UC research produces novel sensor with improved detection selectivity

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UC's William Heineman will present on a UC-developed sensor that combines a variety of testing means (electrochemistry, spectroscopy and selective partitioning) into one device. The three methods are represented in the above photo illustration. Credit: Photo by Andrew Higley, UC Illustration by Lisa Ventre, UC

A highly sensitive sensor that combines a variety of testing means (electrochemistry, spectroscopy and selective partitioning) into one device has been developed at the University of Cincinnati. It's already been tested in a variety of settings – including testing for components in nuclear waste.

The sensor is unusual in that most sensors only have one or two modes of selectivity, while this sensor has three. In practical terms, that means the UC sensor has three different ways to find and identify a compound of interest. That's important because settings like a nuclear waste storage tank are a jumbled mix of chemical and radioactive wastes. The sensor, however, would have a variety of applications, including testing in other environments and even medical applications.

Research related to this novel sensor will be presented at the American Chemical Society biannual meeting March 27-31 in Anaheim, Calif., in a presentation titled "Using Spectroelectrochemistry to Improve Sensor Selectivity."

That presentation will be made March 28 by William Heineman, distinguished research professor of chemistry at the University of Cincinnati. He is one of six international scientists invited to speak by electrochemistry students involved in planning a conference symposium. Heineman has published more than 400 research articles on the topics of spectroelectrochemistry, electroanalytical chemistry, bioanalytical chemistry and chemical sensors, and has won numerous national and international awards for his work.

Research on this sensor concept began more than a decade ago and has received support from the United States Department of Energy for most of that time. "They wanted a sensor that can be lowered in a tank to make lots of measurements quickly or have the option of leaving it in there to monitor what's going on over months or a year," said Heineman, who added that the ideal sensor is both rugged and very selective and sensitive.

The sensor has, in fact, been tested at the Hanford site, a mostly decommissioned nuclear production complex in Washington state, where it was used to detect one important component of the radioactive and hazardous wastes stored inside the giant tanks there.

The basic design and concept for this monitor could be used in many other environmental or medical settings. These include detection of toxic heavy metals and polycyclic aromatic hydrocarbons at superfund sites.

The three-way selectivity comes from the use of coatings, electrochemistry, and spectroscopy. The selective coating only allows certain compounds to enter the sensing region. For example, all negatively charged ions might be able to enter the sensor while all positively charged ions are excluded. Next comes the electrochemistry. A potential is applied, and an even smaller group of compounds are electrolyzed. Finally, a very specific wavelength of light is used to detect the actual compound of interest.

The end result is that compounds, even those present in very low concentrations, can be detected and analyzed. This is especially important in medical monitoring and other applications requiring high selectivity and sensitivity.

"Our goal in this research was to demonstrate that the concept works, and that goal has been met as it's now been tested in several ways. Maybe that's why the students at the ACS meeting wanted to hear about it," said UC's Heineman.

Provided by University of Cincinnati

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