Technology Overview

This invention relates to a series of electrolyte formulations that have a demonstrated ability to support Li-ion battery operation in a wide temperature range, from -20°C to +75°C. In particular, it enables operation of Li-ion technology at higher temperatures than current state-of-art

- A match was identified between lithium bis(oxalate)borate (LiBOB) salt and lactone-based solvents
- A series of lactones were screened to minimize the irreversible capacity in the 1.70 V region:
  - Irreversible capacity directly affects cell impedance and power density
  - Two lactones were found to yield the least irreversible capacity: γBL and γCL
  - The lactone γBL provides the highest stability at elevated temperature
- Electrolyte composition is fine tuned to minimize cell impedance:
  - Mixture with linear carbonates found most effective
- A Li-ion cell based on the new electrolytes can operate in a wider temperature range, with negligible loss in capacity and power density and with enhanced safety

Technology Agreements

Either a patent license or CRADA is sought to advance commercialization

- Further refinement of the invention continues
- CRADA agreement would most likely accelerate research aimed at commercialization
- However, a patent license would also be acceptable path toward this goal
- This technology is currently at a TRL of about 6, and a non-provisional patent application has been filed

Technology Advantages

This technology provides electrolyte formulations that enables high temperature operation of Li-ion batteries with better stability and enhanced safety:

- The salt and solvent components are commercially available
- The capacity retention at high temperatures is improved
  - For NCA chemistry at 75°C: > 90% at the 100th cycle vs ~ 50% for SOA electrolytes.
  - For LFP chemistry at 60°C: > 95% at the 100th cycle vs ~ 80% for SOA electrolytes.
- The Li-ion batteries did not ignite even during severe overcharge to 12 V.

Technology Differentiation

This invention presented a solution for the Li-ion battery’s capacity fading at high temperature

- Currently Li-ion batteries can only be used in a narrow practical service temperature range between -20°C to about 40°C
- Use of LiBOB in combination with γBL and other lactones significantly widens the temperature range to potentially -30°C to 80°C
- In every Li-ion cell built and tested to date, capacity retention stayed ~ 95% with 500 cycles, and > 90% with 1000 cycles

Prototype built with different Li-ion chemistries proved that these electrolyte formulations are “universal” and can be adapted to different new cathode chemistries

Technology Applications

Commercial

- Li-ion battery stability at high temperature is especially vital to electric vehicles
- Stationary application of Li-ion batteries in grid stabilization also requires high temperature stability
- Li-ion market estimated currently to be in ~$11 billion range worldwide

Military

- Electrified power systems in military vehicles and field operating bases require stability in high temperature operations
- Mobile applications in hot climates, in particular dismounted soldier power, demand better Li-ion battery stability and safety.

Electrolyte Formulations for Wide Temperature Lithium Ion Batteries

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