New technique could lead to safer, more efficient uranium extraction

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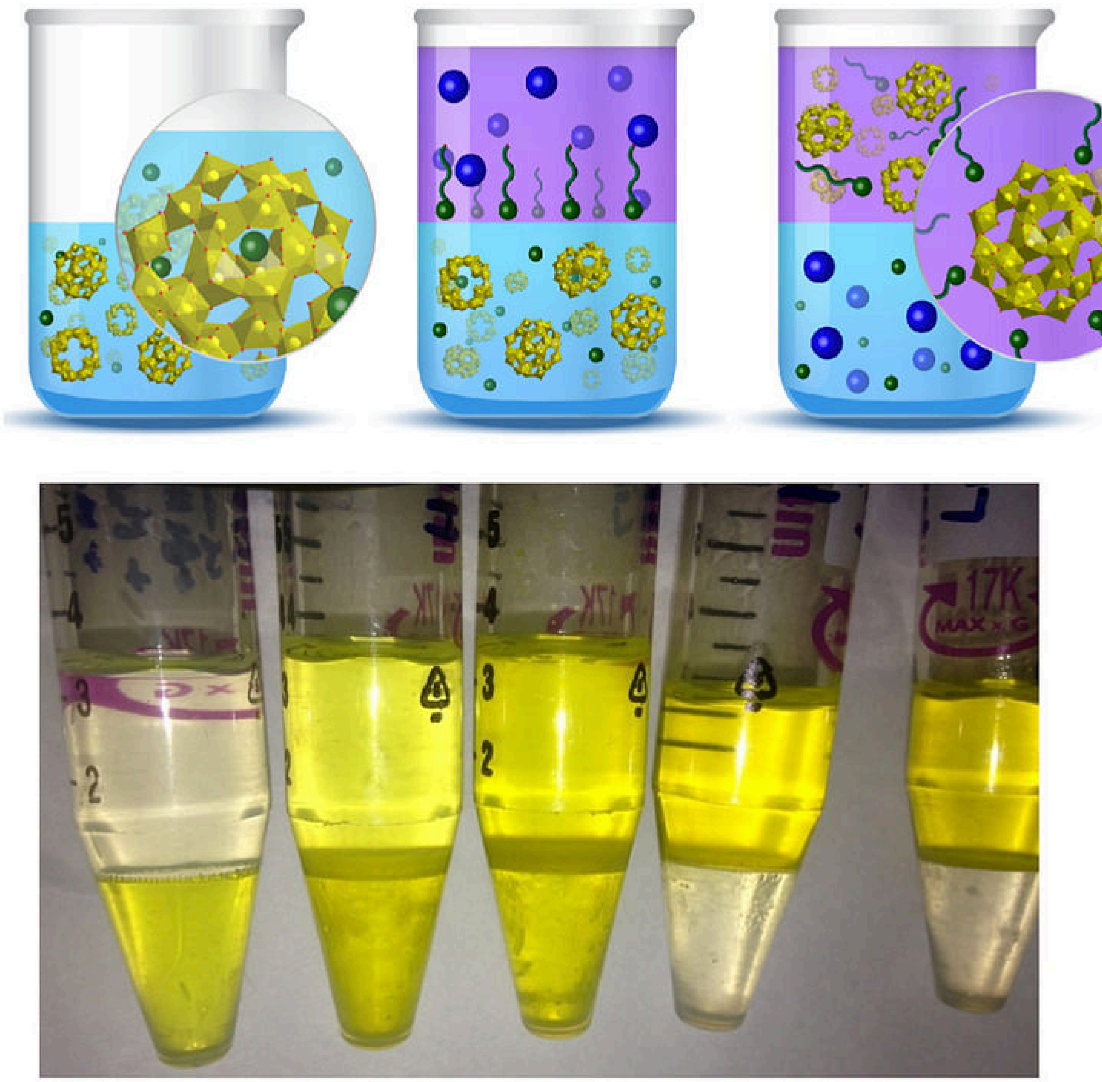

A diagram, top, and photograph show uranium clusters being extracted upward from an aqueous solution into a kerosene solution. Credit: Oregon State University

The separation of uranium, a key part of the nuclear fuel cycle, could potentially be done more safely and efficiently through a new technique developed by chemistry researchers at Oregon State University.

The technique uses soap-like chemicals known as surfactants to extract uranium from an aqueous solution into a kerosene solution in the form of hollow clusters. Aside from fuel preparation, it may also find value in legacy waste treatment and for the cleanup of environmental contamination.

The research at OSU involves a unique form of uranium discovered in 2005, uranyl peroxide capsules, and how those negatively charged clusters form in alkaline conditions. Results were recently published in the *European Journal of Inorganic Chemistry*.

"This is a very different direction," said study lead author Harrison Neal, a graduate student in Oregon State's College of Science. "A lot of the work done now is in acid, and we're at the other end of the pH scale in base. It's a very different approach, overall using less harmful, less toxic chemicals."

Throughout the nuclear fuel cycle, many separations are required—in mining, enrichment and fuel fabrication, and then after fuel use, for the recovery of usable spent isotopes and the encapsulation and storage of unusable radioactive components.

"When you use nuclear fuel, the radioactive decay products poison the fuel and make it less effective," said May Nyman, professor of chemistry at Oregon State and corresponding author on the research. "You have to take it, dissolve it, get the good stuff out and make new fuel."

Nyman notes the work represents significant fundamental research in the field of cluster chemistry because it allows for the study of uranyl clusters in the organic phase and can pave the way to improved understanding of ion association.

"With extracting these clusters into the organic phase, the clusters themselves are hollow, so when we get them into the organic solution, they're still containing other atoms, molecules, other ions," Neal added. "We can study how these ions interact with these cages that they're in. The fundamental research is understanding how the ions get inside and what they do once they're inside because they're stuck there."

When the clusters form, each contains 20 to 60 uranium atoms, "so we can extract them in whole bunches instead of one at a time," Nyman said. "It's an atom-efficient approach."

Existing separation techniques require two extraction molecules for every uranium ion, whereas the OSU technique requires less than one extraction molecule per ion.

More information: Harrison A. Neal et al, Benchmarking Uranyl Peroxide Capsule Chemistry in Organic Media, *European Journal of Inorganic Chemistry* (2017). DOI: 10.1002/ejic.201601219

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