Scientists develop artificial muscle device that produces force 34 times its weight

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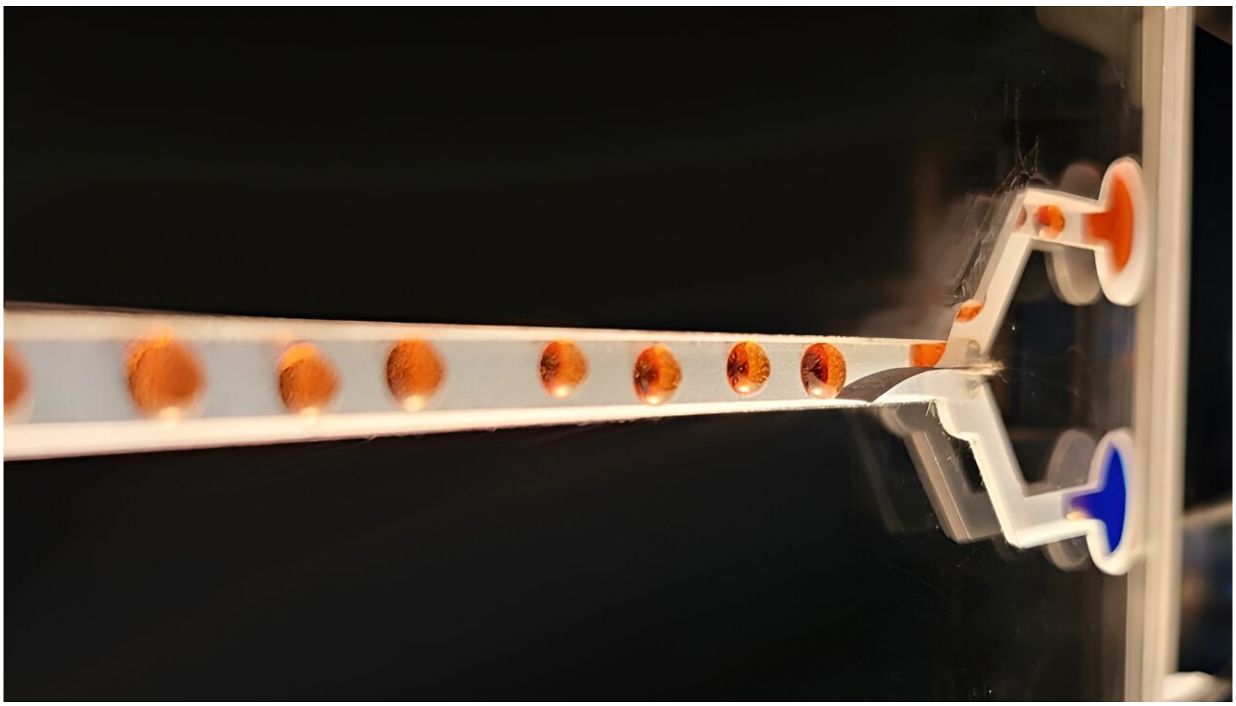


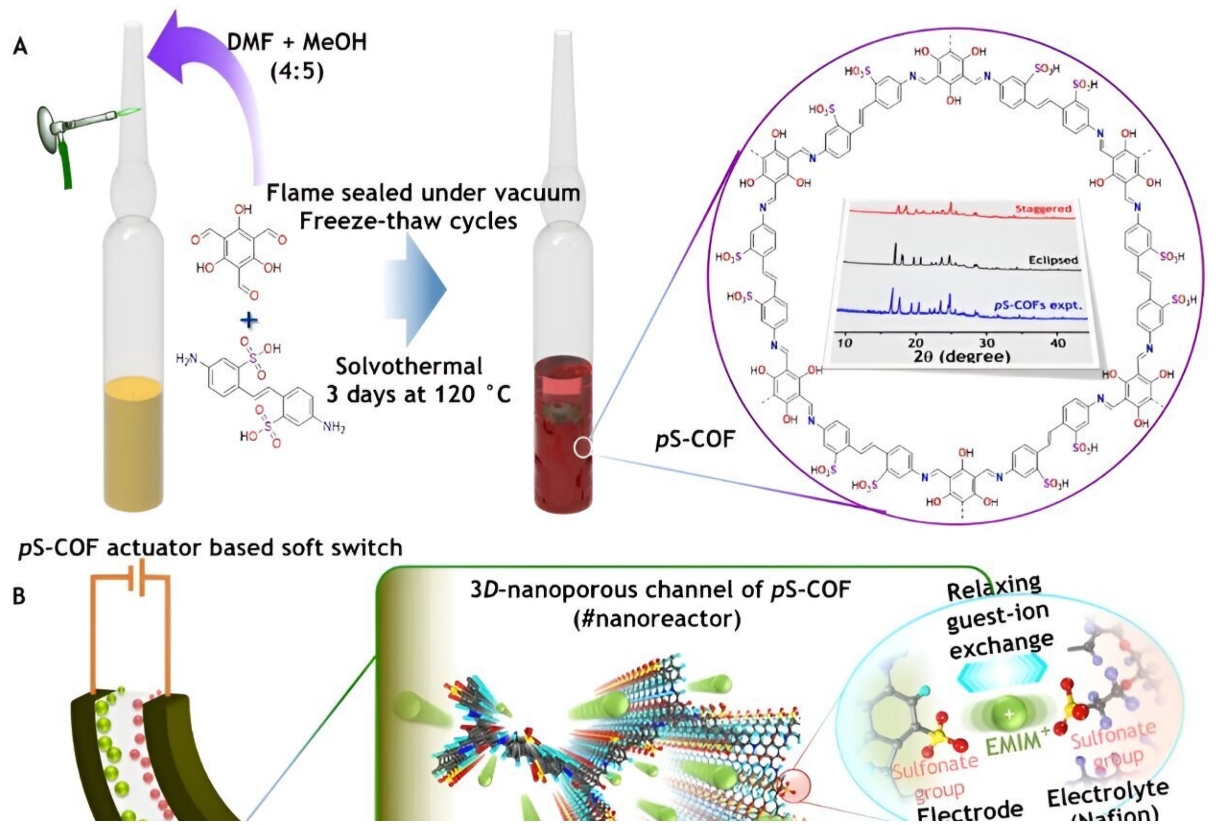
The separation of fluid droplets using a soft fluid switch at ultra-low voltage. Credit: *Science Advances* (2023). DOI: 10.1126/sciadv.adk9752

Researchers have developed a fluid switch using ionic polymer artificial muscles that operates at ultra-low power and produces a force 34 times greater than its weight. Fluid switches control fluid flow, causing the fluid to flow in a specific direction to invoke various movements.

A research team led by Professor Il-Kwon Oh from KAIST's Department of Mechanical Engineering has developed the soft fluidic switch that operates at ultra-low voltage and can be used in narrow spaces. The findings are published in the journal *Science Advances*.

Artificial muscles imitate human muscles and provide flexible and natural movements compared to traditional motors, making them one of the basic elements used in soft robots, medical devices, and wearable devices. These artificial muscles create movements in response to external stimuli such as electricity, air pressure, and temperature changes. For efficient operation, it is important to control these movements precisely.

Switches based on existing motors were difficult to use within limited spaces due to their rigidity and large size. To address these issues, the research team developed an electro-ionic soft actuator that can control fluid flow while producing large amounts of force, even in a narrow pipe, and used it as a soft fluidic switch.



The synthesis and use of pS-COF as a common electrode-electrolyte host for electroactive soft fluid switches. A) The synthesis schematic of pS-COF. B) The schematic diagram of the operating principle of the electrochemical soft switch. C) The schematic diagram of using a pS-COF-based electrochemical soft switch to control fluid flow in dynamic operation. Credit: *Science Advances* (2023). DOI: 10.1126/sciadv.adk9752

The ionic polymer artificial muscle developed by the research team is composed of metal electrodes and ionic polymers, and it generates force and movement in response to electricity. A polysulfonated covalent organic framework (pS-COF) made by combining organic molecules on the surface of the artificial muscle electrode was used to generate an impressive amount of force relative to its weight with ultra-low power (~0.01V).

As a result, the artificial muscle, which was manufactured to be as thin as a hair with a thickness of 180 µm, produced a force more than 34 times greater than its light weight of 10 mg to initiate smooth movement. Through this, the research team was able to precisely control the direction of fluid flow with low power.

Professor Il-Kwon Oh, who led this research, said, "The electrochemical soft fluidic switch that operates at ultra-low power can open up many possibilities in the fields of soft robots, soft electronics, and microfluidics based on fluid control. From smart fibers to biomedical devices, this technology has the potential to be immediately put to use in a variety of industrial settings as it can be easily applied to ultra-small electronic systems in our daily lives."

More information: Manmatha Mahato et al, Polysulfonated covalent organic framework as active electrode host for mobile cation guests in electrochemical soft actuator, *Science Advances* (2023). DOI: 10.1126/sciadv.adk9752

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