Disposable sensor uses DNA to detect hazardous uranium ions

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Researchers at the University of Illinois at Urbana-Champaign have developed a simple, disposable sensor for detecting hazardous uranium ions, with sensitivity that rivals the performance of much more sophisticated laboratory instruments.

The sensor provides a fast, on-site test for assessing uranium contamination in the environment, and the effectiveness of remediation strategies, said Yi Lu, a chemistry professor at Illinois and senior author of a paper accepted for publication in the *Proceedings of the National Academy of Sciences*.

“A unique feature of our uranium sensor is that it contains a small piece of DNA, the same basic building blocks of our genes,” said Lu, who also is a researcher at the university’s Beckman Institute for Advanced Science and Technology, and at the Center of Advanced Materials for the Purification of Water with Systems. “Our sensor combines the high metal ion selectivity of catalytic DNA with the high sensitivity of fluorescence detection.”

While most DNA is double stranded, the catalytic DNA Lu’s research group uses has a single strand region that can wrap around like a protein. In that single strand, the researchers fashion a specific binding site – a kind of pocket that can only accommodate the metal ion of choice.

In this case, the researchers chose to detect uranyl, the most soluble species of uranium ion and the one that poses the greatest threat to

human life.

To search for the unique sequence of DNA that could distinguish uranyl from other metal ions, the researchers used a combinatorial approach called in vitro selection. Simple and cost-effective, the selection process can sample a very large pool of DNA (up to 1,000 trillion molecules), amplify the desired sequence by the polymerase chain reaction, and introduce mutations to improve performance.

Lu, with collaborators at Illinois, the Construction Engineering Research Laboratory, Oregon State University and Oak Ridge National Laboratory, assembled the uranium sensor and tested it on soils containing varying amounts of uranium. The presence of uranyl causes catalytic cleavage of the DNA and release of the fluorophore, resulting in a dramatic increase of fluorescence intensity. With a detection sensitivity of 11 parts per trillion, the disposable sensor rivaled the performance of much more sophisticated laboratory instruments.

In 2000, Lu's research group used the same catalytic DNA process to create a simple but effective lead sensor. "This latest success demonstrates that our methodology can be used to make cost-effective sensors for other hazardous metals, as well, with extremely high sensitivity and selectivity," Lu said. "We can also construct sensor arrays that detect and quantify many metal ions simultaneously."

Source: University of Illinois at Urbana-Champaign