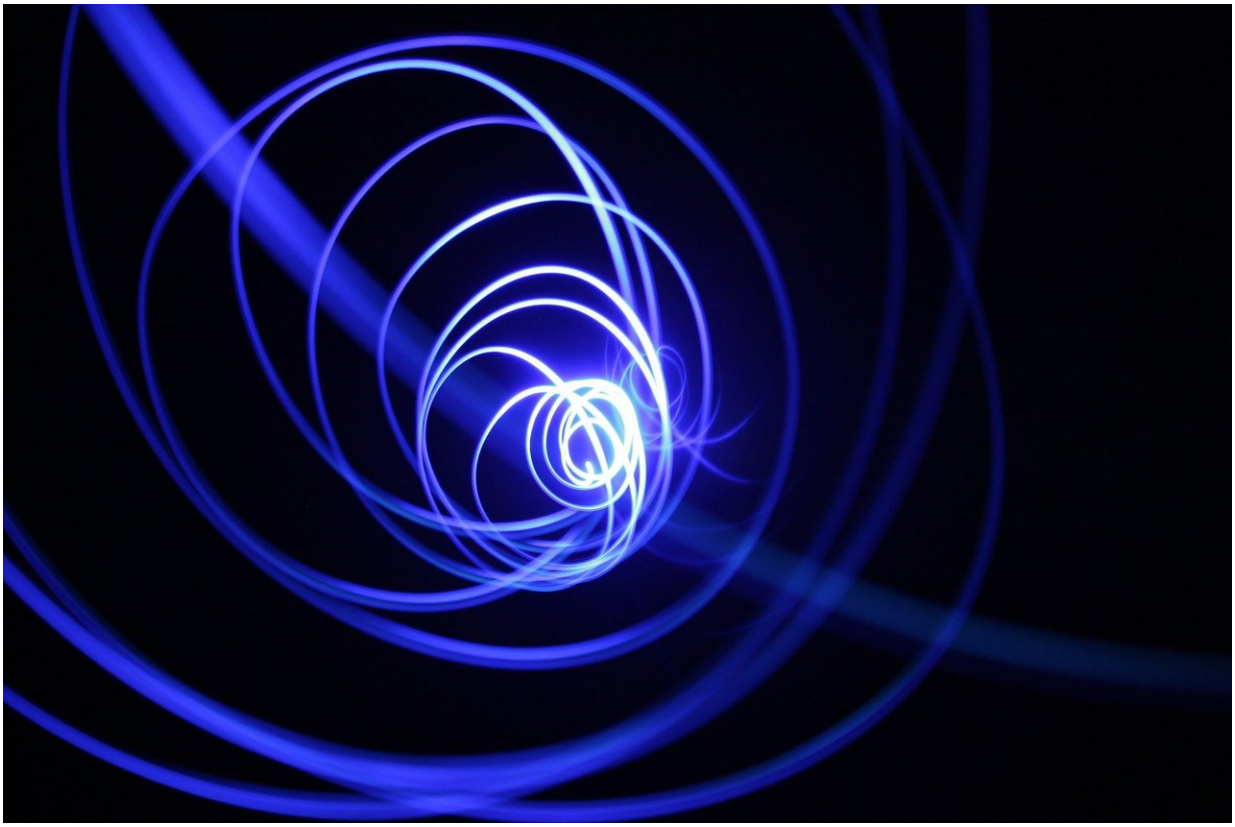
Fighting pandemics with plasma

October 7 2020



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Most types of personal protective equipment, like N95 masks, gowns, and gloves, are designed for single use, which has led to both scarcity and waste during the COVID-19 pandemic. But new research suggests these vital supplies can be safely disinfected and reused.

Scientists have long known that ionized gases called plasma, which are made up of charged molecules, can kill pathogenic bacteria, viruses, and some fungi.

"What was not known was whether or not PPE would work afterward," said physicist David Staack. "Would an N95 still function after it was treated with plasma?"

Staack and his colleagues at Texas A&M University set out to answer that question by generating room-temperature plasma in a 20-foot-long shipping container.

"The idea would be to load up the PPE into this trailer, close the door, and run the cycle," said Staack. "Kind of like a dishwasher." At the end, an exhaust system filters out the reactive oxygen species produced in the process before people can enter and retrieve the equipment.

According to preliminary data presented this week at the American Physical Society's Gaseous Electronics Conference, a 90-minute cycle in the decontamination chamber can kill 99.9% of microbes, including coronaviruses similar to SARS-CoV-2. The researchers tested three different types of N95 masks and found that two of them remained usable, even after being subjected to a sterilization dose of the low-temperature plasma.

These promising results were recently verified by the Centers for Disease Control and Prevention, bolstering the research team's confidence that plasma can not only sterilize N95 masks but also keep them safe for reuse. Staack said they have shared the findings with the Food and Drug Administration for emergency use authorization, which would be required before the technology could be put to use at hospitals and other healthcare facilities.

Staack's group also detailed progress on sterilizing masks, gowns, and other types of PPE with various radiation doses from electron beams, which have long been used to kill microbes on medical devices. While the treatment effectively gets rid of germs, the experiments revealed that the high doses required for sterilization also degraded the masks and gowns—which means they couldn't be reworn.

Another group of researchers, led by Lorenzo Mangolini from the University of California, Riverside, presented an experimental, low-cost approach to sterilizing PPE. The scientists repurposed a plasma ball—the inexpensive toy that seems to produce lightning in a small glass sphere—to generate ozone, which is carried by a jet of compressed air through a facepiece respirator. In proof-of-concept experiments, this approach successfully killed pathogenic Escherichia coli, which, because of its sturdy cell walls, may be more difficult to eradicate than viral particles like those of SAR-CoV-2.

"We've shown that sterilization can be done in a very cost-effective manner," said Mangolini. "For this to work, you just need a compressed air line and a high-voltage power supply from a toy."

Joseph Schwan, a graduate student in Mangolini's lab, estimated that the discarded, single-use PPE during the pandemic likely generates thousands of tons of waste per day. He noted that plasma-based approaches to sterilization and recycling could reduce that number.

More information: apsgec20.onlineeventpro.events/

HIGHLIGHTED ABSTRACTS

Electron Beam Irradiation of Personal Protective Equipment (PPE)
Min Huang, Md Kamrul Hasan, Matt Pharr, David Staack & Suresh D. Pillai

POSTER 4:30 PM, Tuesday, October 6, 2020

Physical integrity analysis of Personal Protective Equipment (PPE) subjected to surface treatment by corona discharge generated Ozone
Md Abdullah Hil Baky, Min Huang, Shariful Islam Bhuiyan, Jamie Kraus, Howard Jemison & David Staack
LIVE 1:45 PM-2:00 PM, Wednesday, October 7, 2020

Development of an Ozone-based Treatment System for Reuse of Personal Protective Equipment (PPE)
John Lassalle, Md Abdullah Hil Baky, Min Huang, Kavita Rathore, Matthew Burnette & David Staack
POSTER 4:30 PM, Wednesday, October 7, 2020

DBD produced ozone in forced convection as a facemask sterilizer
Joseph Schwan, Troy Alva, Giorgio Nava, Carla Berrospe Rodriguez, Joshua Morgan, Justin Chartron & Lorenzo Mangolini
LIVE 1:15 PM-1:30 PM, Thursday, October 8, 2020

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