Pacific Northwest NATIONAL LABORATORY

Fingerprinting Uranium

Researchers show how to use x-rays to identify mobile and stationary forms of atomic pollutant

***This research appeared in an invited perspective article and on the cover of* Surface and Interface Analysis.**

RESULTS

Determining if uranium will zip through the soil or not is easier now, thanks to scientists at Pacific Northwest National Laboratory and the University of North Texas. Dr. Eugene Ilton and Dr. Paul Bagus elucidated a systematic approach for identifying uranium's state and hence mobility. Their method uses x-rays, in the form of x-ray photoelectron spectroscopy. Their technique and detailed analysis appear in an invited perspective article and on the cover of *Surface and Interface Analysis*.

"This is the first time that anyone has formalized this approach and showed how broadly useful it is," said Dr. Eugene Ilton, a PNNL geochemist who has found XPS to be useful in his studies.

WHY IT MATTERS

Uranium poses risks around the world. At one U.S. site, 200,000 kg or about 220 tons of uranium entered the environment. Whether or not the radionuclide travels to nearby water sources depends on its oxidation state, the number of electrons around the atom. The team's method accurately pinpoints uranium's oxidation state. Using this method allows scientists to more accurately predict the atomic pollutant's behavior.

Whether or not uranium travels from nuclear waste sites to nearby waterways depends on its oxidation state. The team's systematic approach accurately pinpoints the pollutant's state, allowing for more accurate predictions.

U.S. DEPARTMENT OF ENERGY

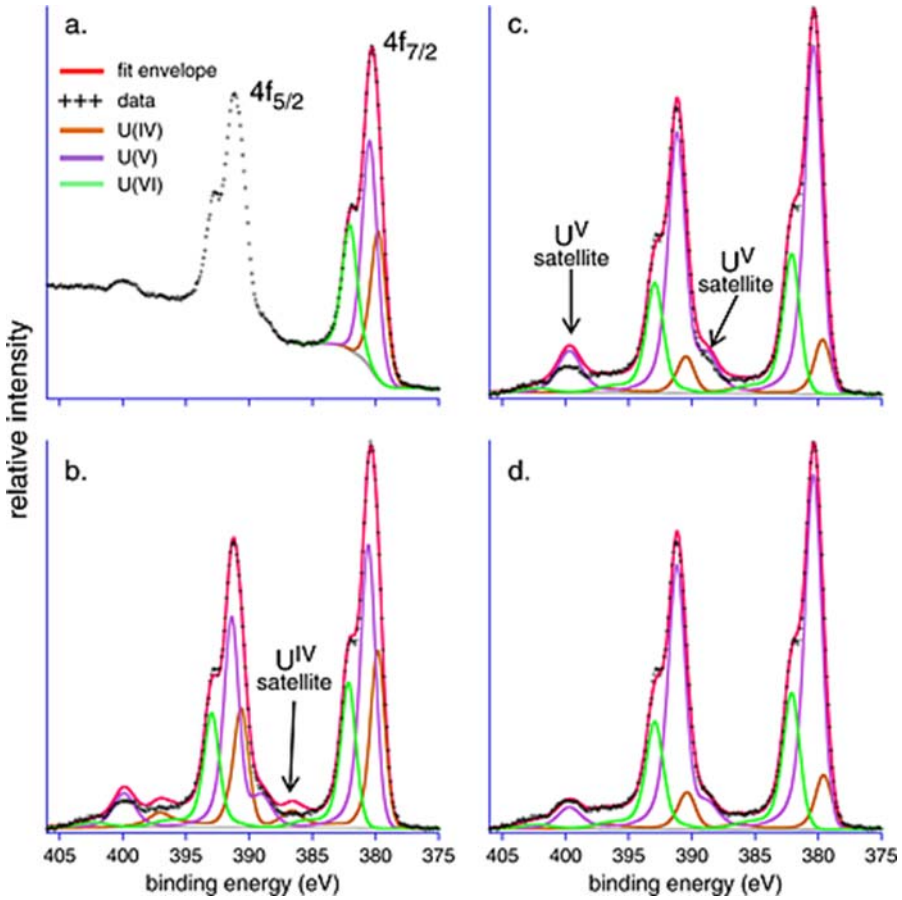
METHODS

This technique begins with XPS, which is used commercially and scientifically to understand materials. The instrument directs a beam of x-rays at the sample, which is placed under ultra high vacuum. The beam excites electrons within the sample, forcing negatively charged particles to leap off. Sensors within the instrument measure the number of electrons that escape. The sensors also measure the kinetic energy or energy with which they leave. These numbers are presented in a series of peaks on a spectrum. Scientists can interpret the size and shape of the peaks to characterize the samples.

Ilton and Bagus began with dilute uranium samples and the XPS in the EMSL.

After running the samples, the pair dissected the experimental data. They also analyzed well-characterized XPS data. They soon charted a methodical process to resolve the smaller peaks on the chart. They clearly resolved the secondary peaks for a broad range of uranium compounds, including uranium with oxygen and water. Unfortunately, the approach does not work with uranium-halide compounds.

While the team was not the first to use XPS to study dilute amounts of uranium, they are the first to present a formal approach that others could follow. “Using XPS provides a definitive fingerprint of the oxidation of uranium,” said Ilton.



The team elucidated a systematic approach for identifying uranium’s state and hence mobility using x-ray photoelectron spectra, such as these shown for a sodium, uranium, oxygen compound on silica.

WHAT’S NEXT?

Ilton and Bagus are working on techniques to pull more information from the XPS spectra, particularly the primary peak. The data they provide can be used in other studies examining the oxidation state of certain uranium compounds.

ACKNOWLEDGMENTS

Funding: U.S. Department of Energy's Office of Basic Energy Sciences Geosciences Research Program in the Chemical Sciences, Geosciences, and Biosciences Division

User Facility: EMSL

Research Team: Eugene Ilton, PNNL; Paul Bagus, University of North Texas

Surface and Interface Analysis, Volume 43, Issue 13, pages 1549-1560, 5 OCT 2011 DOI: 10.1002/sia.3836

REFERENCE

ES Ilton and PS Bagus. 2011. “XPS Determination of Uranium Oxidation States.” *Surface and Interface Analysis*. DOI: 10.1002/sia.3836

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December 2011 | PNNL-SA-84367

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