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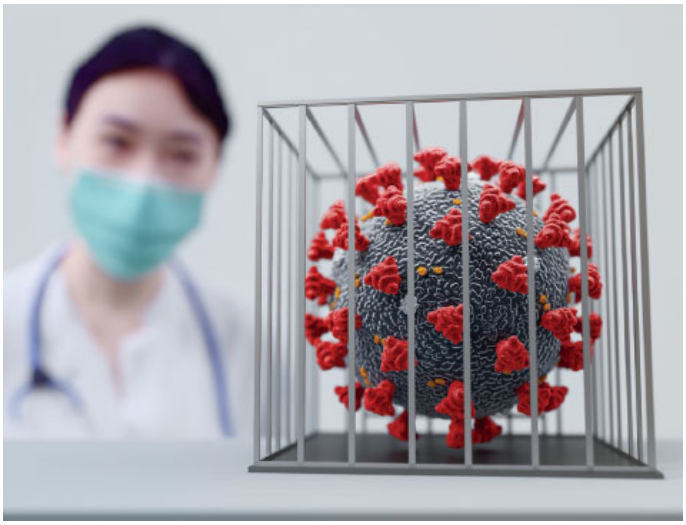
BIOBOARD

New Device Uses Light Tweezers to Trap and Move Viruses

This laser-powered invention could help vaccine development, further SARS-CoV-2 research and diagnosis, and usher in a new era of precision diagnostics.



A team of scientists led by Nanyang Technological University (NTU), Singapore has invented a laser-powered device that can trap and move viruses by manipulating light to act as "tweezers." By allowing scientists to precisely "move" a single virus to target a particular part of a cell, this technology is expected to help pioneer new approaches to disease diagnosis, and further virus research and vaccine development.

"The conventional method of analysing viruses today is to study a population of thousands or millions of viruses. We only know their average behaviour as an entire population. With our laser-based technology, single viruses could be studied individually," explained Associate Professor Eric Yap, from NTU's Lee Kong Chian School of Medicine, a medical geneticist who co-led the research. "As well as diagnosing diseases, our device could be used to spot the outliers – the rare individual virus that has the potential to evolve and create the next wave of an epidemic, for instance. This brings us into an era where we can contemplate precision diagnostics at the single virus level."

The invention, known as a digital virus manipulation chip, is estimated to be the size of a thumbnail, measuring 2 cm by 2 cm. The device consists of a chip that is made from a wafer of silicon oxide and silicon nitride, with nanometre-sized cavities to contain the trapped viruses. Above the chip is a laser directing highly focused light beams with the right amount of energy to act as a pair of "tweezers" that can isolate and move viruses.

Besides moving and trapping viruses, the scientists also revealed that the device can help them separate damaged or incomplete viruses from a group of thousands of other specimens in under one minute, compared to current processes which are tedious and lacking in precision.

"Our invention is a breakthrough in virus research as it allows us to single out individual specimens for study, while comparable technologies today can only handle viruses in large quantities," said Prof. Liu. "For example, we can isolate individual viruses with mutations to develop therapies against these variants. Our invention uses insulating materials that are biocompatible and do not heat up easily, unlike current sorting methods that generate a lot of heat. This means scientists

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SPOTLIGHT

should be confident in handling viruses with this device without affecting their properties and viability."

To test the digital virus manipulation chip, the scientists used adenoviruses, a group of common viruses that cause cold-like symptoms and measure 90 to 100 nm in diameter. While the chip has yet to be tested on coronaviruses, the scientists believe it holds potential to be used for research on the SARS-CoV-2 virus as it is similar in size, between 80 to 120 nanometres in diameter.

To operate the device, a fluid that contains viruses, such as blood, must be loaded into the chip. Then, a laser beam is directed onto it to form spots of light. Since the intensity of the light is highest at the centre of the spots, this creates a strong force that attracts and traps the virus in designated cavities on the chip. By shifting the locations of the spots of light, viruses can be freely moved to other parts of the chip, thereby allowing for the easy sorting and concentrating of viruses of different sizes, ranging from 40 nm to 300 nm.

"Our invention uses light to manipulate viruses in a certain size range and we have proven that it works with adenoviruses. We believe our device could also be used to trap and concentrate SARS-CoV-2 for research and diagnosis," noted Professor Liu Aiqun, from NTU's School of Electrical and Electronic Engineering, who led the research.

At present, the team is working on expanding the applications of their laser-powered device. For one, they are looking into how the device can direct the isolated viruses to infect a targeted part of a human cell, which if successful, would significantly advance virus research and improve the efficiency of vaccine and anti-viral drug development.

"Using this technology, we could hand-pick specific virus particles and study them to gain novel insights into them and the diseases they cause. For example, it could open new channels for more detailed analysis of specific virus mutants, which could lead to new ways in characterising and countering these viral variants," said Associate Professor Yap.

Source: *Shi et al. (2021). Trapping and Detection of Single Viruses in an Optofluidic Chip. American Chemical Society (ACS) Sensors, 6(9), 3445–3450.*

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