Bilayer Nanofibers as Wearable Sensors for Detecting Fentanyl

Homeland Security
Science and Technology

FENTANYL USE IS INCREASING NATIONWIDE—PUTTING FIRST RESPONDERS AT RISK OF EXPOSURE

The Center for Disease Control (CDC) reported that between 1999 and 2015, 300,000 people in the United States died as a result of opioid overdoses; 33,000 of those deaths occurred in 2015. The sudden spike in opioid related deaths in 2015 was primarily related to a rise in the use of fentanyl. Because of this sudden spike, first responders are more likely to respond to incidents involving fentanyl. Fentanyl can be absorbed through the skin and is 50-100 times more potent than morphine, putting many first responders at risk of a fatal contact overdose. Existing technologies are bulky, expensive and have short operating times, leading to use mainly for identifying unknown substances. There is a critical need for a miniaturized sensor for fentanyl compounds to provide early warning of exposure.

DEVELOPING A WEARABLE SENSOR FOR FIRST RESPONDERS TO RAPIDLY DETECT FENTANYL

Reducing the detection response time and alerting exposure to fentanyl is critical to prevent injury or death. Accordingly, the Department of Homeland Security (DHS) Science and Technology Directorate(S&T) partnered with Vaporsens to develop a wearable sensor for continuous personnel monitoring for exposure to fentanyl. These sensors are based on Vaporsens' proprietary nanofiber technology, which provides improved sensitivity and selectivity over other sensor technologies and is suitable for use in wearable devices with low size, weight, and power requirements.

This wearable prototype sensor for detecting fentanyl compounds will be designed with input from S&T's First Responders Resource Group and other potential customers. Sensors will be optimized for responsivity to fentanyl. A sampling system will be developed to deliver fentanyl particles from the air to the sensors. Sensors and the sampling system will be integrated into a wearable prototype. The prototypes will be tested in the laboratory to demonstrate sensitivity to fentanyl analogs in the presence of cutting agents and across a range of environmental conditions. Finally, simulated operational tests will be performed by the DHS S&T National Urban Security Technology Laboratory (NUSTL). By the end of this project, a wearable product will be demonstrated and ready for commercial release.

PROPOSED SYSTEM SPECIFICATIONS

- 3.0" x 1.75" x 0.75", <2 lbs., wearable
- >8 hrs. battery life
- Response time <5 min. to 1 mg/m^3 fentanyl
- Able to detect <1 wt% fentanyl in cutting agents: baking soda, lactose, mannitol, *etc.*
- Audible and visible alarms

DEMONSTRATED PROOF-OF-CONCEPT SENSORS FOR FENTANYL

In the first phase of research and development, Vaporsens created an early stage version of the sensor and demonstrated its ability to detect fentanyl particles in air. Concentrations as low as 1 mg/m^3 were detected in <5 minutes. The sensors did not respond to cutting agents, including baking soda, mannitol and lactose.

UPCOMING MILESTONES

- Optimize sensors and demonstrate performance for detecting fentanyl in the presence of cutting agents and different environmental conditions
- Optimize manufacturing reproducibility
- Develop a wearable prototype and test with fentanyl in various conditions in the laboratory
- Demonstrate prototypes in simulated operating conditions at NUSTL
- Deliver prototypes to DHS S&T

PERFORMERS/PARTNERS

Vaporsens, Inc., Salt Lake City, UT