

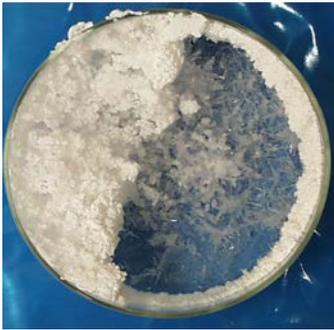
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PURE LIBOB SALT & PURIFICATION PROCESS

(Xu)

Introduction

The present invention includes the synthesis and purification of a new lithium salt, bis(oxalato) borate (LiBOB). The core technology provided by this invention is the purification procedure, the quality-control standard, and the resulting pure form of LiBOB obtained from this procedure. This pure form of LiBOB is a distinct compound as compared with other available commercial products. A pure form of LiBOB is required in order to achieve the desired superior performance at elevated temperatures.



Ultra-pure LiBOB electrolyte salt prepared via SEDD process
(Image source: SEDD)

Concept

LiBOB was invented as a lithium salt to replace the problematic LiPF_6 in Li ion batteries. The theoretical expectation was that the LiBOB would be thermally stable and would enable Li ion cells to operate at high temperatures; especially as required by hybrid electric vehicle (HEV) applications. However, from a development perspective, LiBOB proved to be very difficult to purify. The common impurities it contains inflict unfavorable properties when used in Li ion batteries. These issues include high impedance, low stability at high temperature and very high irreversible capacity during the forming stage of a Li ion battery; thus reducing its energy density. To date, there are reported challenges in developing a reliable purification procedure, a reliable quality-control standard, and an adequately pure form of LiBOB salt that meets the requirements of the battery industry for HEV applications.

Invention Overview

- ❖ Thermally stable; ideal for high temperature environments (i.e., hybrid electric vehicles)
- ❖ Maintains 95% energy density after 1,000 cycles
- ❖ Outperforms industry standard lithium salt (LiPF_6) in Li ion batteries
- ❖ Outperforms commercially available LiBOB
- ❖ TRL 6-7 – Well developed & tested
- ❖ Laboratory data available

Doing Business with ARL

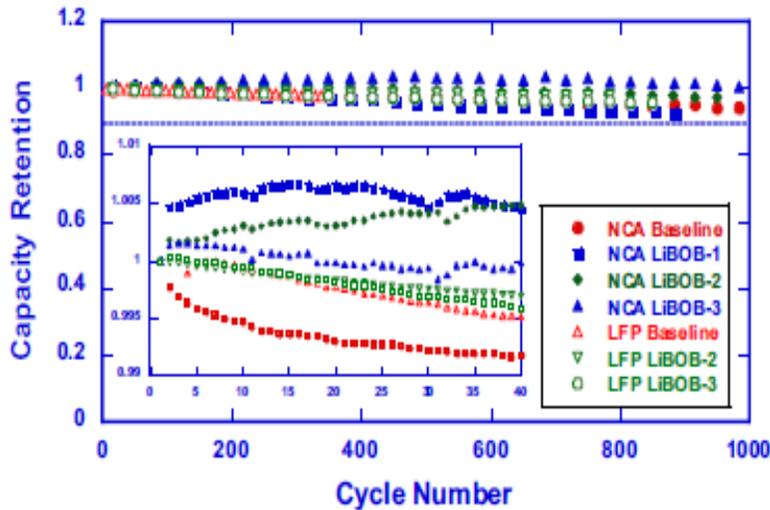
- ❖ ARL-SEDD is a leader in partnering with domestic firms
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Features/Capabilities/Intellectual Property

The pure form of LiBOB described by this invention delivers superior performance that includes negligible irreversible capacity upon cell formation, low impedance on both cathode and anode, and excellent stability when operated at high temperatures up to 80°C. These characteristics are especially critical for the applications in HEV's, which requires the Li ion cell to have high-temperature stability, high power density and long shelf life. Features of the invention include:

- Thermally stable/can operate in high temperature environments (e.g., Hybrid Electric Vehicles)
- Purification procedure and established quality control standards
- Superior performance improvement over commercially available LiBOB
 - + Commercially available LiBOB: Energy density decrease to 70% of original capacity after 100 cycles
 - + Pure LiBOB invention: Maintains 95% energy density after 1,000 cycles



Potential Markets/Applications

The invention provides for a pure form of lithium bis(oxalato)borate (LiBOB) which can be used in Li ion batteries and electrochemical double layer capacitors (supercapacitors). In particular, the invention benefits Li ion battery high temperature applications/environments such as those found in hybrid electric vehicles (HEV).

The purification method developed is also useful for producing other salts that have the BOB anion, such as NaBOB or other metal salts as additives, ionic liquid for double layer capacitors and batteries, etc.

Key Advantages & Benefits

- ❖ Establishes purification process and standard; nearly 100% pure
- ❖ Excellent stability at high temperature; up to 80°C
- ❖ Well suited for harsh environments of Hybrid Electric Vehicles (HEV)
- ❖ Superior performance vs. existing commercial LiBOB; maintains 95% energy density after 1,000 cycles
- ❖ Well developed technology; tested in prototype Li ion cells
- ❖ Inventor team available to work with commercialization partner

Contact Information

This technology was developed by ARL-SEDD. It is now available for licensing and CRADA opportunities.

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