Development of nuclear forensics program at Texas A&M University

T. K. Bhardwaj,[1] J. R. Allred, K. F. Jones, P. M. Mendoza, R. L. Du, C. M. Folden III, and S. S. Chirayath

[1]*Cyclotron Institute and Nuclear Security Science and Policy Institute*
Texas A&M University, College Station, Texas

Nuclear proliferation is a growing concern worldwide due to the increased availability of nuclear materials, knowledge of sensitive technologies, and the possibility of diverting nuclear materials such as uranium and plutonium away from peaceful uses. Due to this increasing risk of nuclear threats, we are developing nuclear forensics capabilities at Texas A&M University with sponsorship from the Department of Homeland Security. Our objective is to determine the differences in fission products and actinides characteristics for uranium samples irradiated in different type of nuclear reactors (thermal and fast reactors).

The experimental equipment used in this research is shown in Fig. 1, The uranium samples for this project were irradiated at the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory. For the chemical processing of the irradiated uranium samples, a glovebox was installed in a radiochemistry lab. The glovebox provides a controlled environment, with both the H_2O and O_2 levels below 100 ppm. It also houses a lead-shielded workstation to handle the radioactive samples while

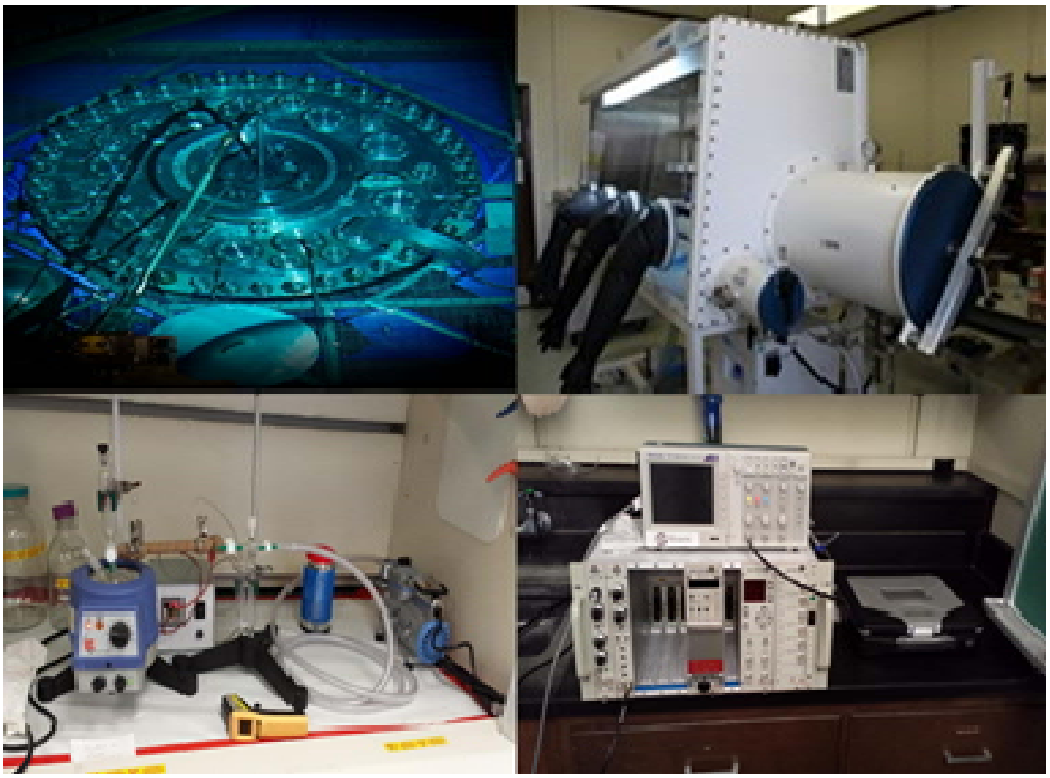

FIG. 1. Clockwise from top left: HFIR at ORNL, glovebox, alpha spectrometer, and dissolution setup at TAMU.

preventing radioactive material from escaping to the atmosphere. A CANBERRA alpha spectrometer was installed to analyze Pu samples. In addition, an experimental setup was designed and developed to dissolve the irradiated UO_2 pellet.

To test the method, experiments were conducted with unirradiated UO_2. Approximately 25 mg of $^{dep}UO_2$ was dissolved in 10 ml of 4 M HNO_3. Ce was added to the dissolved uranium and then the uranium was separated from the mixture by a solvent extraction method. The samples were analyzed by ICP-MS and the results were within the uncertainties of the analytical procedure. During the next stage of the project, the experimental setup was moved to a heavily shielded glovebox at the Nuclear Science Center (NSC) where the actual irradiated $^{dep}UO_2$ pellet will be dissolved. Several test runs were conducted at the NSC to analyze the risk factors and ensure the safety of the dissolution procedure. Additionally, a lead coffin was designed, developed, tested, and moved separately to the NSC to store a flask containing the fission product gases evolved during the dissolution process. All chemicals and equipment have been procured, and flowsheets have been prepared for the quantitative separation and analysis of ^{239}Pu, ^{240}Pu, ^{134}Cs, ^{137}Cs and ^{144}Ce. The first destructive analyses of the irradiated sample will be conducted in May 2014.