Efficient Rechargeable Li/O₂ Batteries Utilizing Stable Inorganic Molten Salt Electrolytes

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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 (Li₂O₂, Li₂O, LiOH and Li₂CO₃) 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⁻/O₂ molar ratio for baseline carbon, oxidatively stable carbon, and metal nanoparticle O₂ electrodes.

Technology:
Long-term, higher rate, low voltage hysteresis Li/O₂ battery cycling enabled by enhanced solubility of discharge products.

Objectives:
- Develop Li/O₂ 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/O₂ battery (Li₂O discharge product).

Deliverables: Combine quantitative gas analysis (pressure monitoring, mass spectrometry) with precise coulometry to analyze oxygen electrode processes. Identify non-carbonaceous O₂ electrode materials and manage Li₂O₂ 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⁻/O₂ and OER/ORR ratio for metals and metal alloys in half cells under pure O₂.
- Q2: Determine the kinetics and mechanisms of electrochemical nitrate reduction in the presence of O₂, H₂O and CO₂.
- Q3: Go/No-Go: Demonstrate e⁻/O₂=2 and OER/ORR ratio=1, +/-5%. Criteria: Correcting for the effect of Li₂O₂ crossover if the battery employs an unprotected Li electrode.
- Q4: Demonstrate Li₂O yield=1, e⁻/O₂=4 and OER/ORR ratio=1, +/-5%.