Advanced Electrochemical Separations of Actinide/Fission Products via the Control of Nucleation and Growth of Electrodeposits

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ABSTRACT:

Electrochemical techniques are of vital importance for development of pyrochemical fuel treatment processes for separation of actinides from the fission products contained in spent nuclear fuel. Using pyroprocessing technology, actinides can be recovered from the spent fuel and prepared for recycle, as fuel, while the fission products can be encapsulated in durable leach resistant waste forms destined for storage. Extensive research has been, and continues to be performed in this area under the US Department of Energy's Fuel Cycle Research and Development program with the ultimate goal of developing efficient, sustainable and environmentally responsible nuclear energy systems.

The development of pyrochemical fuel cycle technologies needs to accommodate both oxide and metallic fuels. The successful development of needed technologies requires deep fundamental knowledge of pertinent electrochemical reaction systems that utilize molten salt electrolytes.

Furthermore, when developing a method for pyrochemical reprocessing of spent nuclear fuels, the following criteria must be considered:

1. Recovered fuel materials must be compatible with current or next generation nuclear reactors
2. The process must be amenable to safeguarding nuclear materials
3. The number and complexity of processing steps should be minimal
4. Final nuclear waste should be amenable to characterization, minimal in volume, and have its final storage mode clearly identified.

It is well known that according to current knowledge the pyroprocessing of spent nuclear fuels invariably leads to the dendritic form of electrodeposits, which from technological point of view is undesirable, for many reasons. *The aim of this research is to find ways to preclude the formation of electrodeposits with dendritic morphology (of essential importance to FC-1 Program)*. This goal is very ambitious considering the fundamental challenges described in this proposal.

The objectives of the proposed research are to:

- Search for technically acceptable and chemically functional additives to the LiCl-KCl molten salts that will place the electrodeposition of actinides and fission products in active region.
- For the first time, in molten LiCl-KCl electrolytes, study the morphology (nucleation and growth) of electrodeposits as a function of electrolyte additives, such as ionic liquids.
- Redesign the electrochemical molten salt cell for use of distinct cathodic and anodic compartments, and reexamine the fundamental results obtained in one-compartment cell.