Additive for Enhancing the Performance of Electrochemical Cells

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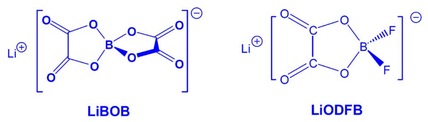
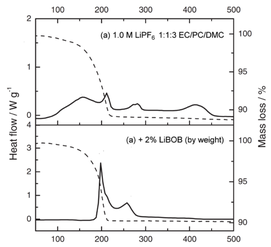
Technology Overview

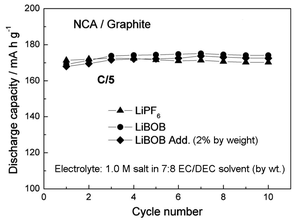
- This is a novel electrolyte system containing a new additive for improving the performance of Li-ion batteries.
- The new additive is a salt that can be used with industry standard salts, $LiPF_6$ or $LiBF_4$, featured in current state-of-the-art lithium electrolytes.
- This solvent can easily be inserted in the present electrolyte manufacturing.
- This additive salt is derived from an anion of a mixed anhydride of oxalic acid and boric acid.
- The specific additive salts include lithium bis(oxalato) borate and lithium oxalyldifluoroborate.
- This new electrolyte system can be applied to Li-ion battery systems having a carbonaceous anode paired with a wide variety of cathode materials
- *J. Power Sources*, 2007, 163, 1074-1079.



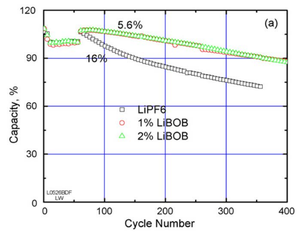
Samples of additives



Additive improves thermal stability of graphite anode
(Source: J. Electrochem. Soc. 157 (2010) A721-A728)



Additive increases capacity at room temperature
(Source: J. Electrochem. Soc. 157 (2010) A721-A728)



Additive improves capacity retention at 55°C
(Source: J. Power Source 163 (2007) 1074-1079)

Technology Advantages

- Reduces first-cycle irreversible loss of charge capacity by about one-half when compared to existing Li-ion cells containing $LiPF_6$ or $LiBF_4$ in carbonate solvent mixtures.
- Retains as much as 20% higher reversible capacity for subsequent cell cycling at elevated temperatures (55°C); it also has higher capacity utilization at lower temperatures.
- The new electrolyte formulations facilitate the formation of solid electrolyte interface (SEI) that protects carbonaceous anode and various cathode materials.
- It does not add cost for electrolyte materials.
- It does not alter manufacturing process for the production of Li-ion batteries.

Proof of Concept

- Demonstrated significant reduction of irreversible capacity loss by adding small amount of LiBOB in the electrolyte of $LiPF_6$ or $LiBF_4$ in EC-PC-EMC solvent mixtures in graphite/$LiNi_{0.15}Co_{0.80}Al_{0.05}$ cells.
- As illustrated in the graph above, this technology has demonstrated excellent capacity retention at 55°C in graphite/$LiNi_{0.15}Co_{0.80}Al_{0.05}$ cells.
- TRL 5 – Prototype cells containing these innovations have been demonstrated.

Technology Differentiation

- The charge capacity and the cycle life of batteries is typically reduced substantially at elevated temperatures. Such performance fading erodes the operational run time of an electrical power system, which for the military increases the logistical burden of carrying additional Li-ion batteries to the battlefield.
- This invention reduces the capacity fading throughout the temperature range of Li-ion cells, but particularly at elevated temperatures. This allows longer operational run time, which reduces the logistical burden of supplying Li-ion batteries and ultimately reduces battlefield management costs.

Technology Agreements

- Patent License Agreements, CRADA, and/or Test Service Agreement are sought
- The agreements would be used to speed the commercialization of the invention
- This technology is currently at TRL 5, and has been issued two patents (US Patents 7,172,834 and 7,524,579)

Technology Applications

Commercial:

- Portable electronic devices such as Notebook PC, smart phones
- **HEV** and **PHEV**
- Electrolyte market worldwide is estimated to be more than $1 billion

Military:

- Soldiers power for all portable devices
- Vehicle power for hybrid electric drives and auxiliary power.

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