Title: Flow Cells for Scalable Energy Conversion and Storage

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Flow Cells for Scalable Energy Conversion and Storage

Los Alamos NATIONAL LABORATORY EST.1943

Enabling high energy/power density flow cells through rational materials and system design

LDRD innovation for our nation

BACKGROUND & MOTIVATION

How Do you Store Massive Amounts of Renewable Electrical Energy?

- Solar and wind energy offer tremendous potential as renewable energy sources but they are intermittent resources
- Renewables will require energy storage when their penetration grows
- Flow cells provide a pathway to gigawatt/hours of energy storage
- Current flow systems are V-aqueous based and not cost effective

INNOVATION

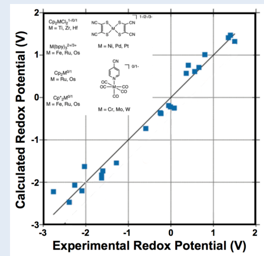
Dramatically increase energy density and power density of flow cells

- Theory guided approach to screen Fe and Ni based charge carrier complexes that have maximized redox voltage window.
- Improve solubility of redox-active compounds through ligand engineering to achieve vastly improved storage densities.
- Develop durable high-conductivity alkaline membranes with nominally zero cation crossover compatible with non-aqueous electrolytes.
- Design and integrating new electrodes and flow-geometries, involving novel electrocatalysts, electrolytes, membranes, and redox couples.

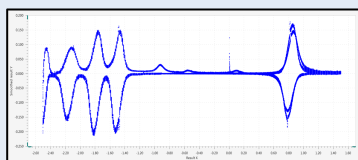
DESCRIPTION

Density Functional Theory (DFT) used to compute dG between oxidized and reduced state

- Screen redox couples with large potential window and high solubility.
- Hybrid density functional theory calculations used to optimize molecular geometries in the presence of solvent molecules.

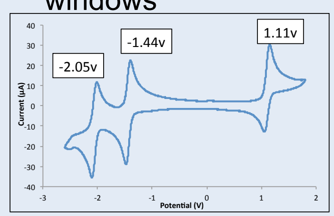


L.E.Roy, E. Jakubikova, M.G. Guthrie, and E.R. Batista, J. Phys. Chem. A, ***113****, 6745 (2009)*

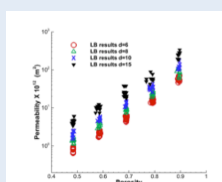


Identified promising reversible Fe (left) and Ni (bottom) complexes with high redox potential windows

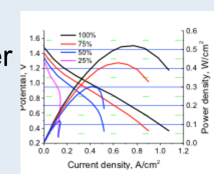
Voltage	Current Height Ratios
-2.5	2.292133572
-2.17	1.690426421
-1.82	1.41890987
-1.53	1.254591087
0.781	1.028510375



Flow modeling



High power V-aq flow cell

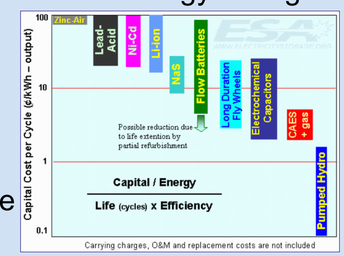


Design high efficiency flow cells : Guided by modeling

LDRD funding will develop this technology from TRL Level 2 to TRL 4. Proof of concept non aqueous flow cells with improved energy and power density will be designed and tested.

ANTICIPATED IMPACT

Energy Secretary Ernest Moniz: "Energy storage is a vital component of a more resilient, reliable and efficient electric grid. We must continue developing innovative energy storage technologies and finding new ways to ensure wider adoption to help move the nation closer to the grid of the future."



PATH FORWARD

Phase 1 – LDRD: Proof of concept flow cells using non-aqueous electrolytes, alkaline membranes and multi-electron redox couples

Phase 2 – Applied Energy Development Seek funding from DOE-EERE-OE, DOE-EERE-FCTO, DOE-EERE-ARPA-E and Industrial partners for applied development and optimization.

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