New light sensor to spot deadly bacteria in minutes

The risk of catching fatal Legionnaires' disease from air conditioning units can be dramatically reduced, thanks to a new biophotonic light sensor that spots Legionella bacteria 240 times quicker than methods used today.

Outbreaks of Legionnaire's Disease, a respiratory infection that can cause pneumonia, and in severe cases organ failure or septic shock, are more common than we might think. With anyone being susceptible, more than 100 cases are reported each week both in America and in Europe, with a fatality rate of around 10%.

Naturally occurring in freshwater lakes and rivers, the Legionella bacterium is harmless in small enough quantities, but problems start when it multiplies in plumbing systems, air conditioning units, Jacuzzis, decorative fountains or in a public water supply. Here it can be transmitted to humans when it condenses into droplets of fine mist which are inhaled and then settle in the lungs.

Roughly 5,000 cases are reported in the United States every year, while 2013 saw 5,851 cases reported by 28 EU Member States and Norway, according to the European Centre for Disease Prevention & Control (ECDC).

The European group POSEIDON, (or 'Plasmonic-based automated lab-on-chip sensor for the rapid in-situ detection of Legionella') intends to change all this, having developed their scanner to spot the deadly Legionella bacteria in under one hour, a process that normally takes 10 days of cultivation and analysis.

Equipped with tiny sensors, the device works by using the photonics technique of Surface Plasmon Resonance (SPR), a procedure that reads information from a refracted laser beam, allowing fast, highly sensitive, inexpensive detection from a small sample without the need for 'labelling', the process of binding to a protein in order to be detected.

SPR occurs when polarized beams of light hit a metal film at the interface of two media. A charge density oscillation of free electrons (or "surface plasmons") at the metal film occurs, reducing the intensity of reflected light. The scale of the reduction depends on the substance on the metal at the interface. Information then gathered from the refracted can then be analysed, and a pre-programmed pathogen confirmed, resulting in an unambiguous detection of the bacteria in situ.

"Detection and investigation of viruses, bacteria and eukaryotic cells is a rapidly growing field in SPR bio sensing, but the detection has only been achieved in laboratory settings. With our unique innovative SPR sensing architecture, POSEIDON provides reliable measurement readouts of legionella bacterial cells that are driven and entrapped on a custom sensing surface specifically designed with opportune positive and negative controls."

Surviving and flourishing at temperatures between 25º to 45º C, Legionella bacteria are normally prevented by heating water units above 70º C in order to kill them off. However new bacteria can form quickly, and not all of the pathogens are necessarily removed. The POSEIDON project aims to remove the uncertainty involved. Scientific coordinator, Roberto Pierobon explains:

"POSEIDON is a first for detecting Legionella with light and provides an inexpensive, user-friendly, state of the art early warning system on an air-conditioning unit. We aim to reduce the time involved in a diagnosis from 10 days to less than 1 hour. In order to prevent outbreaks at critical times of the year, we should be talking about a matter of minutes, rather than days."

“Cells remain intact throughout the whole fluid transportation system in the device, and do not adhere to the fluidic piping and microfluidic channels. Virtually all of the bacteria cells in the sample are delivered to the sensing unit, giving extremely high sensitivity and specificity,” said Pierobon.

Hoping to have these revolutionary new pathogen detectors ready within 3 years, Bruno Bellò, project coordinator and CEO of Clivet, is excited about the implications for the future,

“The exciting feature of this device is that with future development, it could be recalibrated to look for other pathogens, which would provide incredible safety options for the environmental, medical or food industries,” Bellò said.

Earlier last year the POSEIDON consortium received funding of € 4,068,781 from the Photonics Public Private Partnership, via the European Commission’s H2020 program for a three year research project. Coordinated in Italy, POSEIDON is comprised of a number of European partners, including Protolab, Clivet, A.R.C (Italy), Catlab (Spain), Metrohm Applikon (Netherlands), and Uppsala University (Sweden).

The POSEIDON consortium is set to run a Spring School in 2017 *Photonics for Health and Diagnostics Applications*, hosted in the Dolomites Mountains region, Northern Italy. With networking opportunities available, this international symposium aims to promote the new research of the project to the entire photonics community.

About POSEIDON

The POSEIDON project targets to change the approach in bacteriological environmental monitoring and in infection risk management by developing a fully automatic and reliable system. Handling of the air/water sample will be designed and integrated in preconditioning system and microfluidic device through which whole bacteria cells will be transported from the sampling module to the sensing plasmonic surface. The complete measure protocol will be integrated and performed according to EU legislation guidelines. Specificity will be ensured by immuno-functionalization of gratings surfaces and enhanced system sensitivity will be granted by the optimization of the optical detection system architecture. Sensors based on Grating Coupled Surface Plasmon Resonance (GC-SPR) in azimuthally rotating configuration have recently proved sensitivity enhancement up to almost two orders of magnitude. Furthermore, the symmetry breaking related to grating rotation allows exploiting the incident polarization, more easily controlled with respect to incidence wavelength and angles interrogation. The prototype will be designed to be integrated in water distribution or HVAC systems in order to demonstrate its feasibility in industrially relevant fields and to open new applications and new market opportunities. POSEIDON project aims to address new solutions in this relevant health and safety societal challenge.

http://www.poseidonproject.eu

About Photonics21

Photonics21 is the European Technology Platform (ETP) for photonics –a technology encompassing all of the products and processes around the emission, manipulation and detection of light. It is integral to a wide range of industries that include the medical, healthcare, transport, manufacturing, and telecommunications sectors. In December 2005 "Photonics21" was set up to bring the community of photonics professionals and industries together.

In September 2009, the European Commission defined photonics as one of five European Key Enabling Technologies (KET's) and shortly after the European Research & Innovation Program

"Horizon 2020" invited Photonics21 to become a "Public Private Partnership" (PPP). In November 2013 the "Photonics 21 Association", a legal entity under Belgium law, became the private contract partner in a Public Private Partnership (PPP) in conjunction with the EU Commission.

Today Photonics21 represents more than 2600 personal members from all over Europe. Our members are experts in the photonics industry, research organisations and universities who actively engage with us to develop a joint photonics strategy for future research and innovation in Europe.

With the global photonics market growing at twice the world economic growth rate, from 350 Billion Euros in 2011 to 615 Euros in 2020, Photonics21 stands in a secure global market position. The production of European photonics alone accounts for 60 billion Euros and employs over 350,000 people directly.

With strong growth forecast, current industry trends like digitalisation, resource efficiency, individual and zero failure production will drive the photonics industry further.

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