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Device uses 'light tweezers' to trap and move viruses (w/video)

(*Nanowerk News*) A team of scientists led by Nanyang Technological University, Singapore (NTU Singapore) has created a laser-powered device that can trap and move viruses using light.

The device, which has the ability to manipulate light to act as 'tweezers', would aid in the development of new approaches to disease diagnosis and the study of viruses, as the device can precisely 'move' a single virus to target a particular part of a cell.

It would also aid in vaccine development, as the device allows scientists to 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, said the scientists.

Associate Professor Eric Yap, from NTU's Lee Kong Chian School of Medicine, a medical geneticist who co-led the research, said: "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.

"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 researchers tested their device known as a digital virus manipulation chip on adenoviruses, which is a group of common viruses that can cause cold-like symptoms, measuring 90 to 100 nanometre (nm) in diameter. Although not yet tested on coronaviruses, it has the potential to be used for research on SARS-CoV-2 virus, which causes COVID-19, as it is similar in size, between 80 to 120 nm in diameter.

Professor Liu Aiqun, from NTU's School of Electrical and Electronic Engineering, who led the research, said: "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."

The findings of the study were published in the peer-reviewed scientific journal *ACS Sensors* ("[Digital virus manipulation chip with a large array of all-dielectric nanocavities](#)").

Researchers from Hong Kong Polytechnic University, the University of Hong Kong, the Hong Kong University of Science and Technology, the Agency for Science, Technology and Research (A*STAR), University of Technology Sydney and the Australian National University, were also involved in the study.

The 'light' way to manipulating viruses with great precision

Measuring 2 cm by 2 cm, about the size of a thumbnail, 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.

The device works by loading a fluid that contains viruses, such as blood, into the chip. After which, a laser beam is directed on to it, forming spots of light. As the intensity of the light is highest in 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. This allows for the easy sorting and concentrating of viruses of different sizes, ranging from 40 nm to 300 nm.

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

Assoc Prof Yap added: “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.

The scientists are working on expanding the usage of their laser-powered device.

For example, they are looking to study how the device can direct the isolated viruses to infect a targeted part of a human cell. The team said this would lead towards advances in virus research and improve the efficiency of vaccine and anti-viral drug development.