2021 DOE OE Energy Storage Peer Review

Redox Flow Batteries

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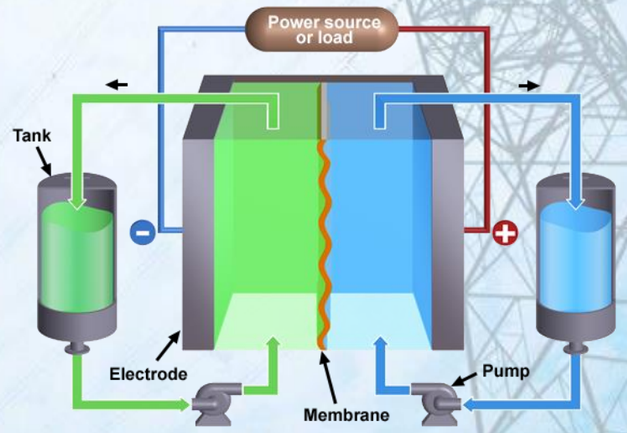

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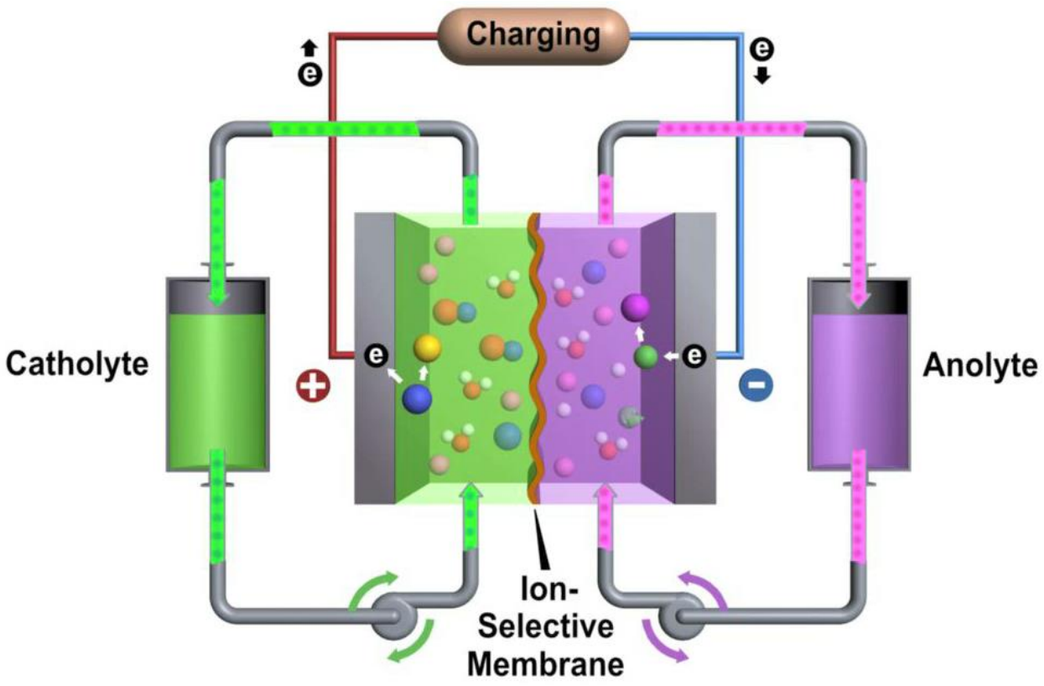
Redox flow batteries session speakers



Technical advantages

- High safety
- Environmentally friendly active materials preparation and recycling
- Modular design

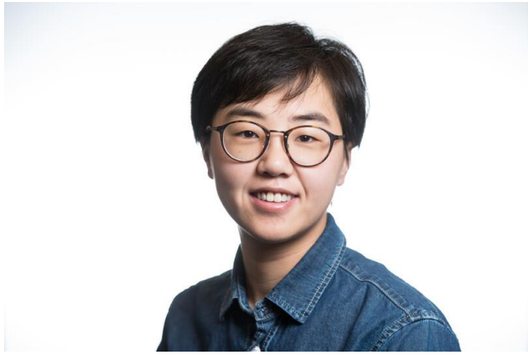
Application: long-duration energy storage

- Decoupled energy (duration) and power (rate)
- Low self-discharge
- Potentially low-cost active materials

Redox flow battery session speakers

Dr. Jagjit Nanda
Oak Ridge National Laboratory

Dr. Cy Fujimoto
Sandia National Laboratory



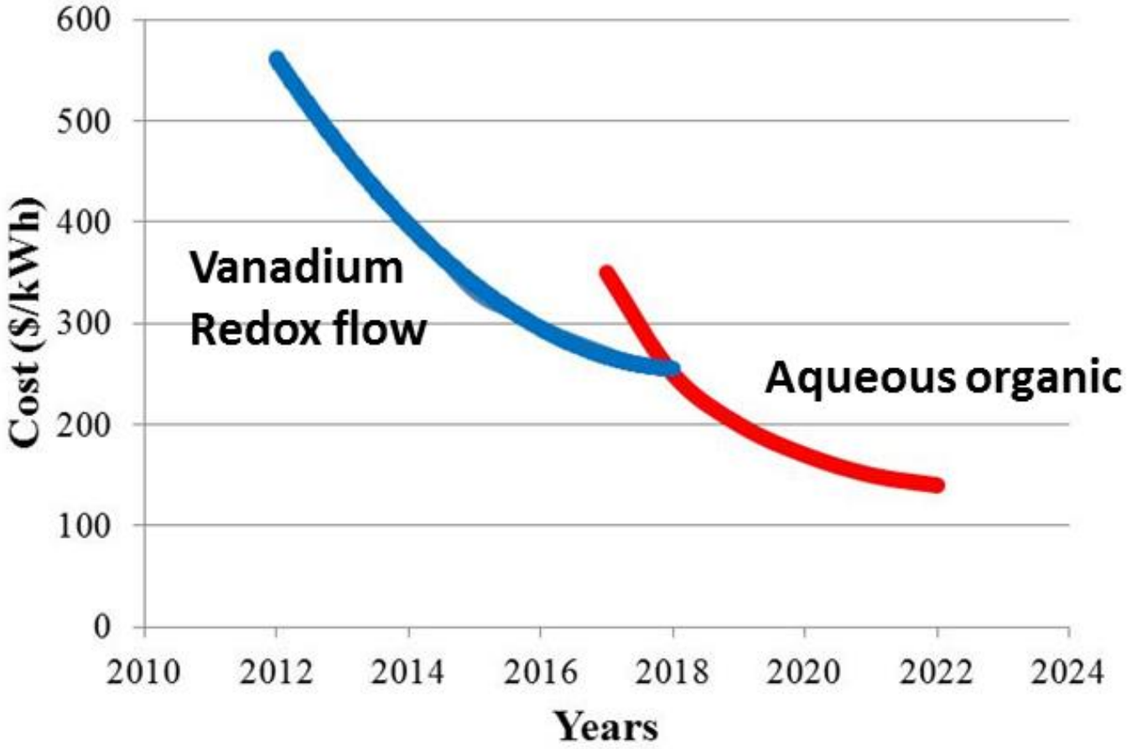
Dr. Ruozhu Feng
Pacific Northwest National Laboratory

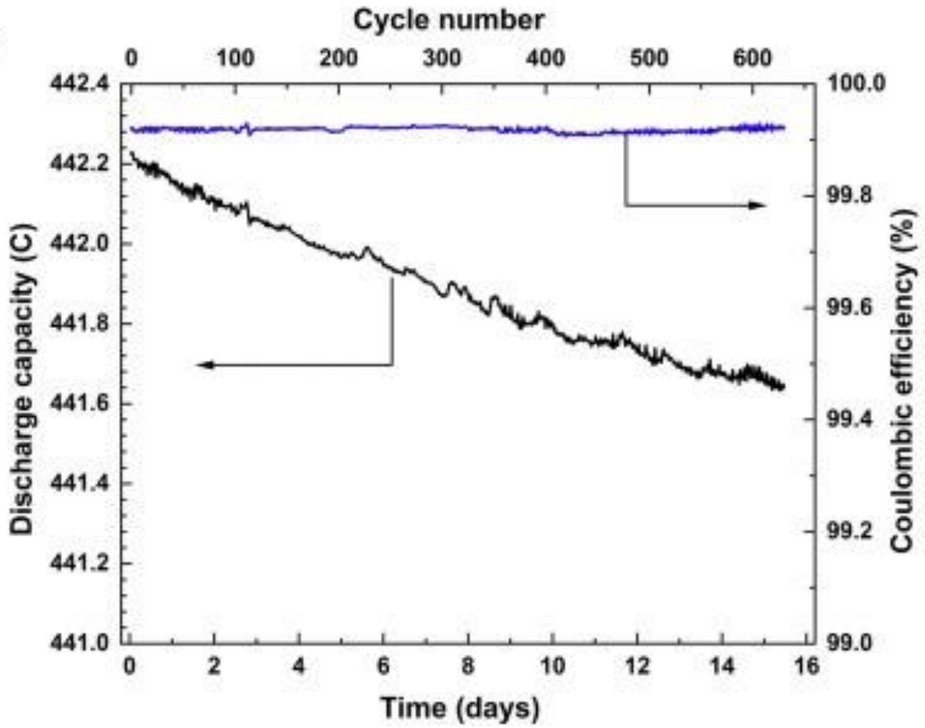
Professor Michael Aziz
Harvard University

Professor Sri Narayan
University of Southern California

Dr. Rangachary Mukundan
Los Alamos National Laboratory

Low-cost aqueous organic redox flow batteries (AORFBs)





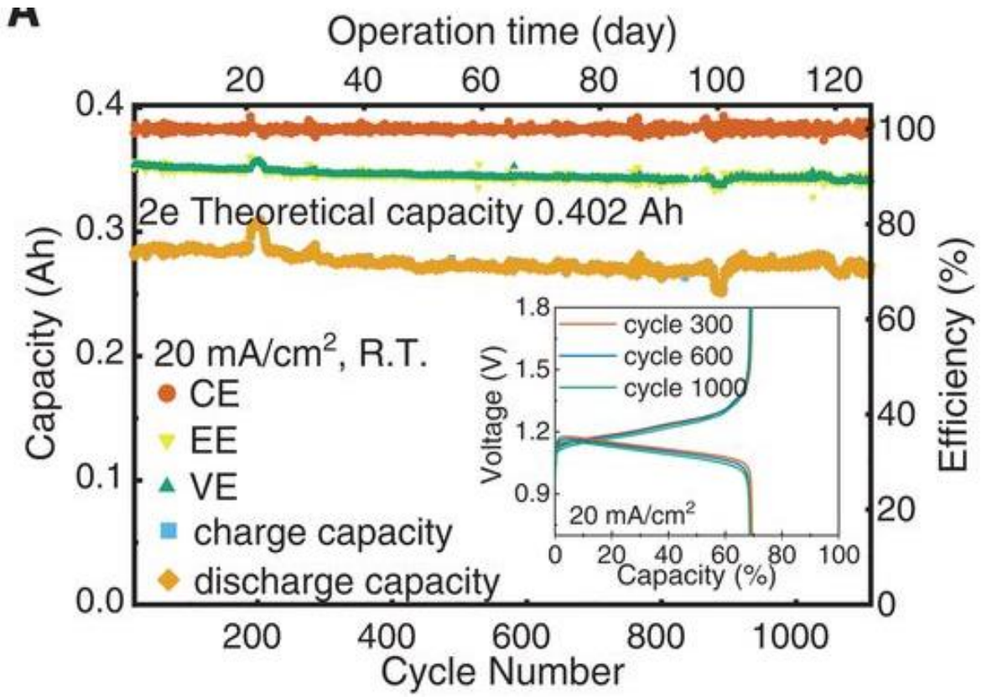
Challenge in cycling stability

- Long-term cycling
- Cycling in non-demanding environment
- Cycling at elevated temperatures

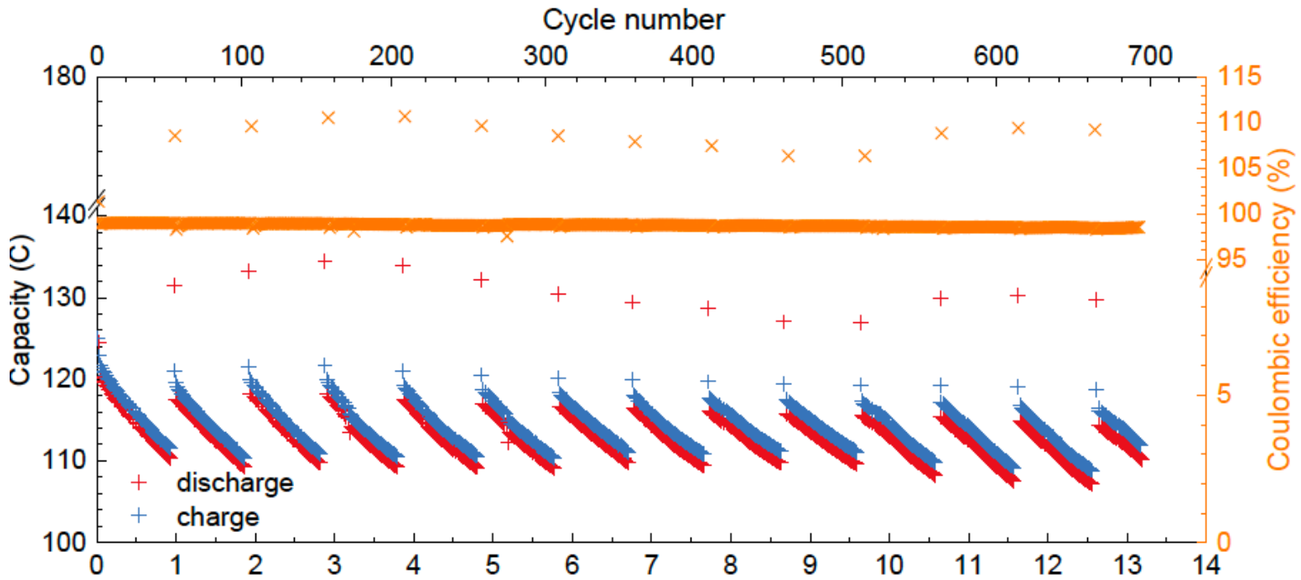
Wu et al., Chem6, 1432–1442

Breakthrough in the development of stable AORFBs

Stable fluorenone derivatives



Capacity restoration approach

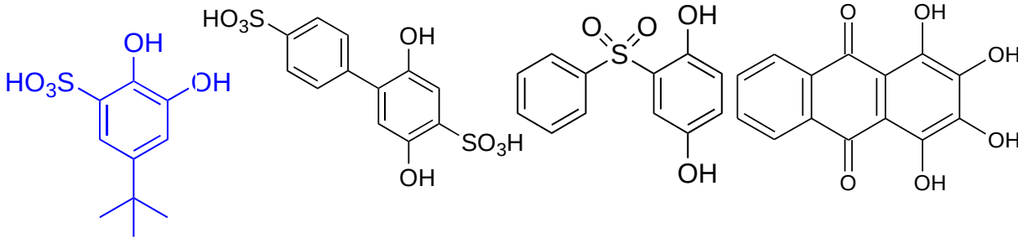


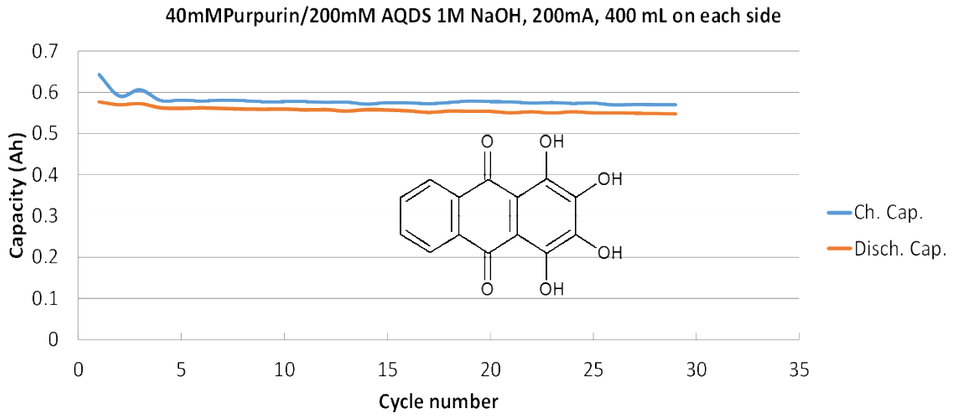
Talk: Reversible ketone hydrogenation and dehydrogenation for aqueous organic redox flow batteries

Talk: Long Lifetime Aqueous Soluble Organic Flow Battery Development

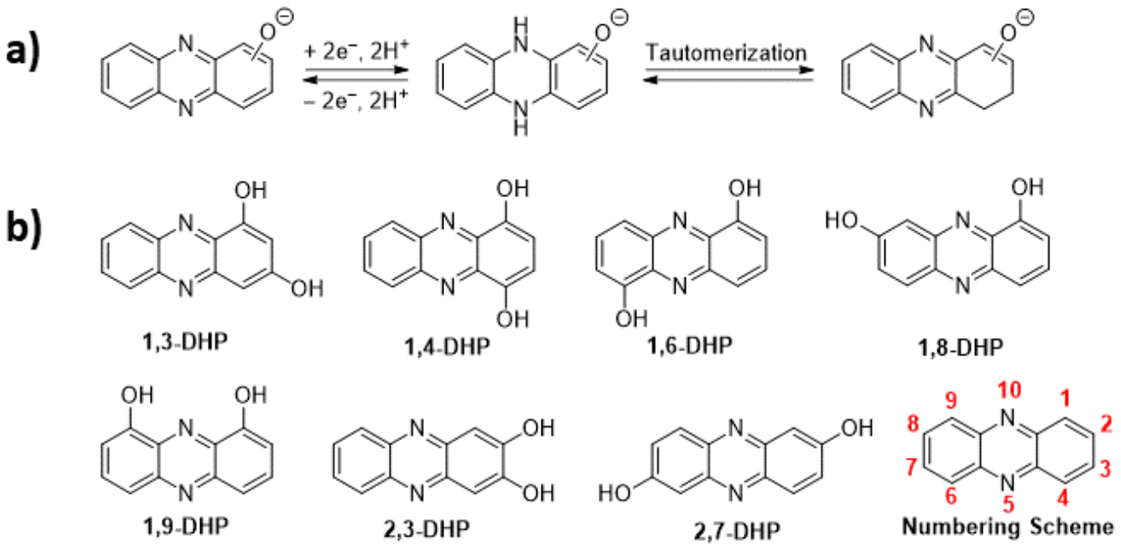
Mechanistic understanding of the degradation mechanism

Impact of substitution type on the stability





Impact of substitution pattern on the stability

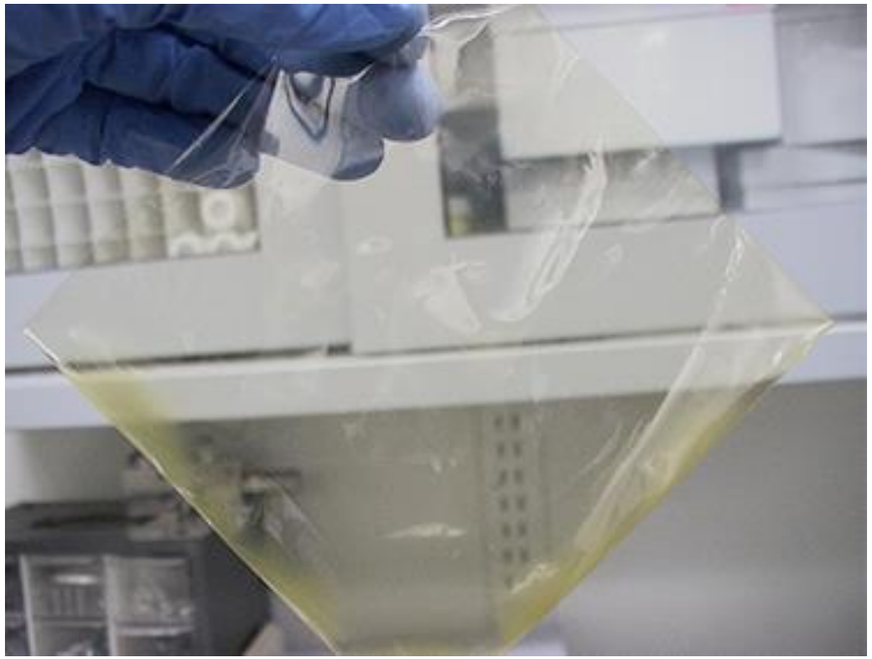


Talk: Understanding the stability of positive electrode materials for aqueous organic redox flow batteries

Poster: Decomposition pathways and mitigation strategies for highly-stable hydroxyphenazine flow battery anolytes

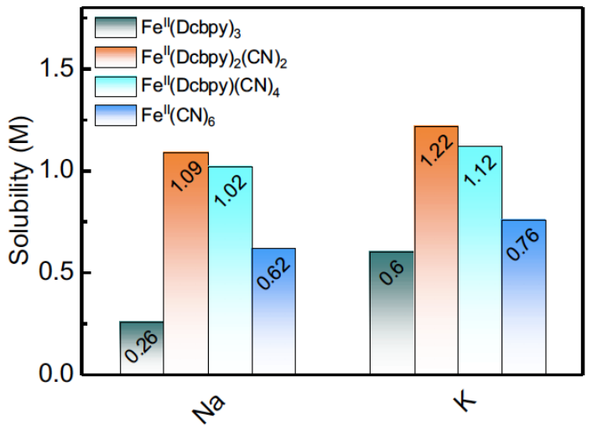
Membrane and catholyte development

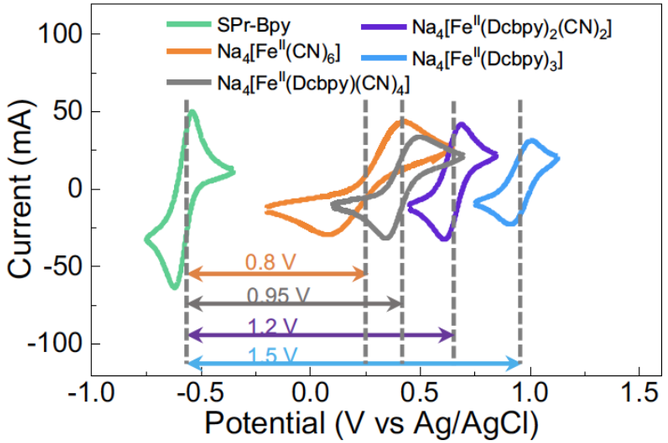
Flow Battery Membranes

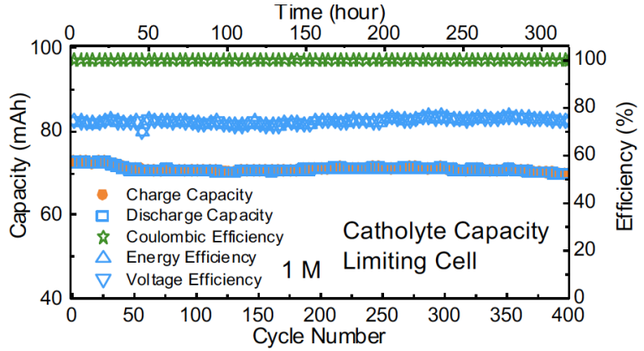


Talk: Sandia's Flow Battery Membrane Development

High potential, high solubility organic iron complex catholyte





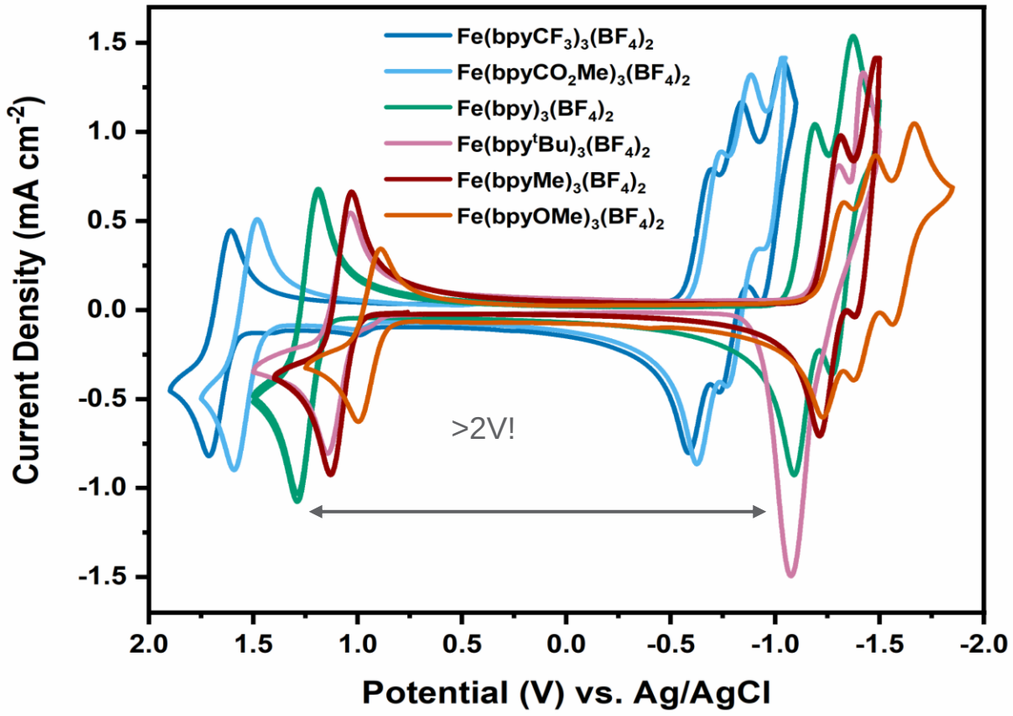


Poster: Symmetry-Breaking Design of an Organic Iron Complex Catholyte for a Long Cyclability Aqueous Organic Redox Flow Battery

Development of non-aqueous systems

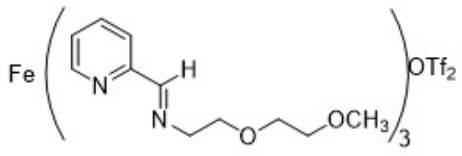
Fe/pyridine ligand systems

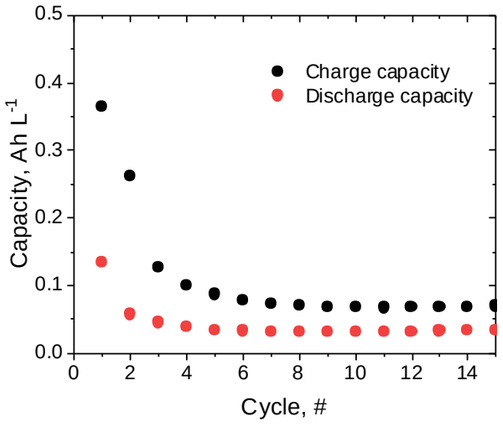
Modified Fe-bipyridines



Fe-aminopyridines

High Solubility (~1.5 M in MeCN)





Poster: Metal Coordination Complexes for Symmetric, Non-aqueous Flow Batteries

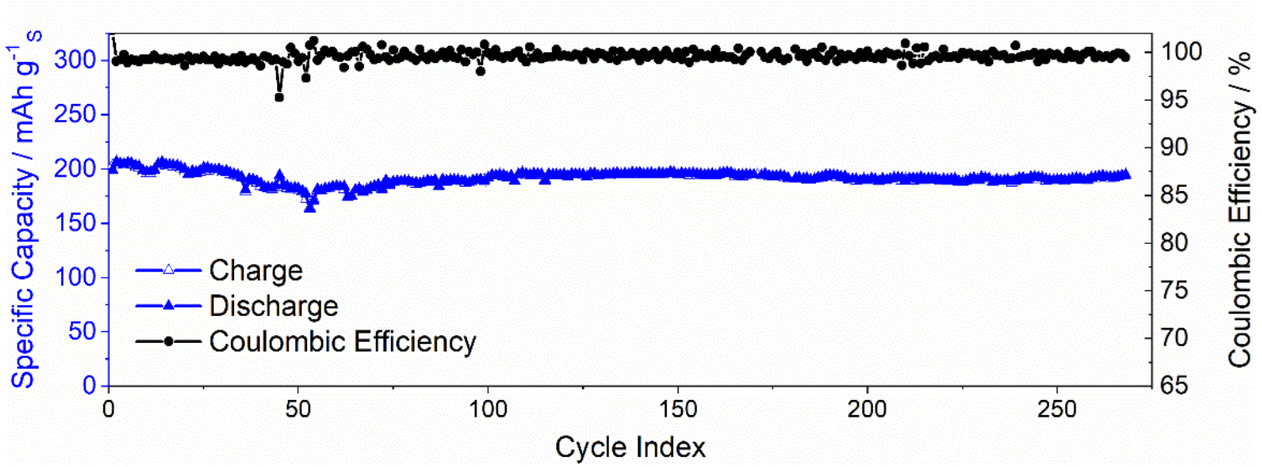
Talk: Non-Aqueous Redox Flow Battery : Materials Development

Hybrid flow battery systems

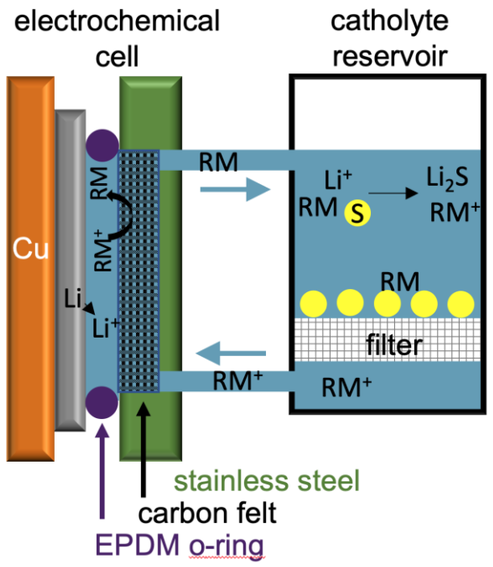
Ambient Temperature Polysulfide-Based RFBs

Full Cell: Cycling Insoluble Phases

$Na_2S_8 \leftrightarrow S_8$ ($Q_{theoretical}$ = 209 mAh/g_S)



Mediated Li-S RFB



Anode: Li-metal

Cathode: Sulfur

Ion-Selective Separator: None

Enabling Technology: Redox Mediators in Electrolyte

Talk: Development of Sodium Polysulfide as Catholyte for Ambient Temperature Redox Flow Batteries

Poster: Mediated Lithium-Sulfur Flow Batteries

Summary

- In FY21, the research teams supported by the Department of Energy Office of Electricity's Energy Storage Program made significant contributions through concerted efforts to the advancement of redox flow technology.
- These advancements enable redox flow battery technology to better support long-duration energy storage applications and use cases in support of the nation's decarbonization efforts.

Thank you