Unique Chemical Signatures

Detecting Clandestine Nuclear Processing

Los Alamos
NATIONAL LABORATORY
EST. 1943

A national security need is to identify and locate clandestine nuclear processing and purification of plutonium and uranium. We are identifying new chemical signatures and observables, increasing the sensitivity of existing signatures, and expanding the range and temporal resolution of signature detection for nonproliferation efforts.

Left: *Ohu nuclear power plant near Landshut West Germany.*
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Inset: *Glass isolation rack used to characterize airplumes.*

Background

No known work has been performed on the stable isotope signatures of plutonium processing—a new area of research that we are currently exploring for non-proliferation science. The state-of-the-art research on stable isotope forensics has focused on uranium ore and uranium oxide materials to better determine the origin of the uranium in varying processing facilities as a safeguard to movement. Preliminary measurements made in our laboratory show a promising chemical signature generated at the last step of the plutonium purification process in US facilities.

Capabilities

Stable isotopes provide a novel tracer to identify and locate upstream covert nuclear processing and can also indicate what methods are being used within the facility to isolate actinides. We explore light stable isotopes as a detector for nuclear processing by (1) identifying the range of stable isotope ratios of C, N, O, and H produced at each step within the plutonium purification stream at LANL's facility and also through yellowcake processing; (2) determining how these signatures vary with plutonium purification; and (3) determining the fate and transport of these signatures in other natural environments.

Future Applications

We will expand this work by looking at both US and non-US targets and focus on additional tracers that can be used for nuclear processing.

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Below A unique stable isotope signature from a nuclear power plant differs greatly from that of other sources (left). The fundamental physics of isotope fractionation which causes these signatures to exist is illustrated at right.