Uranium Recovery from Used Nuclear Fuel Using Metal Sulfides

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ABSTRACT:

We propose an alternate and original method based on a new class of ion-exchange materials to recover the uranium from spent fuel from high-assay low-enriched uranium (HALEU) fuels. The project is motivated by the fact that the large quantity of valuable enriched U-235, if recovered efficiently, could prove economical for reuse. This is a collaborative project between Northwestern University and Argonne National Laboratory aiming to achieve the recovery of over 99% of uranium from highly acidic HALEU solutions. This project investigates a potentially superior complement to existing processes for selectively separating uranium from HALEU sources. We propose the low-cost metal-sulfide materials, which are chemically tailored to capture selectively the uranyl ion while at the same time being regenerable and usable multiple times. The specific fundamental research objectives and tasks are: 1) study the ion-exchange properties of layered metal sulfides for uranyl ions in very concentrated acidic aqueous solutions relevant to HALEU; 2) investigate three different types of metal sulfides each with different structural characteristics that can modulate the selectivity and capacity for the uranyl ions under HALEU-relevant conditions. Each material type presents a unique intracrystalline environment that can be investigated for its specific interactions with the cations of interest; 3) develop a conceptual framework of trends in extractive selectivity by studying related derivatives of materials from each class; 4) study complexation modes in the solid phase with single crystals of suitable model systems. Project deliverables will be a) highly selective sulfide-based absorbers for uranium recovery from HALEU used fuels under relevant conditions, b) new information and assessment of how alternative sorbents such as metal sulfides can selectively capture large quantities of uranium from HALEU related solutions. c) full assessment of the performance capture and release the uranium for recovery and re-use of the down-selected sorbent.