NEXT-GENERATION BIOAEROSOL DETECTION & IDENTIFICATION

A Surface Acoustic Wave Immunosensor For Aerosol Detection

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Detection of chemical and biological threats disseminated via aerosolized release have long been a major risk to the Joint Force. However, historical aerosol detection technology has lacked in sensitivity and applicability to harsh environments where warfighters operate. As a novel solution to these challenges, Raytheon BBN Technologies (BBN) is developing a small, throwable detection platform consisting of a surface acoustic wave (SAW) sensor attached to a specific antibody and protective hydrogel coating. This multiplex-able platform is swappable and networkable, providing an agile response in a rapidly evolving threat environment.

BBN's novel modality has been proven to detect small molecules in aerosol samples ranging from the explosives TNT and RDX, to cocaine, to biomarkers that indicate disease. These targets can be detected in quantities as low as picograms (10-12 g). First, the vapor phase biosensor is constructed by immobilizing a monolayer of any IgG type antibodies onto the surface of a SAW device and coating with a hydrogel. Desired antibodies can be designed and produced in a matter of days, then printed onto the platform chassis with hydrogel. Further, desktop bio-printers have made it possible to rapidly produce these sensors in resource-scarce environments. Up to three different antibodies can be loaded on a single sensor board in the current design. The major enabling technology of this platform is a novel hydrogel that encases and supports the antibody, allowing it to function in a wider range of environments. The printed chassis is connected into an oscillator circuit and the frequency of oscillation is precisely measured. When the antigen binds to the antibody, the acoustic velocity is decreased and the oscillator frequency shifts to a lower value. The system is able to detect aerosol targets within seconds to minutes. This disposable sensor can last for up to a week at 40% relative humidity (RH), and is easily swappable after a positive detection event or when dried out. The complete platform is measured in inches, runs on AA batteries and currently supports data transfer over USB.

Importantly, this sensor platform requires no sample processing or other user interaction, it is truly plug-and-play. The sensor itself is modular, and is comprised of a disposable sensor board that consists of the SAW and attached antibodies coated in hydrogel. A separate control board will analyze the signal from the sensor board. This control board can be in a separate location from the deployed sensors and can be connected to multiple sensor boards allowing for visualization of plume movement over time and space. Further, the sensor can be integrated onto mobile platforms such as unattended aerial or ground vehicles (UAVs, UGVs) for use in urban contested environments. It can also be left in place for unattended perimeter monitoring scenarios. Overall, the unique combination of gold standard technology in a modular, deployable package with the capability to integrate and remotely visualize results makes this platform a force multiplier for layered defense scenarios.