Molten Salt Spectroelectrochemistry of Europium

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Abstract:

With growing interest in clean energy production and environmental stewardship, advanced nuclear reactor production has increased to meet societal demands. The Generation IV International Forum (GIF) selected the molten salt reactor (MSR) as one of its six reactor technologies for the future of nuclear energy. A critical area of need for MSR technologies is the development of materials accountancy capabilities to support responsible utilization of this energy resource. The focus of research has been to develop online monitoring techniques and spectroscopic techniques which can provide an immense advantage in this area. As part of the research that will be presented, a 3-D high temperature furnace has been constructed that enables simultaneous measurements using Raman and UV-Vis spectroscopy with electrochemical techniques. The electrochemical studies will provide diffusion coefficients that will provide insight into *f*-element speciation in solution. These measurements coupled with UV-Vis or NIR spectroscopy, otherwise referred to as spectroelectrochemistry (SEC), will be used for the quantitative determination of *f*-element metal ion behavior useful for spectroelectrochemical sensor capabilities in used nuclear fuel pyroprocessing systems. Molten salt SEC has many design challenges, so room temperature aqueous systems have been demonstrated as a proof of concept before moving onto more challenging molten salt systems. Lastly, Raman spectroscopy will be used in combination with electrochemical and UV-vis measurements to probe the *f*-element coordination environment to facilitate analyte concentration. The ultimate focus of this work will be monitoring higher concentrations of europium and uranium in a molten LiCl-KCl eutectic that could be relevant to reactor conditions. Proof of concept studies successfully demonstrating the utility of the custom-built furnace will be presented.