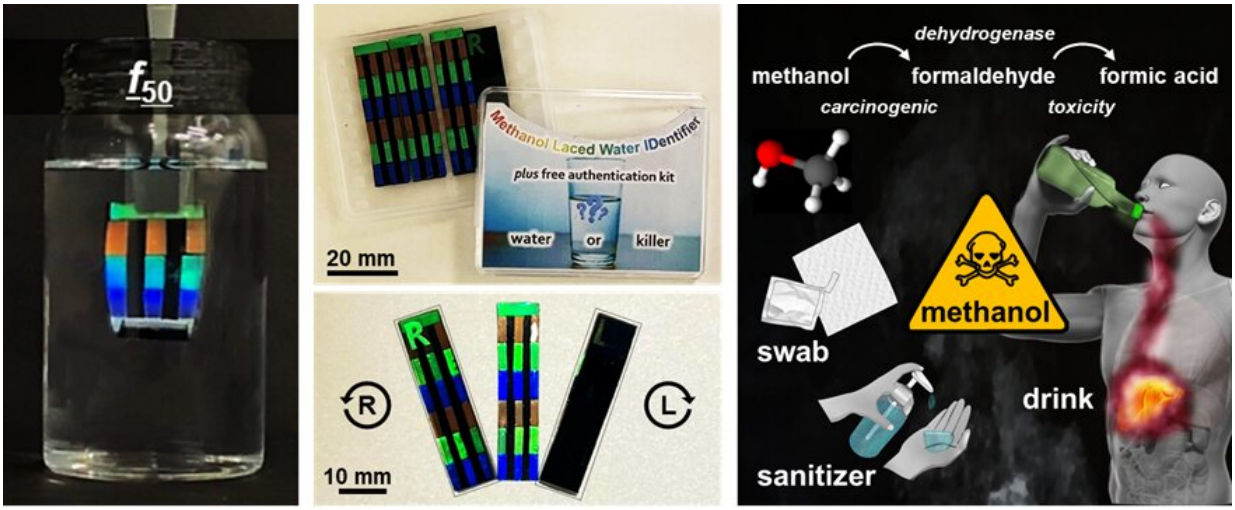
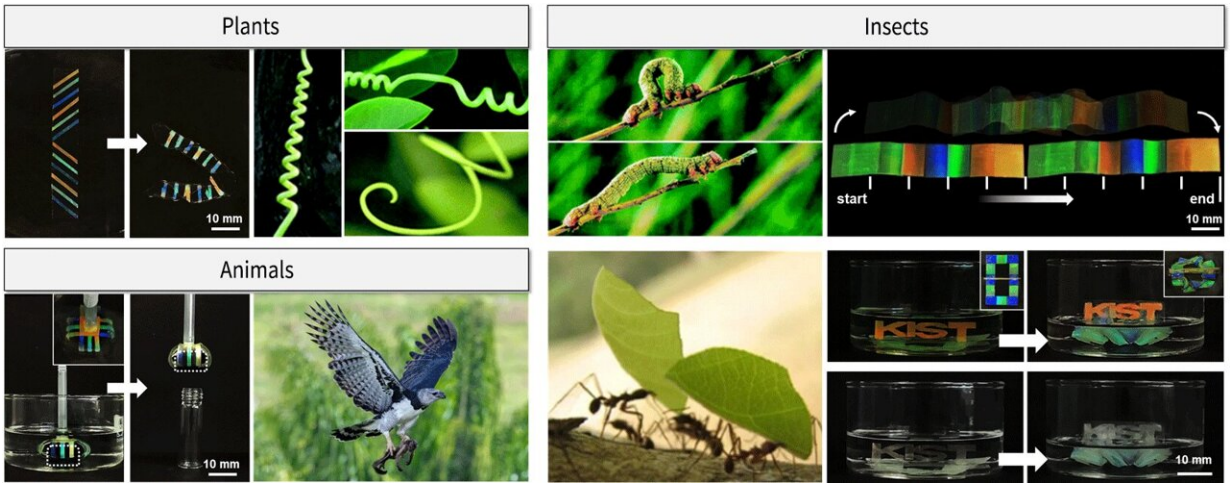


Development of the kit to detect methanol contamination in water. Credit: Korea Institute of Science and Technology

Robots are currently employed in industrial sites and fields, including disaster rescue, medicine, security, and national defense. Conventional metal-based robots exert strong operating power due to rigid body construction with joints connected to actuators such as motors. However, they may have difficulty with flexible movements and can cause harm during malfunctions. Recently, "soft robots" made of smooth and flexible materials have emerged, but they may be more difficult to control than metal-based robots.

A research team composed of Dr. Dae-Yoon Kim of the Functional Composite Materials Research Center, Dr. Seung-Yeol Jeon of the Carbon Composite Materials Research Center, and Prof. Kwang-Un Jeong of the Department of Polymer-Nano Science and Technology at Jeonbuk National University (JBNU) has succeeded in manufacturing a soft robot with a Janus structure and has developed a smart sensor for methanol detection. The work is published in the journal *Advanced Functional Materials*.

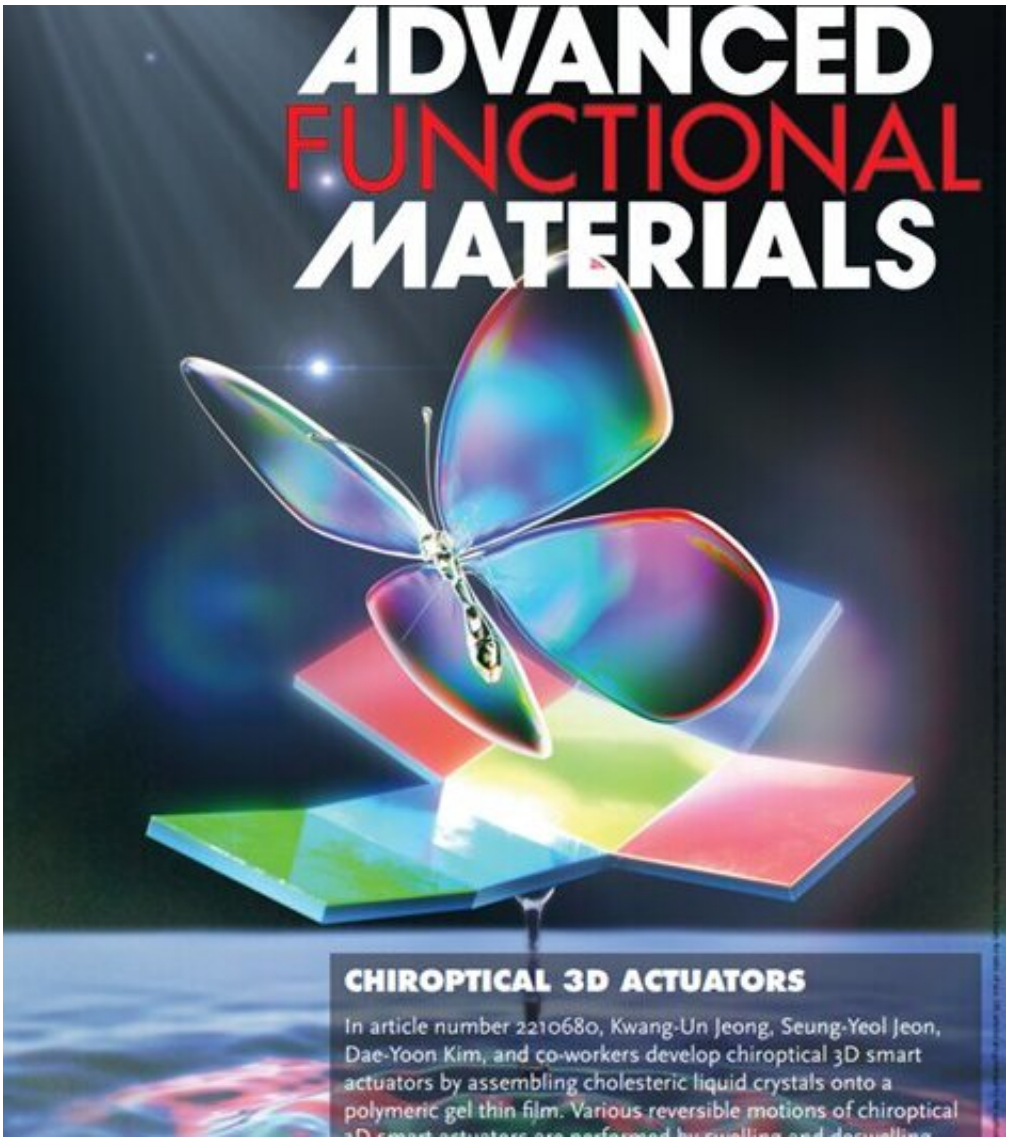


Realization of various motions of plants, insects and animals. Credit: Korea Institute of Science and Technology

Inspired by the free motions of mollusks such as the octopus, the research team adopted a method of allowing the movements of a soft robot to react spontaneously to the surrounding environment rather than controlling it with precise computing. By patterning two types of flexible polymer films with different expandability, the soft robot was allowed to move naturally in the desired direction according to the surrounding environment.

Its motions include bending, folding, and twisting. In addition, a helicoidal nanostructure found in insects such as butterflies was introduced into the soft robots, resulting in photonic crystal properties that selectively reflect the light of various colors. When the soft robot moves due to changes in the surrounding environment, the user can easily recognize this through color changes.

Excessive exposure to methanol causes headaches, vomiting, dizziness, and visual disturbances in humans and may be fatal. However, as methanol is more than 70% cheaper than ethanol, cases of misuse and abuse are increasing after COVID-19. The authors developed a sensor that can easily and quickly detect methanol contamination in water by applying the developed soft photonic crystal robot.



Credit: Korea Institute of Science and Technology

The methanol detection sensor using the soft photonic crystal robot is economical because it can be reused many times. The robot does not require electricity to operate, so it can easily detect methanol in water in any location. Additionally, the circular polarization properties from the helicoidal nanostructure of the soft robot are difficult to forge and alter, so they are very effective in securing product reliability.

Dr. Dae-Yoon Kim of KIST said, "This research has significance in implementing soft robots in everyday life. In the future, when multi-stimulus responsive materials capable of promptly and simultaneously responding to various external stimuli are developed, soft robots will be widely commercialized."

More information: Seung Hui Han et al, Chiroptical 3D Actuators for Smart Sensors, *Advanced Functional Materials* (2022). DOI: 10.1002/adfm.202210680

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