# Fighting Respiratory Virus Outbreaks Through 'Nano-Popcorn' Sensor-Based Rapid Detection

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Viral respiratory diseases are easily transmissible and can spread rapidly across the globe, causing significant damage. The ongoing COVID-19 pandemic is a testament to this. In the past too, other viruses have caused massive respiratory disease outbreaks: for example, a subtype of the influenza virus, the type A H1N1 virus, was responsible for the Spanish flu and the Swine flu outbreaks. Thus, to prevent such health crises in the future, timely and accurate diagnosis of these viruses is crucial. This is exactly what researchers from Korea have attempted to work toward, in their brand-new study.

For several decades now, polymerase chain reaction (PCR)-based assays have been the gold standard for detecting influenza viruses. And while these assays are highly sensitive, they can require expensive reagents and complicated protocols. A potentially better alternative can be "surface-enhanced Raman scattering" (SERS). SERS-based assays work by depositing a liquid sample onto a substrate material with a nanostructured noble metal surface.

Viral particles from the samples are detected when they hybridize with substrate-bound "aptamers," molecules that can bind to specific target molecules. This binding is visually detected as a change in "signal intensity," which decreases as viral load increases due to conformational changes on the substrate. However, a major drawback of these assays is the poor reproducibility of signals from heterogeneous hot junctions (electron-dense regions that contribute to signals).

In an attempt to overcome this challenge, the aforementioned researchers from Chung-Ang University and Korea Institute of Materials Science, led by Professor Jaebum Choo, designed a novel 3-D "nano-popcorn" plasmonic substrate. Speaking of the significance of their study published in Biosensors and Bioelectronics, Prof Choo says, "Infectious disease, caused by respiratory influenza, SARS, MERS, and SARS-2 viruses, can spread periodically and are a threat to global health. Our SERS-based aptasensor approach provides a new diagnostic platform for respiratory infectious diseases in the future."

In their design, the scientists coated two layers of gold particles on a polymer substrate using thermal evaporation sequentially. The two coats were separated by treatment with a compound called "perfluorodecanethiol: (PFDT). The energy difference between PFDT and gold layer was what caused the gold ions to diffuse to the surface, forming nanoparticles that appear as uniformly spaced "popcorns." This arrangement collectively strengthened the signal intensity that was produced, by generating multiple "hotspots" on the substrate.

The scientists then assessed the performance of the assay using different concentrations of the H1N1 virus. They successfully detected different viral loads in merely 20 minutes and from a minute volume of 3 μL (3 microliters: a 1000th part of 3 ml). Moreover, the system could also classify different strains of influenza viruses accurately and detected H1N1 viruses at a sensitivity three-fold higher than that of the routinely used ELISA tests. Not just this, the assay was found to be highly reproducible.

Pleased with the results, Prof. Choo states, "Our assay system enabled the ultrasensitive and reliable analysis of the influenza virus. Such a method would enable early-stage diagnosis, facilitate antiviral treatment initiation, and provide infection surveillance, particularly for those at high risk for virus-related complications."

In fact, the team is confident that their findings can, someday, be used to fight the current pandemic. Prof. Choo says, "We are currently developing a SERS-based aptasensor for the rapid diagnosis of the coronavirus from human respiratory samples. We are also developing a new diagnostic approach to differentiate between influenza A viruses and coronaviruses."

Hopefully, the new "nano-popcorn" assay can help to fight many major health crises in the future.

Read the original article on Nano Magazine.