Project Title: In situ Characterization of Transient Radioactive Compounds

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ABSTRACT:

The Notre Dame Radiation Laboratory (NDRL) is a premier facility supported by the DOE Office of Science for the study of radiation-induced chemistry. Several unique capabilities have been developed at the NDRL to generate and probe the intermediate species fundamental to this chemistry. A workhorse facility is the 8 MeV electron linear accelerator (LINAC), where the optical spectroscopy and kinetics of short-lived reactive species are characterized at subnanosecond to second timescales. Other unique instruments to probe transient species include conductivity, resonance Raman spectroscopy, and electron paramagnetic resonance (EPR) of free radicals. Virtually no other laboratory in the world has this complementary combination of facilities for transient radiation chemistry studies.

Until now, the focus of research at the NDRL has been on the fundamental radiolysis of liquid solutions, primarily aqueous, but which contain no radioactive elements. Handling radioactivity naturally requires stricter safety rules and engineering controls, which can otherwise be avoided. The national laboratories have recently recognized and prioritized the need to study the radiation chemistry induced by radioactive materials. This interest extends across the DOE as research is being ramped up to support the next generation of nuclear reactors to meet our future energy needs. Among applications that need to be addressed, we can mention

- Fundamental effects of radiation and radiolysis in chemistry of the radioactive elements,
- Understanding temporal changes that occur in separation systems,
- Characterization of radiation effects on field-enhanced separation systems, and
- Molten salts and other solvents proposed for next generation reactors.

The purpose of our proposal is to improve the NDRL infrastructure to allow for radiation chemistry experiments on radioactive materials.

Near the NDRL on the Notre Dame campus is the Actinide Research Laboratories, which have extensive experience in working with radioactive materials, especially the transuranic elements. This proposal will combine the expertise of radiochemists and radiation chemists to create a new synergistic thrust in “Radiation Research”. Stock solutions of radioactive compounds will be prepared at the Actinide Research Laboratories, and then taken to NDRL. The essence of the proposal is to install radioactivity-qualified gloveboxes within the NDRL building. Dilutions and mixtures of solutions for radiation chemistry studies can then be created very close to the accelerator facility to facilitate timely data collection.

Combining the capabilities of these two Notre Dame laboratories will result in a world-class facility with considerably more opportunities for collaborative research. It will enable us to use and share our equipment and instrumentation with other interested university departments, programs from other universities, and national and international laboratories. These interrelationships should prove to be very useful to attract students to the field and to provide their comprehensive education and extensive training for their future employment. It is our intention to invite other researchers to work with us as a part of DOE’s Nuclear Science User Facilities (NSUF).