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## The Electrochemical Separation of Curium and Americium: Quarterly Report August-December 2004

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**DOE/TRP Quarterly Report  
Funding Years 2004  
August 2004 – December 2004**

**This is a list of the personnel working with foams on the UNLV campus.**

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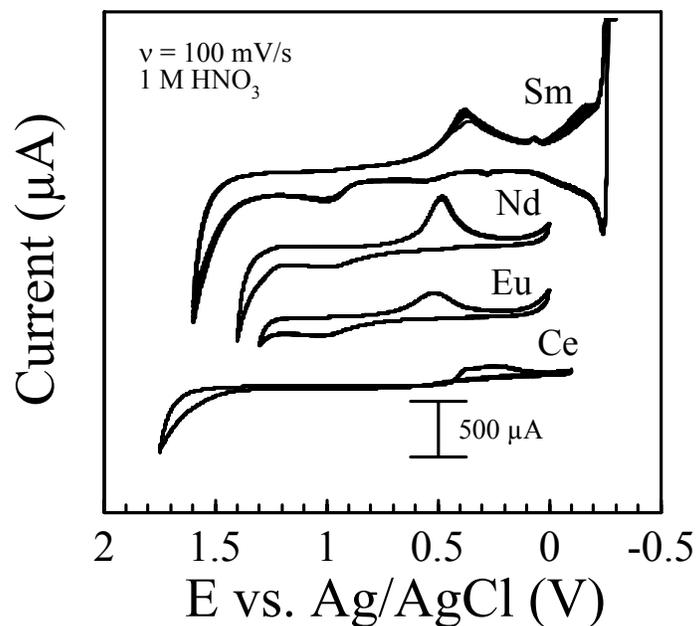
**Title: The Electrochemical Separation of Curium and Americium.**

This research report outlines the current status and progress associated with the electrochemical separation of Curium and Americium. The following pages outline the progress on our project to date. We have been actively performing research on this project for three months and are currently on schedule in terms of the proposed timelines.

The project was initiated in August 2004. The initial focus of the project involved setting up the laboratories for the studies outlined in the grant proposal. The instrumentation needed included an electrochemical work station that will perform the bulk of the electrochemical studies. This instrument will complement the electrochemical instrumentation in Dr. Hatchett's laboratory and will be housed in Dr. Czerwinski's laboratory. In addition the required electrodes, electrochemical glassware, side apparatus including nitrogen degassers and the chemicals for the initial studies were obtained. The laboratories are up and running currently and both graduate students are actively participating in the studies.

The initial studies required that the graduate students were educated in electrochemical analysis and techniques. This was initiated the first month of the project and both students were given guidance in obtaining electrochemical data. Specifically Moustapha Eid Moustapha was responsible for examining the nitrate salts of Cerium, Neodymium, Samarium, and Europium in 1 M HCl. These species were chosen as model species to initiate the separation studies. The initial goal is to examine the

electrochemical behavior of these species to develop a complete thermodynamic picture. The next step involves the complexes formed with a variety of ligands. Electrochemical data from the complexes will be compared directly to the data from the species prior to complexation to determine how the thermodynamics can be altered. The electrochemistry of Ce, Sm, Eu, and Nd in 1 M HNO<sub>3</sub> is presented in **Figure 1**.



**Figure 1.** Electrochemical response of a Pt electrode in solution containing  $1 \times 10^{-3}$  M Ce, Eu, Nd, and Sm in 1 M HNO<sub>3</sub>. Scan rate = 100 mV/s.

The results show that the electrochemistry of Nd and Eu are closely matched. The voltammeteric waves shown are for the Nd(2+/3+) and Eu (2+/3+) couples. In addition the magnitude of the current associated with the oxidation and reduction of the two species shows that the reduction to Nd<sup>2+</sup> and Eu<sup>2+</sup> is thermodynamically more favorable than the more oxidized species. In contrast the electrochemistry of Sm and Ce are not like other species. The voltammeteric response for Ce shows two waves between 0.5 and 0 V vs. Ag/AgCl corresponding to the reduction of Ce(III) to Ce(II). However, under the solution conditions employed the reversible oxidation is not observed. The electrochemical response of Sm shows the reduction and reversible oxidation from Sm(III) to Sm(II) and possible Sm(I). The multi-wave oxidation for Sm suggests that a fraction of the species in solution have undergone a two-electron reduction to Sm(I). Further studies will be completed to determine the oxidation pathways of Sm.

Additional studies were initiated which examine the influence of pH on the voltammetric response. It is important to understand how pH influences the electrochemical properties of the species. The pH should influence the metal ions ability to give and receive electrons. These changes should be manifested in changing electrochemical potentials for the oxidation/reduction processes. These studies have been initiated at present and Figure 2 shows the effect of changing pH on Ce.

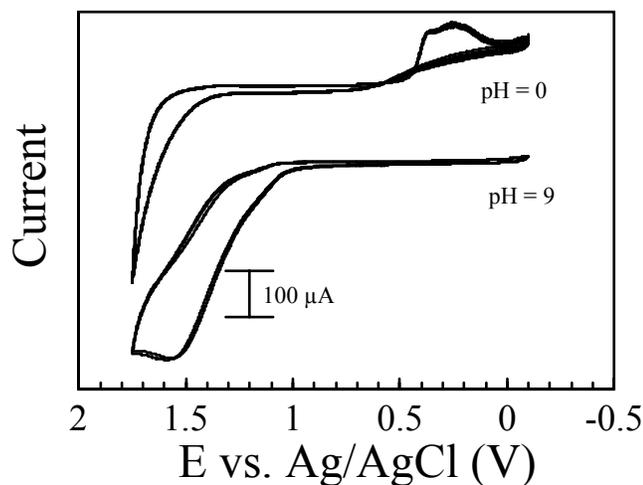


Figure 2. Electrochemistry of Ce(III) at pH = 0 and pH = 9. Scan rate = 100 mV/s.

The electrochemical response in Figure 2 indicates that the voltammetric behavior of Ce is dramatically influenced by the pH. In the case of the pH = 0 solution two reduction waves are observed as noted previously. These voltammetric waves are absent in the pH = 9 solution. However, a new redox process is resolved at 1.5 V vs. Ag/AgCl. The emergence of both the oxidized and reduced species can be observed on the sloping background between 1.0 and 1.75 V. The initial studies confirm that pH influences the electron affinity and ionization potential of the solution species of Ce. We expect the same trend for the other species of interest. These studies will be expanded to include all of the species presented in Figure 1.