Ex-situ and In-situ Molten Salt Chemical Analysis Capabilities for the Development of Materials in Molten Salt Environments

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Collaborators: N/A

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ABSTRACT:

The University of Wisconsin-Madison (UW) Nuclear Engineering program has unique strength in experimental programs to develop nuclear technology, currently performing advanced nuclear research in support of multiple advanced concepts, including high-temperature gas-cooled reactors, fluoride salt-cooled reactors, and sodium-cooled fast reactors, as well as constantly supporting the research and development of current LWR's technologies. Ongoing experimental programs include thermal hydraulics, safety and material science studies in water, sodium, helium, supercritical carbon dioxide, and molten salts, as well as radiation damage studies of both ceramics and metals for reactor service. To support these projects, the department has the following facilities: the Tantalus facility for testing in high stored-energy environments, the Extreme Environments Laboratory for conducting high-temperature corrosion testing, the Environmental Degradation of Nuclear Materials Laboratory for studying materials' corrosion and irradiation in-situ, , the Wisconsin Ion Beam Facility for studying radiation damage and performing surface science, the Characterization Laboratory for Irradiated Materials for performing electron microscopy and other analyses on irradiated samples, the Molten Salt Corrosion laboratory to perform long term corrosion test in high-temperature, well-controlled, molten salt environments and the University of Wisconsin Nuclear Reactor Laboratory.

The proposing team focuses on the addition of a state-of-the-art LIBS system, which will complement the department molten salt research capabilities with ex situ and in situ chemical analysis characterization tool that can detect all impurities in the salt even low-Z elements. This will accelerate the purified salt production process, as well as, the material discoveries for MSR applications. This equipment will also accelerate the standardization of molten salt characterization across the U.S. by providing multiple laboratories with purified salts. The chemical compositions of the salt before and after purification will be evaluated with LIBS to optimize the purification step and obtain the salt in the purest state. This process will be applied on various salt compositions necessary for different experiments and laboratories. Ex situ LIBS measurements will be utilized to characterize the impurities in the salt before and after applications in loop and static tests. On the other hand, in situ measurements are critically needed to monitor the impurity types and concentrations during corrosion experiments. During corrosion, elemental species are continuously dissolved by the salt leading to change in the salt redox potential and the corrosion kinetics. Real time monitoring of the chemical species of the salt will allow a better understanding of the dissolution processes and the role of different impurities in the corrosion.