Efficient Rechargeable Li/O_2 Batteries Utilizing Stable Inorganic Molten Salt Electrolytes

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Technical Approach:

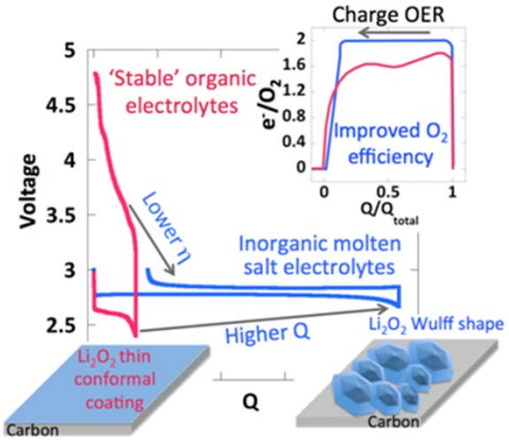
- Replace volatile, unstable and/or air-intolerant aqueous or organic electrolytes with inert molten nitrate electrolytes and operate battery above liquidus temperature (>80° C).
- Improved reversibility and rate capability since battery discharge products (Li_2O_2, Li_2O, LiOH and Li_2CO_3) are stable and sparingly soluble in molten nitrate electrolytes; Electrode kinetics and mass transport are faster at elevated temperature.

Status:

- Developed strong testing protocol to characterize battery reactions and performance.
- Measured battery discharge products solubility and diffusivity in molten nitrate electrolytes.
- Determined e^-/O_2 molar ratio for baseline carbon, oxidatively stable carbon, and metal nanoparticle O_2 electrodes.

Technology:

Long-term, higher rate, low voltage hysteresis Li/O_2 battery cycling enabled by enhanced solubility of discharge products.



Objectives:

- Develop Li/O_2 batteries comprising inorganic molten salt electrolytes and protected Li anodes which demonstrate high (>500 Wh/kg) specific energy and efficient cycleability in ambient air.
- Demonstrate very high capacity, reversible, 4 electron Li/O_2 battery (Li_2O discharge product).

Deliverables:

Combine quantitative gas analysis (pressure monitoring, mass spectrometry) with precise coulometry to analyze oxygen electrode processes. Identify non-carbonaceous O_2 electrode materials and manage Li_2O_2 dissolution and precipitation.

Funding:

- Duration - 3 yrs (Yr 2)
- Total DOE share - $1,050,000
- Total Liox share - $375,000

FY 2016 Milestones:

- **Q1**: Quantify e^-/O_2 and OER/ORR ratio for metals and metal alloys in half cells under pure O_2.
- **Q2**: Determine the kinetics and mechanisms of electrochemical nitrate reduction in the presence of O_2, H_2O and CO_2.
- **Q3**: Go/No-Go: Demonstrate e^-/O_2=2 and OER/ORR ratio=1, +/- 5%. Criteria: Correcting for the effect of Li_2O_2 crossover if the battery employs an unprotected Li electrode.
- **Q4**: Demonstrate Li_2O yield=1, e^-/O_2=4 and OER/ORR ratio=1, +/- 5%.