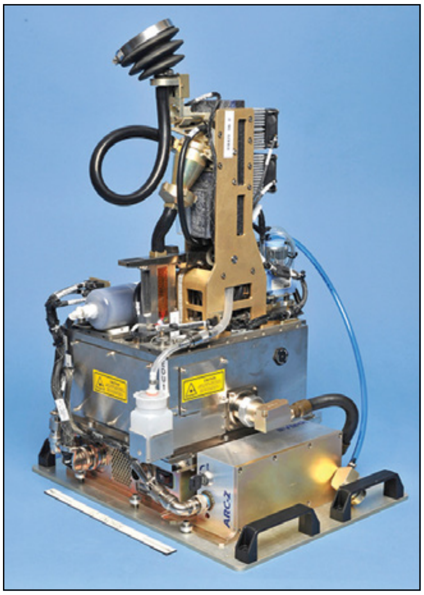
(UV) laser is activated to illuminate the particle and multiband laser-induced fluorescence is collected.

The detection process continues as an embedded logic decision, referred to as the "spectral trigger," uses scattering from the NIR light and UV fluorescence data to predict if the particle's composition appears to correspond to that of a threat-like bioagent. If the particle seems threat-like, then spark-induced breakdown spectroscopy is enabled to vaporize the particle and collect atomic emission to characterize the particle's elemental content.

Spark-induced breakdown spectroscopy is the last measurement stage. This spectroscopy system measures the elemental content of the particle and its measurements involve creating a high-temperature plasma, vaporizing the aerosol particle, and measuring the atomic emission from the thermally excited states of the aerosol. The measurement stages are integrated into a tiered system that provides seven measurements on each particle of interest. Of the hundreds of particles entering the measurement process each second, a small subset of particles is down-selected for measurement in all three stages. The RAAD algorithm searches the data stream for changes in the particle set's temporal and spectral characteristics. If a sufficient number of threat-like particles are found, the RAAD issues an alarm that a biological aerosol threat is present.

To improve detection reliability, the RAAD team chose to use carbon-filtered, HEPA-filtered, and dehumidified sheathing air and purge air (compressed air that pushes out extraneous gases) around the optical components. This approach ensures that contaminants from the outside air do not deposit onto the optical surfaces of the RAAD, potentially causing reductions in sensitivity or false alarms.

For more information, contact Dorothy Ryan at dryan@ll.mit.edu; 781-981-8616.

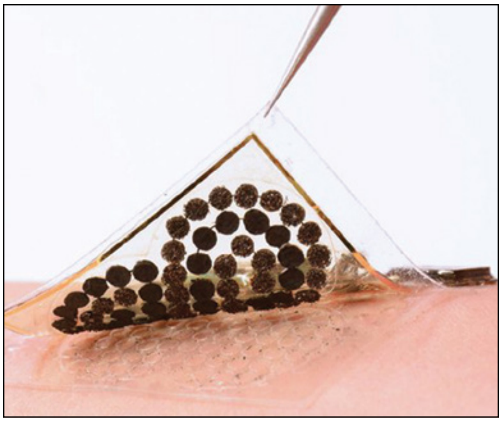


The Rapid Agent Aerosol Detector was photographed with a 12" ruler to illustrate scale. (Photo: MIT Lincoln Laboratory)

Electronic Skin Powered by Sweat Serves as Human-Machine Interface

The e-skin monitors heart rate, body temperature, levels of blood sugar, and metabolic byproducts that are indicators of health.

California Institute of Technology, Pasadena, CA



Made from soft, flexible rubber, the electronic skin is applied directly on top of real skin. (Photo: CalTech)

Researchers have developed electronic skin (e-skin) that is applied directly on top of real skin. Made from soft, flexible rubber, it can be embedded with sensors that monitor information like heart rate, body temperature, levels of blood sugar, and metabolic byproducts that are indicators of health as well as nerve signals that control muscles. It does so without the need for a battery, as it runs solely on biofuel cells powered by one of the body's own waste products.

Human sweat contains very high levels of the chemical lactate, a compound generated as a byproduct of normal metabolic processes, especially by muscles during exercise. The fuel cells built into the e-skin absorb that lactate and combine it with oxygen from the atmosphere, generating water and pyruvate, another byproduct of metabolism. As they operate, the biofuel cells generate enough electricity to power sensors and a Bluetooth device similar to the one that connects a phone to a car stereo, allowing the e-skin to transmit readings from its sensors wirelessly.

While near-field communication is a common approach for many battery-free e-skin systems, it could be only used for power transfer and data readout over a very short distance. Bluetooth communication consumes higher power but is a more attractive approach with extended connectivity for practical medical and robotic applications.

Devising a power source that could run on sweat was not the only challenge in creating the e-skin. It also needed to last a long time with high power intensity with minimal degradation. The biofuel cells are made from carbon nanotubes impregnated with a platinum/cobalt catalyst and composite mesh holding an enzyme that breaks down lactate. They can generate continuous, stable power output (as high as several milliwatts per square centimeter) over multiple days in human sweat.

Next steps are to develop a variety of sensors that can be embedded in the e-skin so it can be used for multiple purposes. In addition to being a wearable biosensor, this can be a human-machine interface — the vital signs and molecular information collected using this platform could be used to design and optimize next-generation prosthetics.

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Intro Cov ToC