



New biosensor designed to detect toxins and more

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LOS ALAMOS, N.M., April 22, 2021—A device from Los Alamos National Laboratory researchers is not quite the Star Trek “tricorder” medical scanner, but it’s a step in the right direction. The Portable EnGineered Analytic Sensor with aUtomated Sampling (PEGASUS) is a miniaturized waveguide-based optical sensor that can detect toxins, bacterial signatures, viral signatures, biothreats, white powders and more, from samples such as blood, water, CSF, food, and animal samples.

“The ability to detect pathogens, biological threats or toxins, quickly and accurately, without prior knowledge of the agent, would lead to improved human and environmental health outcomes,” said lead researcher Harshini Mukundan. “This is an important step toward understanding what an emergency responder is dealing with, and providing them with quick results.”

PEGASUS does not require trained personnel or laboratory equipment to operate, which means it can be used easily in remote areas of the world. It can discriminate between bacterial and viral signatures, allowing for the proper choice of treatment, which should improve health outcomes of patients and decrease the spread of antimicrobial resistance, Mukundan said.

The sensor includes an integrated sample-processing device with minimal hands-on steps, aimed at ensuring every sample is of the quality needed for detection. “It can help to solve the problem of misidentification of biomolecules, especially in the field, allowing us to be prepared for any potential outbreak or biothreat event,” said Mukundan.

“Detection occurs in two major steps,” said Kiersten Lenz, a researcher on the project. “First, the sample is processed in a microfluidic device, which requires only a small sample volume. Next, the processed sample is loaded onto the miniaturized sensor, where detection occurs. The microfluidic device and sensor can be packaged up into a rugged briefcase that can be brought anywhere in the world, allowing for greater access to this sensing tool.”

“We are hoping for broad uses for this device,” Mukundan continued. “It can be used to detect bacterial infections in humans or animals, or outbreaks in the food supply, identify white powders, detect the presence of specific viruses in humans, animals, food, or water, identify potential biothreat agents, and more. For example, our technology can rapidly detect infection in a doctor’s office, a remote clinic, or a laboratory. In the case of bacterial infections, it can discriminate between Gram-positive, -negative, and indeterminate sources, without prior knowledge of the infection type, in 15-30 minutes,” she said. For such infections, once the class of bacteria is

known, appropriate treatments can be chosen which will result in important benefits for the patient's recovery. In addition, knowing the exact bacterium involved can also reduce the prescribing of broad-spectrum antibiotics, which can lead to the evolution of antibiotic-resistant organisms.

Another potential impact is in the field of biosurveillance. Since the biosensor can be used in remote areas of the world and can detect a variety of biological molecules from a variety of sources, it can have impact in monitoring the presence of potential biothreat agents or outbreaks. The sensor can detect the presence of biomolecules from food sources, the water supply, and can help to identify unknown white powders that are mailed in suspicious packages or spilled on the highway. With better surveillance and monitoring, we can be better prepared for potential outbreaks, since we will have a better understanding of the specific agents at play.

How it works

The device's technology is based on a benchtop waveguide-based optical biosensor developed at Los Alamos. The sensing system detects analytes on a planar optical waveguide surface in a very small (~200nm) field. In order to produce the sensing field, a laser is coupled at a critical angle of incidence into the planar waveguide, and total internal reflection of light occurs between the layers of the waveguide, due to their different refractive indices. This causes an evanescent field to radiate off the surface of the waveguide, where fluorescent molecules are detected.

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