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Ananya Palivela

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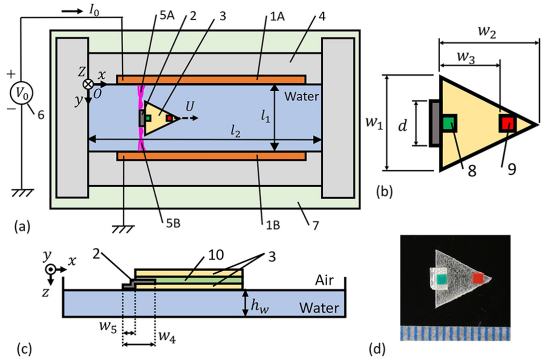
A gliding microrobot employs electric discharge to reach high velocities while moving freely in water.



Fast, untethered microswimmers are versatile water-based robots that can serve as microfluidic carriers, aid water treatment via electrical discharge, and facilitate mixing in rotary pumps. They can have applications in medical, agricultural, and industrial settings.

Inspired by two seemingly unrelated natural phenomena — the way a water strider uses its hydrophobic exterior to glide on the surface of a pond, and the explosive effect of lightning in water — Sugioka and Arai designed a water-resistant swimmer propelled by explosive boiling.

Explosive boiling relies on an electrical discharge to rapidly heat water, converting heat energy into large amounts of mechanical energy and providing a means of propulsion. However, microswimmers are too small to generate this electricity on their own, so the authors used a miniaturized antenna to receive the electricity from two nearby electrodes.

“We placed the discharge antenna at the back of the device, which induces an explosive boiling phenomenon selectively behind the device,” said author Hideyuki Sugioka. “This generates a wave that moves opposite the swimmer’s travel direction, propelling it forward and allowing the microrobot to glide untethered at a high speed.”

The research shows that the swimmer achieves a top speed of 14 cm/s on the water by utilizing high-voltage pulses between parallel electrodes in a shallow pool. They found that the swimmer moves slower in shallower water due to greater flow resistance.

“To overcome this problem, in the future we will install another discharge antenna at the bottom of the device to create a vapor layer and levitate the device, reducing the resistance,” said Sugioka.

The researchers intend to apply this technology to micro aerial vehicles and incorporate directional movement.

Source: “Rapid swimmer using explosive boiling due to electrical discharge in water,” by Hideyuki Sugioka and Yuki Arai, *Physics of Fluids* (2023). The article can be accessed at https://doi.org/10.1063/5.0164528.