Electro-sprayed micro-droplets help kill bacteria and viruses

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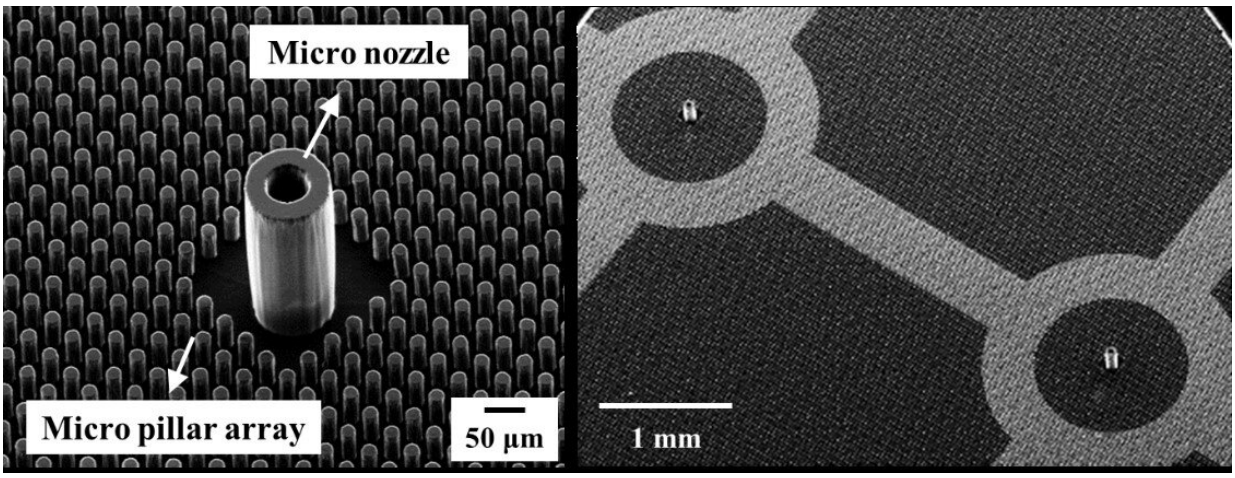

Figure 1. Polymer micro-nozzle array. Credit: The Korea Advanced Institute of Science and Technology (KAIST)

With COVID-19 raging around the globe, researchers are doubling down on methods for developing diverse antimicrobial technologies that could be effective in killing a virus, but harmless to humans and the environment.

A recent study by a KAIST research team will be one of the responses to such efforts. Professor Seung Seob Lee and Dr. Ji-hun Jeong from the Department of Mechanical Engineering developed a harmless air sterilization prototype featuring electro-sprayed water from a polymer

micro-nozzle array. This study is one of the projects being supported by the KAIST New Deal R&D Initiative in response to COVID-19. Their study was reported in Polymer.

The electro-sprayed microdroplets encapsulate reactive oxygen species such as hydroxyl radicals, superoxides that are known to have an antimicrobial function. The encapsulation prolongs the life of reactive oxygen species, which enable the droplets to perform their antimicrobial function effectively. Prior research has already proven the antimicrobial and encapsulation effects of electro-sprayed droplets.

Despite its potential for antimicrobial applications, electro-sprayed water generally operates under an electrical discharge condition, which can generate ozone. The inhalation of ozone is known to cause damage to the respiratory system of humans. Another technical barrier for electro-spraying is the low flow rate problem. Since electro-spraying exhibits the dependence of droplet size on the flow rate, there is a limit for the amount of water microdroplets a single nozzle can produce.

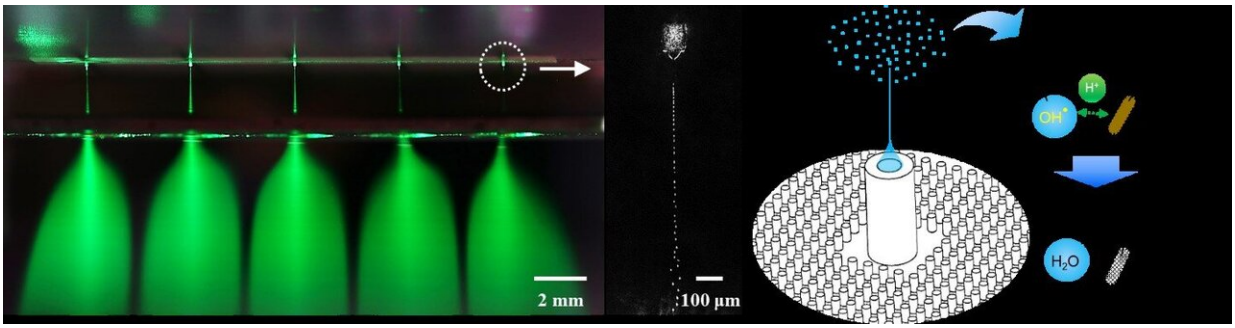

Figure 2. The multiplexed electrospray of water and antimicrobial effect. Credit: The Korea Advanced Institute of Science and Technology (KAIST)

With this in mind, the research team developed a dielectric polymer micro-nozzle array to perform the multiplexed electro-spraying of water without electrical discharge. The polymer micro-nozzle array was fabricated using the MEMS (Micro Electro-Mechanical System) process. According to the research team, the nozzle can carry five to 19 micro-nozzles depending on the required application.

The high aspect ratio of the micro-nozzle and an in-plane extractor were proposed to concentrate the electric field at the tip of the micro-nozzle, which prevents the electrical discharge caused by the high surface tension of water. A micro-pillar array with a hydrophobic coating around the micro-nozzle was also proposed to prevent the wetting of the micro-nozzle array.

The polymer micro-nozzle array performed in steady cone jet mode without electrical discharge as confirmed by high-speed imaging and nanosecond pulsed imaging. The water microdroplets were measured to be in the range of six to 10 μm and displayed an antimicrobial effect on Escherichia coli and Staphylococcus aureus.

Professor Lee said, "We believe that this research can be applied to air conditioning products in areas that require antimicrobial and humidifying functions."

More information: Ji-hun Jeong et al. Polymer micro-atomizer for water electrospray in the cone jet mode, *Polymer* (2020). DOI: 10.1016/j.polymer.2020.122405

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