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Injecting gas bubbles creates shortcut for plasma propagation FREE

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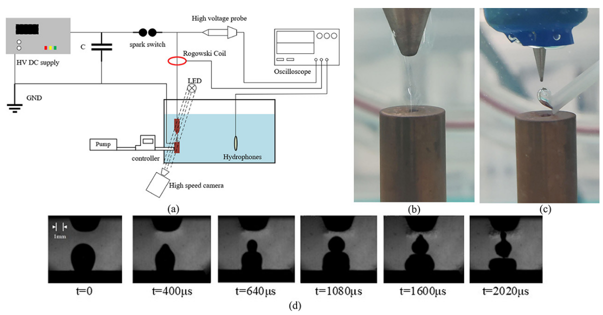
The bubbles facilitate and guide the development of underwater pulsed spark discharges by enhancing the electric field strength in their vicinity.



Alone, water cannot easily conduct electric current. But when a suitable pulsed voltage is applied to dielectric water using a pair of electrodes, charges will multiply due to ionization and propagate to bridge the electrodes as breakdown. This creates a plasma channel that looks like a spark and is thus called underwater pulsed spark discharge.

This process transports a huge amount of electrical energy into the water, causing intensive heating and various physical and chemical reactions, such as the emission of acoustic pressure waves and light. These resultant reactions are used in environmental decontamination, wastewater treatment, biomedical applications, and other processes.

However, the randomness of discharge propagation can result in extensive energy loss before breakdown. Guo et al. explored how injecting a gas bubble in between the electrodes can guide discharge propagation and reduce energy loss.

“Gas bubbles enhance the electric field strength in their vicinity. This will ‘attract’ the discharge during its development from the high voltage electrode towards the ground electrode,” said author Ying Sun. “In other words, the gas bubble acts as a shortcut for discharges.”

The team investigated different combinations of electrode spacing and voltage, with and without the gas bubble, as well as bubbles in different positions. They also examined the influence of the breakdown voltage and electrode spacing on the acoustic wave properties.

“The guiding effect of these bubbles on the discharge propagation path was clearly demonstrated and the fundamental mechanism was preliminarily studied based on electrodynamics,” said Sun.

In the future, they plan to study the influence of gas bubble size and composition and the deformation of the expanding plasma channel.

Source: “The guiding effect of artificially injected gas bubble on the underwater pulsed spark discharge and its electrical and acoustic parameters after breakdown,” by Xu Guo, Ying Sun, Chen-Lei Liu, Lin Jing, Yuan-Tao Zhang, Xiao-Long Wang, and Igor Timoshkin, *Physics of Plasmas* (2022). The article can be accessed at https://doi.org/10.1063/5.0122080.