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A Single Substance Organic Redox Flow Battery

Presented By:

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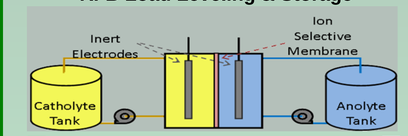
Abstract

Abundant energy, in the exajoule range, is available everyday from solar and wind flux. However, green sources of this energy are subject to intermittent and/or periodic fluctuations. Mitigation of supply obstacles is possible through the use of cost effective and dispatchable energy storage methods. During Phase I of this SBIR project, Vinazene has successfully synthesized and begun characterizing a group of new electroactive organic compounds, that are amenable to large scale Redox Flow Batteries.

Feature	Advantage	Benefit
Single Substance	Less deleterious crossover problem	Simplicity of design
Organic active material	Low cost Avoids toxic metals	Can be processed at low cost at the system level Green chemistry
Scalability	Flow batteries can easily scale to the application	Increase the size of the market, from home to grid
Non-aqueous, non-acidic, non-gaseous	Higher voltages Less corrosive active material	Fewer cells needed Less costly packaging
Increased solubility	Organic materials can be modified for solubility	Energy density scales with solubility

Source Fluctuations

RFB Load Leveling & Storage



Grid | **Agricultural & Industrial** | **UPS** | **Commercial & Residential**

Charging Mechanism

The Z compound, as described in Vinazene Patent 8,080,327, undergoes the following half reactions during charging:

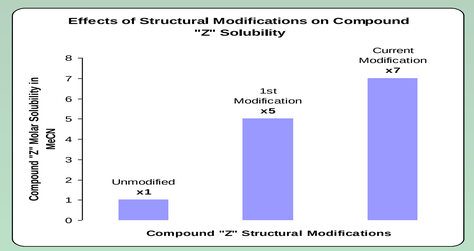
$Z \rightarrow Z^{+} + e^{-}$ $\quad E^0 = -1.3V$

$Z + e^{-} \rightarrow Z^{-}$ $\quad E^0 = -1.5V$

$2Z \rightarrow Z^{-} + Z^{+}$ $\quad E^0 = -2.8V$

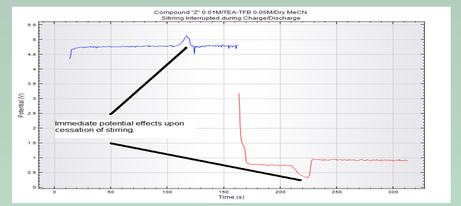
Energy Density

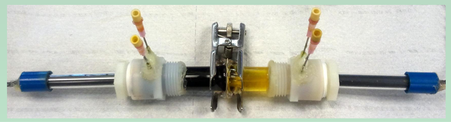
RFB energy scales with concentration of electroactive species. During Phase I, Vinazene has successfully synthesized Z compound variants by tailoring R1 and R2 to afford increased solubility.



Static vs. Flow Batteries

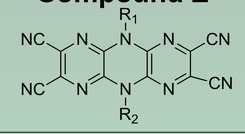
The following chart demonstrates the need to stir or flow charged species away from the electrodes.





Components

Compound Z



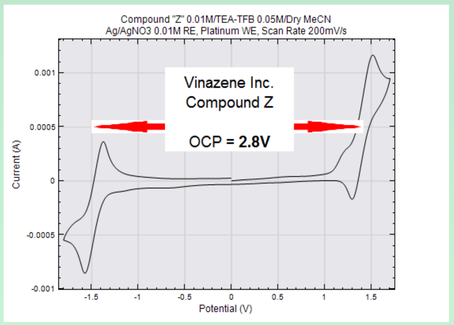
Tetraethylammonium Tetrafluoroborate ($TEA\text{-}BF_4$)

Maintains Electroneutrality

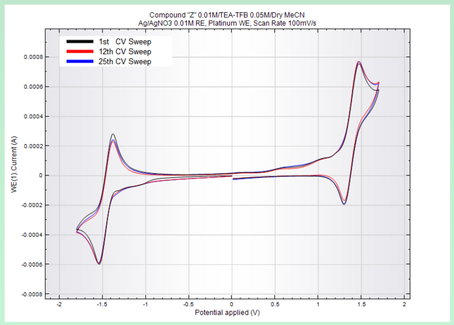
Acetonitrile (MeCN)

Dielectric and Transport medium

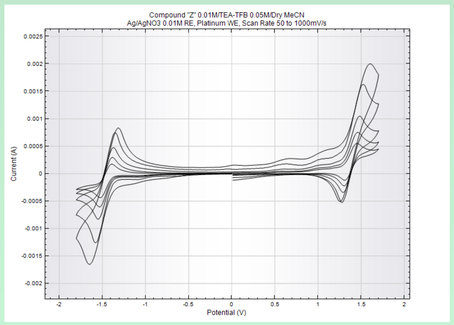
Cell Potential



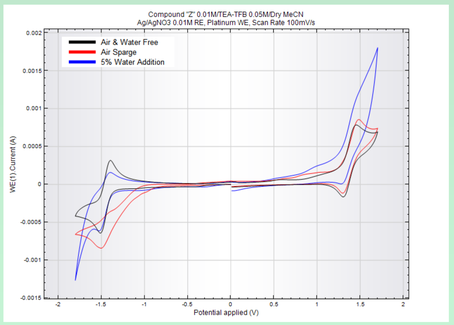
Multiple Cycle Reversibility



Kinetic Effects



Air and Water Effects



Summary and Future Plans

Charge/Discharge experiments are underway to optimize conditions for storage. Preliminary results for up to 30% state of charge indicate high cell resistance and the need for membrane improvement. Nevertheless initial discharge voltages as high as 2.2 v have been observed in stirred cells. An additional patent application is in preparation to cover the new active materials.

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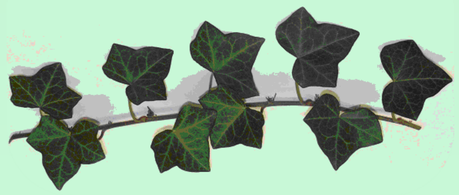

Acknowledgements

The Author would like to express gratitude for funding and support received from:

ArborWind
Next generation wind turbines

John Schroder, EE
Consultant Vinazene/MAREC

MAREC
Michigan Alternative & Renewable Energy Center

Paulson Law
Alternative Energy Siting Specialists

Porous Power
Battery Separator Specialists

SPARK Ann Arbor
Small Business Accelerator

US Department of Energy
Energy Storage Systems

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