Development of Uranium Based Batteries

Paul Dunbar, Ph.D., P.E.
Co-PI Rhonda Lee-Desautels, Ph.D.

University of Kentucky
Paducah Extension Campus

Project Goals

- Characterize uranium dioxide's electrochemical properties in various organic solvents/lithium salts commonly used in commercial battery industry.
- Construct cells in a glove box where the moisture and oxygen concentration will be controlled.
- Test the cells using common electrochemical methods to determine the reversibility of Uranium compounds in organic solvents with lithium salts
  - cyclic voltammetry
  - impedance spectroscopy
- **If feasible** this information will be used to construct a battery with uranium dioxide as the cathode.
- Manufacturing of uranium-lithium compounds in a muffle furnace to mirror the construction of manganese-lithium compounds commonly used in commercial batteries.

Collaborators and Consultants

- Applied Power International
  - Walter Tracinski, Lithium Battery Expert
- CAER
  - Dr. Stephen Lipka-Electrochemist/Material Scientist
- Dr. Bruce Hinds
  - Material Scientist that allows me to work with UO_2 powder

Literature Search

- UO_2 used as a cathode in a thermal battery constructed by the U.S Navy in 1965

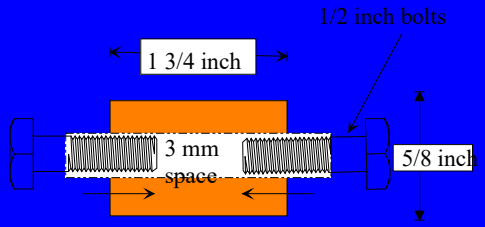
- UO_2 behaves like a semi-conductor similar to MnO_2
  - Limited thickness 40,000 ohms of resistance at 2 mm in thickness (Miserque, et. al. Journal of Nuclear Materials (2001))
  - Primary batteries Li-MnO_2

- Cyclic Voltammetry experiments performed with UO_2 in aqueous corrosion studies shows reversibility . *("A Critical Evaluation of the Redox properties of Uranium, Neptunium, and Plutonium ions in Acidic Aqueous solutions", IUPAC,Pure and Applied Chemistry, (71), 1771-1807)*

$$UO_2(OH)_2 \xleftrightarrow{-0.3V} UO_2 \xleftrightarrow{-2.6V} U(OH)_3 \xleftrightarrow{-2.10V} U$$

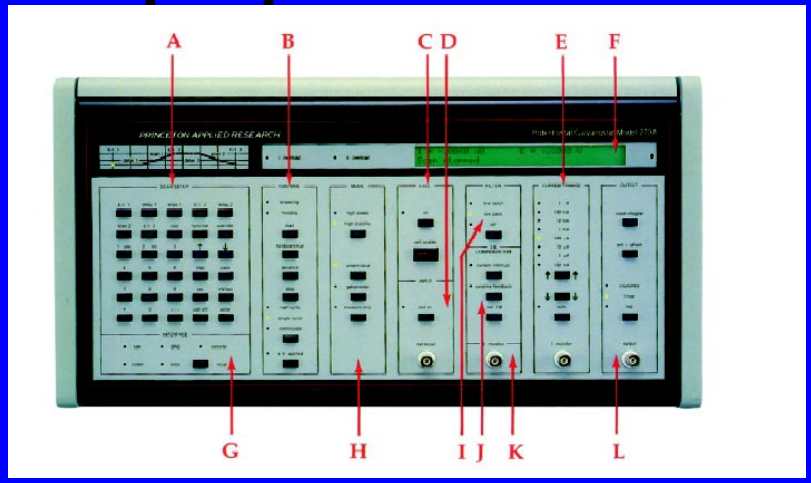
Experimental Work

- Constructed porous UO_2 Pellet for a working electrode in an electrochemical cell
- Natural UO_2 instead of depleted $90 for 50 grams from Cerac Inc. in Milwaukee
  - PDVF as a binder 0.1 gram
  - graphite 0.1 gram
  - UO_2 0.8 gram
  - Add to the “bolt press” heat to 130 C
  - Allow cool for 30 minutes



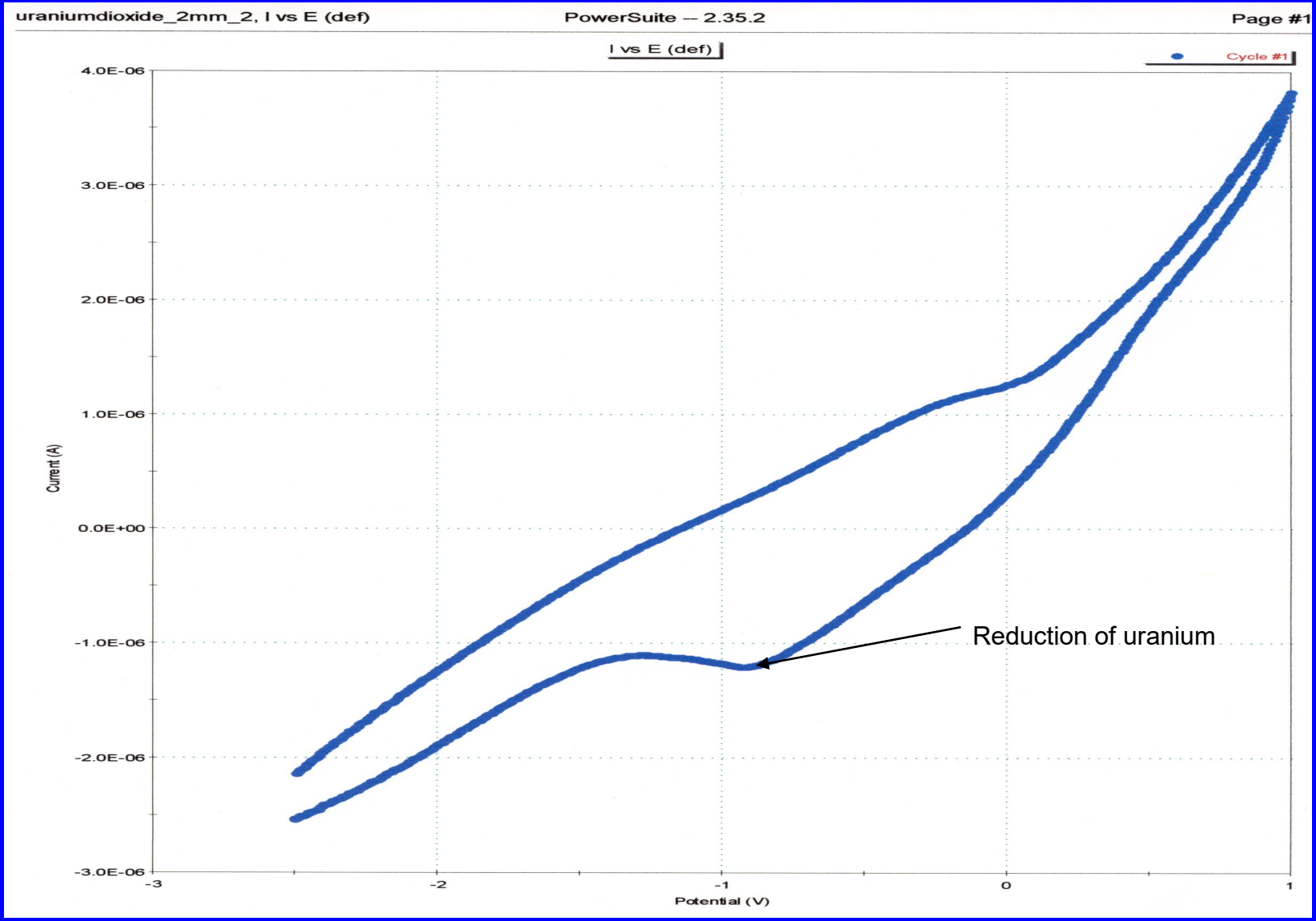
Experimental Equipment

- Perkin Elmer 273A Potentiostat and Solartron 1250 FRA
- Vac Atmospheres Glove Box to control atmosphere to construct a 3-cell electrode
  - 3-Cell electrode Lithium as RE, Lithium as CE, and UO_2 as working electrode

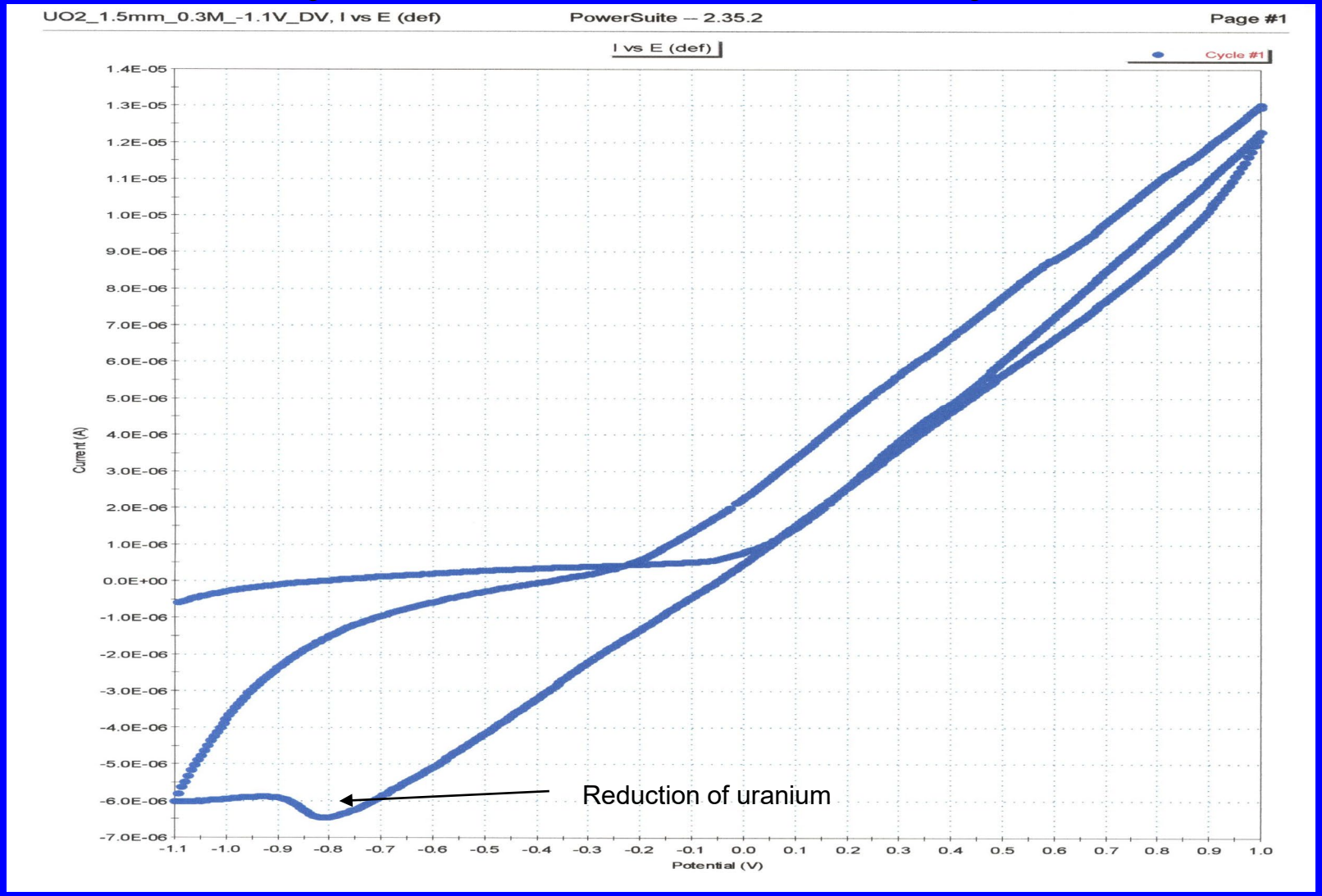


Glove Box

Cyclic Voltammetry



Cyclic Voltammetry 2



Status

- Waiting for some equipment
- June on-line

Acknowledgements

- Initial 1 year funding ($40K) by ORNL (2002-2003) feasibility study
- Two years funding by KSEF (2003-2005)