WashU

Office of Technology Management

LOW COST ELECTRODE DECOUPLED REDOX FLOW BATTERIES FOR GRID-SCALE ENERGY STORAGE

Ramani, Vijay, Sankarasubramanian, Shrihari

Maland, Brett

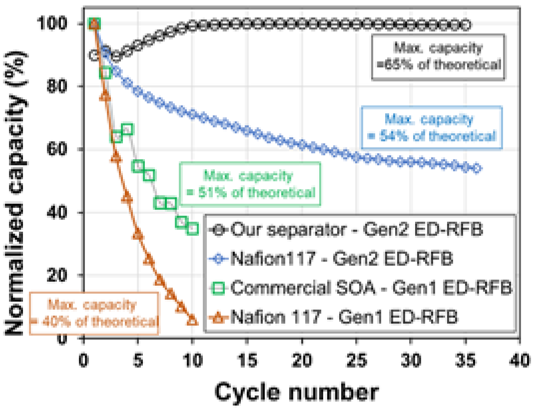
T-018530

Technology Description

Engineers in Prof. Vijay Ramani's laboratory have developed an electrode decoupled redox flow battery (RFB) with stable electrolyte materials that can generate power densities comparable to all-Vanadium RFBs at less than half the cost.

RFBs are a promising option for grid-scale energy storage because their storage capacity can be scaled by increasing the volume of stored electrolyte instead of increasing the number of expensive battery stacks. However, current commercial RFB systems do not meet DOE cost targets of <$100/kWh due to the cost of the all-Vanadium active material used at both electrodes. This new RFB design addresses this problem by decoupling the electrodes (i.e. allows the use of different cationic actives at the anode and cathode without mixing) with an anion exchange membrane that separates the positive and negative electrolytes. The system provides greater flexibility to tailor RFB chemistries to meet cost and performance goals. Furthermore, the inventors identified a low-cost pair of metals that can provide the necessary power density with remarkable long term performance stability.

Related Technology: The Ramani lab has developed anion exchange membranes (AEM) separators (WUSTL Technology T-018608 and others) that were used in the RFB prototype.



Performance of electrode-decoupled RFB (Gen2) using the AEM separator.

Stage of Research

Lab-scale Prototype - The inventors demonstrated the electrode-decoupled RFB consisting of a 0.5M Ti-Ce cell with a sulfate anion and 0.9M Ti-Ce cell with a methanesulfonate anion. Results showed: power densities of >500 mW/cm^2; ~300 mW/cm^2 power density at the charge voltage of 1.2 V; cumulative >2000hrs of cycling with minimal (<5%) loss of energy efficiency over >600hrs continuous operation (8hr charge-8hr discharge cycles) and separator stability over 6 weeks at 40^{o}C in highly acidic environments.

Applications

- **Grid-scale energy storage**

Key Advantages

- **Low cost:**
    - active materials less than half the cost of materials for an all-vanadium RFB with comparable power density
    - demonstrated DOE cost target (<$100/kWh; <$0.05/kWh-cycle)
- **Excellent stability** – cumulative >2000hrs of cycling with minimal (<5%) loss of energy efficiency over >600hrs continuous operation
- **Advantages of redox flow batteries -** modular and scalable because power and energy are decoupled and they have a low per-cycle cost

Patents

- Redox flow battery (U.S. Patent Application, Publication No. US20190280323)

Website

- Ramani Lab