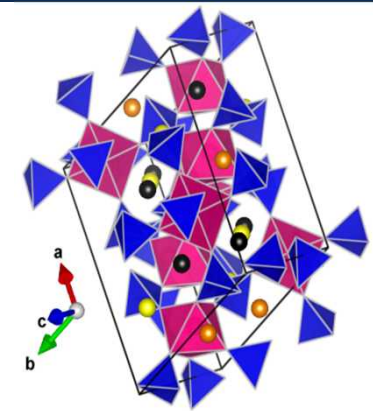
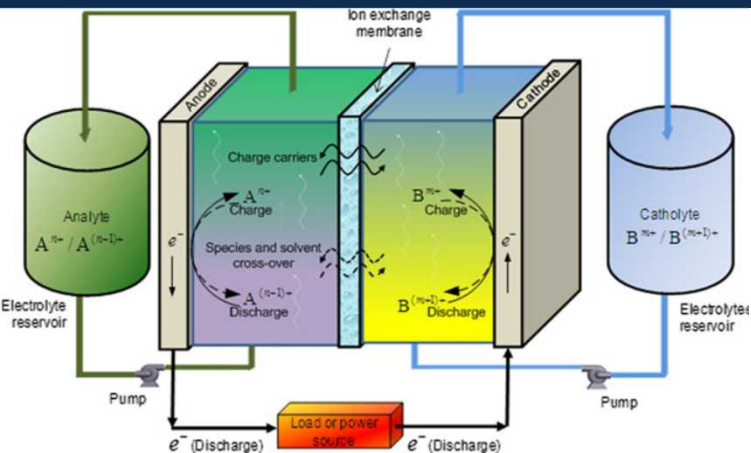


*Exceptional service in the national interest*



# Aqueous Na-ion Redox Flow Battery with Ceramic NaSICON Membrane

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**Motivation:** Use of a non-porous ceramic ion-exchange membrane eliminates species/solvent cross-over

- Improved cell life and efficiency
- Flexibility of separate supporting electrolyte media for anolyte / catholyte

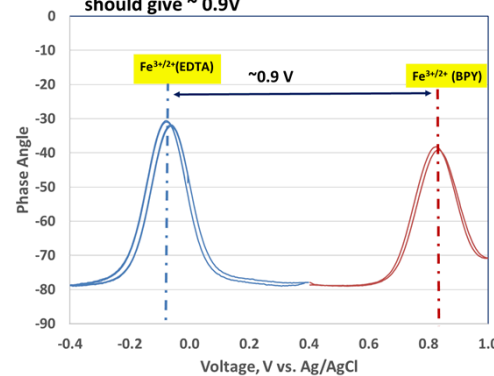
\*Acknowledgement to the financial support of Dr. Imre Gyuk and the DOE Office of Electricity Delivery and Reliability



## Proof of concept

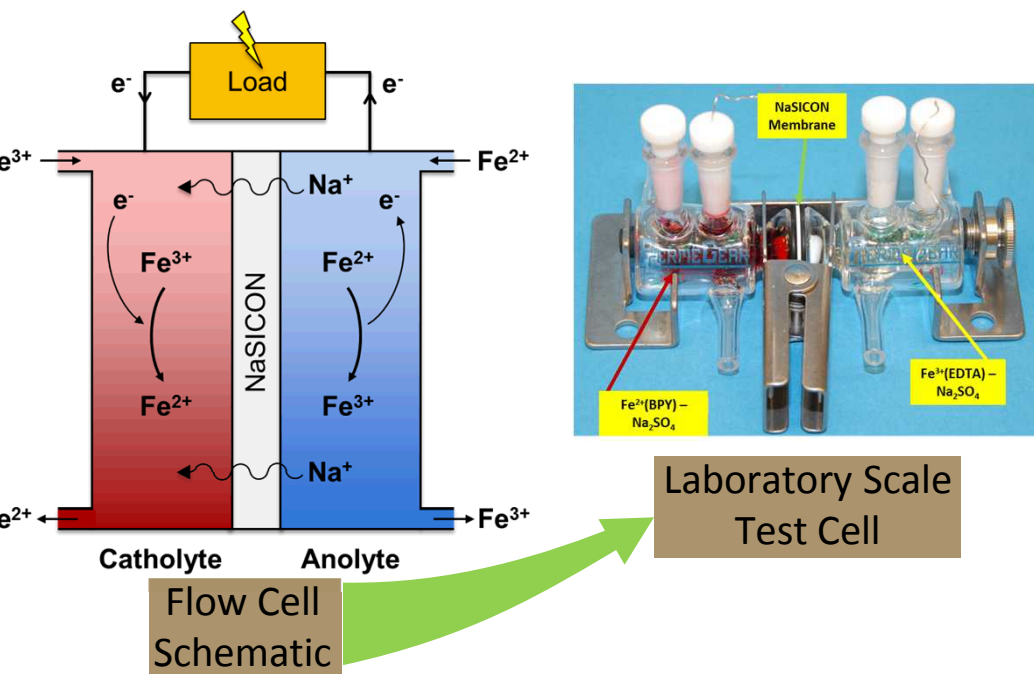
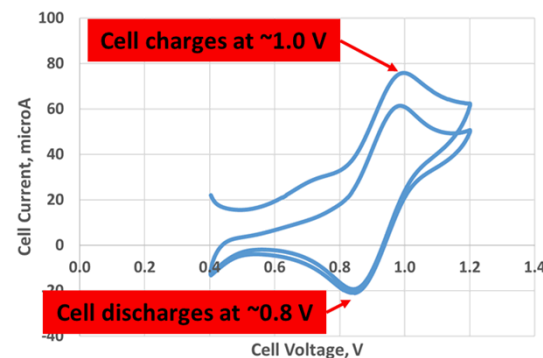
Redox couples of chelated transition metal complexes ferric-EDTA and ferrous-bipyridyl

The two redox couples when paired in a cell should give ~ 0.9V



Full cell utilizing NaSICON membrane shows ~100mV polarization relative to theoretical voltage based on material CVs

Full Cell CV @ 5 mV/sec  
 $\text{Fe}^{3+}(\text{EDTA}) // \text{NaSICON} // \text{Fe}^{2+}(\text{BPY})$   
 0.4M  $\text{Na}_2\text{SO}_4$



Laboratory Scale Test Cell

## NaSICON Ceramic

- High Na-ion conductivity enables operation with low polarization
- Water compatibility allows for development of safe, inexpensive, non-corrosive, environmentally friendly aqueous redox couples
- Good mechanical, thermal, electrochemical stability