U.S. Department of Energy

Actinide Foil Production for MPACT Research

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Program: Fuel Cycle R&D

ABSTRACT

Sensitive fast-neutron detectors are required for use in lead slowing down spectrometry (LSDS), an active interrogation technique for used nuclear fuel assay for Materials Protection, Accounting, and Controls Technologies (MPACT). During the past several years UNLV sponsored a research project at RPI to investigate LSDS; began development of fission chamber detectors for use in LSDS experiments in collaboration with INL, LANL, and Oregon State U.; and participated in a LSDS experiment at LANL. In the LSDS technique, research has demonstrated that these fission chamber detectors must be sensitive to fission energy neutrons but insensitive to thermal-energy neutrons. Because most systems are highly sensitive to large thermal neutron populations due to the well-known large thermal cross section of ^{235}U, even a miniscule amount of this isotope in a fission chamber will overwhelm the small population of higher-energy neutrons. Thus, fast-fission chamber detectors must be fabricated with highly depleted uranium (DU) or ultra-pure thorium (Th), which is about half as efficient as DU. Previous research conducted at RPI demonstrated that the required purity of DU for assay of used nuclear fuel using LSDS is less than 4 ppm ^{235}U, material that until recently was not available in the U.S.

In 2009 the PI purchased 3 grams of ultra-depleted uranium (uDU, 99.99998% ^{238}U with just 0.2 ± 0.1 ppm ^{235}U) from VNIIEF in Sarov, Russia. We received the material in the form of U3O8 powder in August of 2009, and verified its purity and depletion in a FY10 MPACT collaboration project. In addition, chemical processing for use in FC R&D was initiated, fission chamber detectors and a scanning alpha-particle spectrometer were developed, and foils were used in a preliminary LSDS experiment at a LANL/LANSCE in Sept. of 2010. The as-received U3O8 powder must be chemically processed to convert it to another chemical form while maintaining its purity, which then must be used to electro-deposit U or UO_2 in extremely thin layers (1 to 2 mg/cm^2) on various media such as films, foils, or discs. After many months of investigation and trials in FY10 and 11, UNLV researchers developed a new method to produce pure UO_2 deposits on foils using a unique approach, which has never been demonstrated, that involves dissolution of U_3O_8 directly into room temperature ionic liquid (RTIL) followed by electrodeposition from the RTIL-uDU solution (Th deposition from RTIL had been previously demonstrated). The high-purity dissolution of the U_3O_8 permits the use of RTIL solutions for deposition of U on metal foils in layers without introducing contamination. In FY10 and early FY11 a natural U surrogate for the uDU was used to investigate this and other techniques.

In this research project UNLV will deposit directly from RTIL to produce uDU and Th foils devoid of possible contaminants. After these layers have been deposited, they will be examined for purity and uniformity. UNLV will complete the development and demonstration of the RTIL technology/ methodology to prepare uDU and Th samples for use in constructing fast-neutron detectors. Although this material was purchased for use in research using fast-fission chamber detectors for active inspection techniques for MPACT, it could also contribute to R&D for other applications, such as cross section measurements or neutron spectroscopy for national security.