Photonics Scientists Develop Laser-based Instant Saliva Test for Coronavirus

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European photonics scientists are developing an ultrasensitive laser sensor that detects coronavirus at the earliest point of infection from a saliva or nasal swab in minutes.

Responding to the European Commission's Express Calls to tackle the coronavirus pandemic, photonics scientists are developing a new rapid, non-invasive 'optical biosensor' demonstrator that will detect Covid-19 in humans as soon as it is present in the body.

Using photonics – technology that manipulates light – the ultrasensitive demonstrator could detect 'day 1' infections on patients who have a low viral load, representing a breakthrough in tackling the coronavirus pandemic.

With the ability to diagnose in real-time with high specificity from a low concentration sample, the sensor is much more reliable than the coronavirus rapid-test, 'finger-prick' kit which detects if a person has had the coronavirus before and has since recovered.

Looking at tiny molecules, the new point-of-care detector examines virus antigens using miniaturised chips – or 'nanophotonic biosensors' - from a simple nasal or saliva swab.

Once a sample is prepared and is in place, the device confirms a positive or negative for coronavirus instantaneously. However, allowing for preparation time and analysis, a result - from sample to diagnosis - may take up to 30 minutes.

Nanotechnology in Battle Against Coronavirus ...

Testing

Having already created six working laboratory demonstrators for other applications, the research team says the technology still needs further adaptation and testing but could be available in a year at the latest.

Calling themselves CONVAT and coordinated at 'ICN2' (the Catalan Institute of Nanoscience and Nanotechnology, Spain) the researchers have tested the demonstrators previously on patients' samples provided by Vall D´Hebrón Hospital in Barcelona and several other hospitals in Spain for other pathologies.

Project coordinator, Professor Laura Lechuga said: "With thousands of deaths worldwide, we are in urgent need of a rapid new testing kit that is accurate, highly sensitive, non-invasive and cheap to produce".

"We are currently integrating all the instrumentation in a portable 25x15x25 cm box with a tablet control. At present, our detector is user-friendly, with the preparation being only technical expertise required, and could be widely deployed for GPs or nurses to test patients. Our nanosensor is capable of detecting RNA strands which will fully identify the new coronavirus."

The bioreceptors on the sensor surface are specifically ‘tuned’ to a particular antigen of the virus, only the coronavirus molecules are captured along the sensor.

Unique Interferometric Technology

The detector works by looking at the 'binding' of the coronavirus molecules to the sensor surface - producing a new signal when the virus is present.

The CONVAT team use a Nano-Interferometric Biosensor, the most sensitive, label-free detection technology available in the world today- identifying at the molecular level.

Since the bioreceptors on the sensor surface are specifically tuned to a particular antigen of the virus, only the coronavirus molecules are captured along the sensor.

Light travelling in the sensor generates an evanescent field of few nanometres over the sensor surface. Here, receptors (like antibodies or DNA strands) can recognise the antigens of the virus capsid, when a respiratory fluid sample passes through.

This recognition event produces a change in the refractive index, causing the light to slightly change its direction of travel.

This change can be measured and determined precisely against a set of existing values – and could give an instant diagnosis for coronavirus expected at the picomolar to attomolar (pM–aM) range without any need amplification.

Professor Lechuga said: "Our patented interferometric technology is unique for biosensing. We use our "Bimodal Waveguide interferometer" which uses two modes of a light beam (at visible wavelength) travelling in a single waveguide.

"The light interacts with analytes during their travel and at the end of the bimodal waveguide, we record the interference between both light modes. The signal is collected with a photodetector and processed by electronics, all instantly in real-time."

Clean Detection

"Photonics is renowned for its rapid, stand-off, and clean detection capabilities, so it made perfect sense to develop a device that exploited light amid this terrible pandemic," said Professor Lechuga.

With thousands of new cases reported each day, COVID-19 is a novel coronavirus that had not previously been present in humans. While it is not known exactly how the virus is spreading from person to person, it is thought the outbreak – similar to the 2002 SARS coronavirus – may have spread via cough and sneeze droplets.

"Our nanophotonic POC biosensor can examine respiratory body fluids for rapid diagnostics

and screening. It looks directly at the human or animal reservoir samples without the need for PCR or other time-consuming treatments".

"In our previous work, we demonstrated sensitivities at the attomolar (aM) level for direct specific miRNA detection and 4 CFU/mL for whole pathogen detection.

"While our previous results are promising, our sensor will be further optimised and evaluated also for viral RNA analysis in a multiplexed format for more accurate diagnosis and identification of virus strains among different coronaviruses and other clinically relevant viruses," Professor Lechuga said.

Chair of the Photonics21 Healthcare Workgroup, Dr Jurgen Popp, said: "The CONVAT team are working round the clock to develop a rapid, non-invasive test for coronaviruses. The ability to spot this terrible virus quickly will contribute to the worldwide effort in fighting 2019-nCoV and highlights yet another success for photonics and light technologies.

Philippe Vannson, Head of the Photonics Unit, DG CONNECT, at the European Commission said: "Light-based technologies are providing tools and solutions to every industry in every region in the world. By creating Instant diagnosis of major diseases photonics is making healthcare fast, precise and cost-effective."

Existing Technology

The technology to be employed in the coronavirus detector was a pre-existing piece of apparatus developed by Dr Lechuga to examine different pathologies, like bacterial infections, or cancer biomarkers. However, in response to the 2019-nCoV pandemic, the researchers knew their technology could be modified to detect early, low viral load cases:

"My colleague, a researcher from the University of Barcelona, who has worked on the surveillance of Coronaviruses in animal reservoirs for many years, often suggested that we should work together on a project. So when we saw the Express Call for proposals, one of the

specific Coronavirus fighting calls – with a deadline of 30 Jan 2020, I telephoned him and said, now is the time to work together.

"In just eight days we worked more than 12 hours per day to put together a consortium of four partners, writing a successful proposal to the EC. It was approved and now I've been contacted by the Spanish Minister for Science and Innovation an invited onto TV and radio talk shows."

Funded by Horizon 2020, the European Commission's scientific research initiative, the scientists only began work on their detector at the start of March, in response to the pandemic.

Read the original article on Photonics21.