A New Paradigm for Building Medical, Military and Space Grade Batteries

November, 2007

Quallion LLC
12744 San Fernando Road
Sylmar, CA 91342

Powering Life.™

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2 ways for High Reliable Battery Production

Highly regulated precision production

- Small quantity
- Imbedded QC testing

High volume robotic production

- Large quantity (>3M cells per month per line)

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Highly Regulated Precision Production

- Electrode Mfg
- Cell Assembly
- Cell Testing
- Pack Assembly
- Pack Testing

- Dry room
- Mixing, coating, slitting, die cutting
- Micro-winding & stacking technologies
- Welding technologies: Ultrasonic, Resistance, Laser
- 100% X-ray inspection
- 100% GC-MS/gross leak detection
- 100% Helium fine leak detection
- 100% Electrochemical testing
- Battery Development
- Battery Integration
- System testing
- 100% traceability

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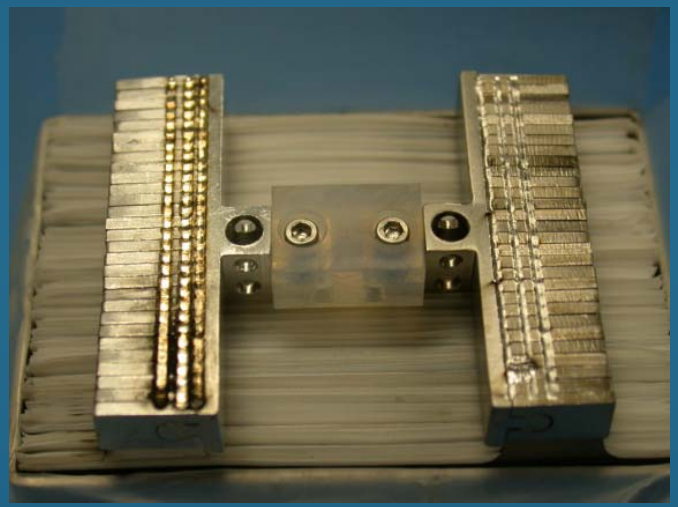
True Prismatic Li-ion Space Battery Manufacturer

- **15Ah and 72Ah cells**



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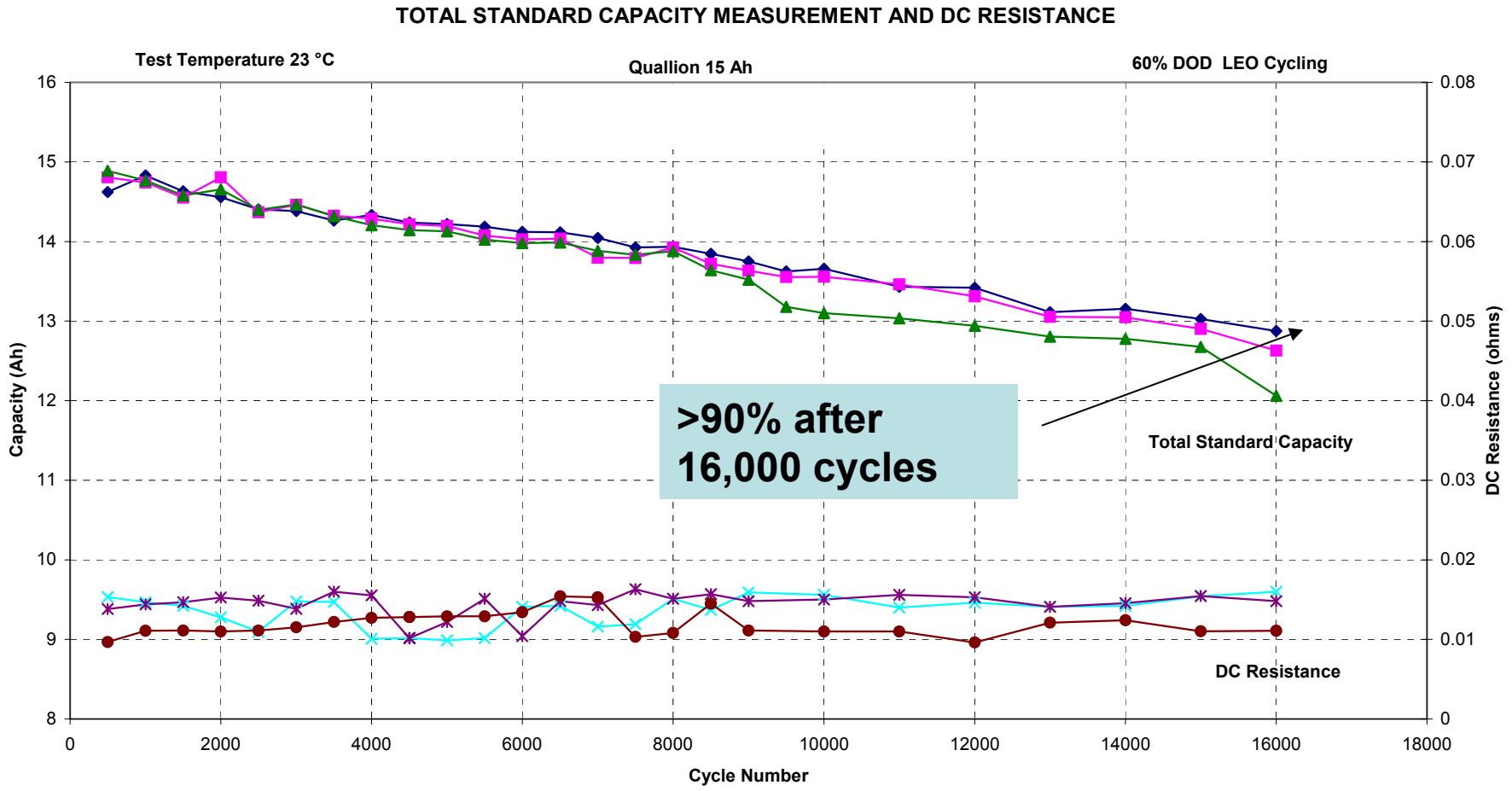
15Ah LEO cell: DOD 60% cycle (62Wh/kg per cycle)



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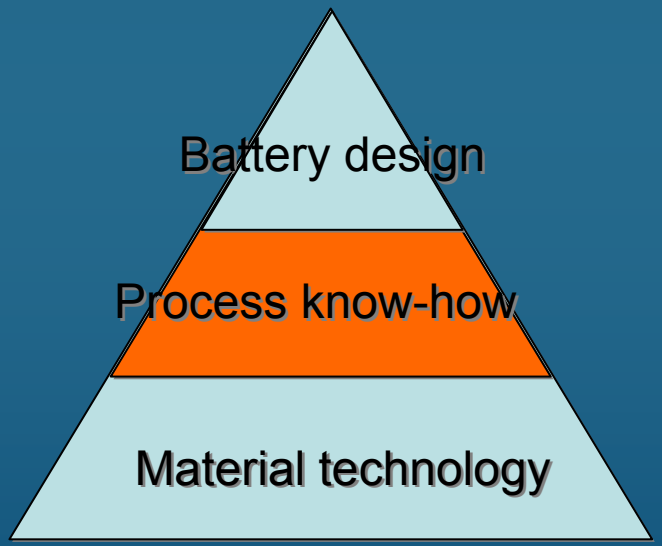
In-house Material Capability

The Battery Technology



Quallion Material Lab
- SEM
- EDX
- TG/DTA
- DSC
- XRD
- Micro calorimetry
- Solartron
- BET surface area analysis
- Particle counter
- NMR
- FT-IR
- ICP
- GC-MS

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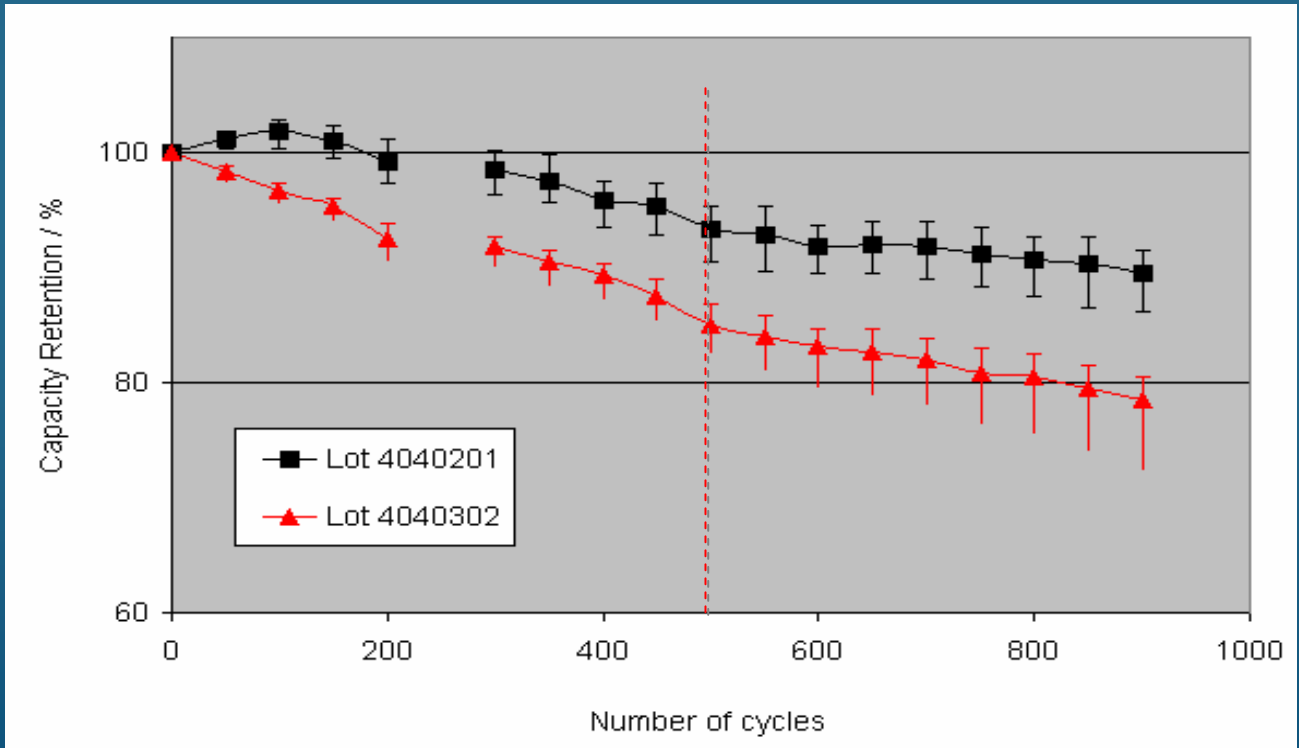
Collaboration with material company

-trusted material and battery technology-

Incoming Inspection Test Procedure Identifies Performance Variance with Among Lots



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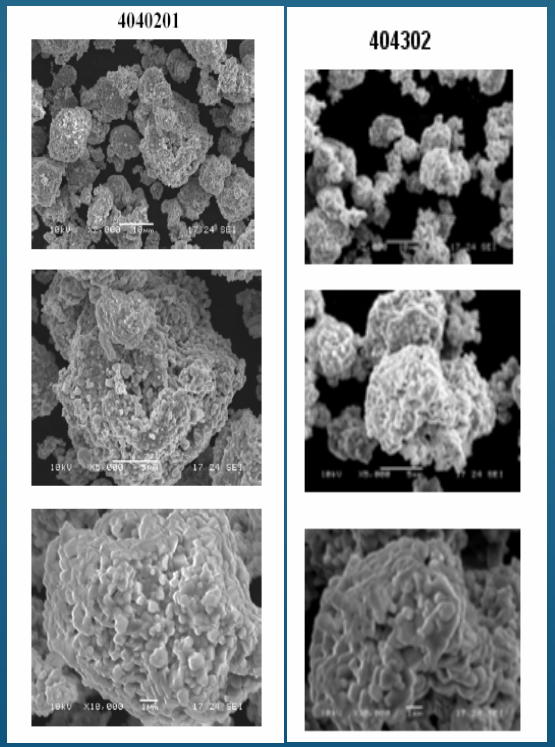
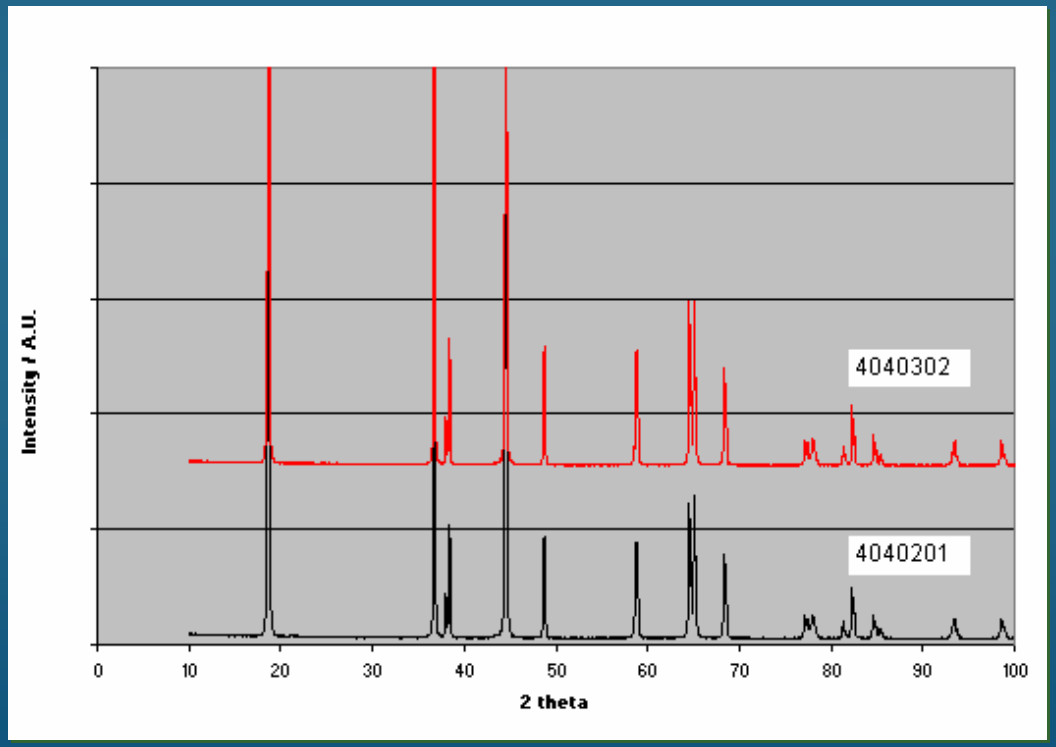
Identical morphology and Identical XRD pattern





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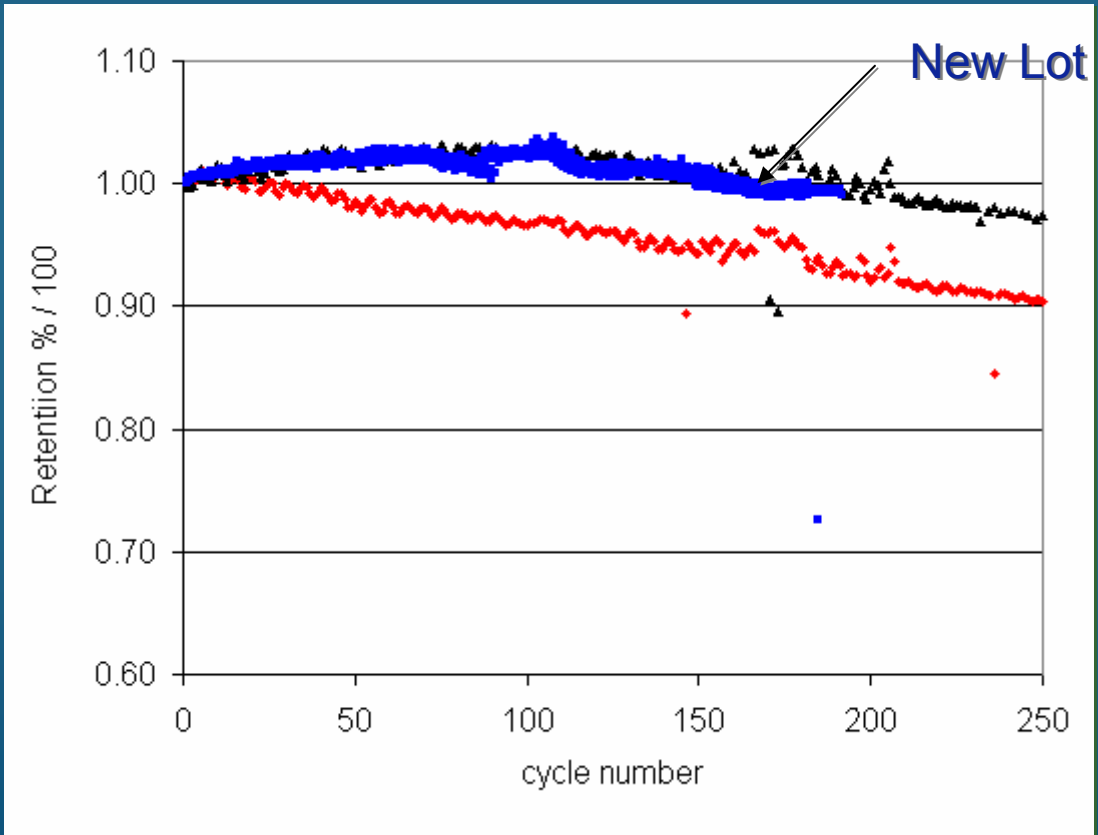
Precursor, Process review and testing with the Material company



Successfully reproduced desired particle

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Unique Safety Technology

- Zero volt technology
- SaFE-LYTE
- HAM
- E-beamed separator

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Zero-volt Storage technology

Unexpected and Unwanted Deep Discharge

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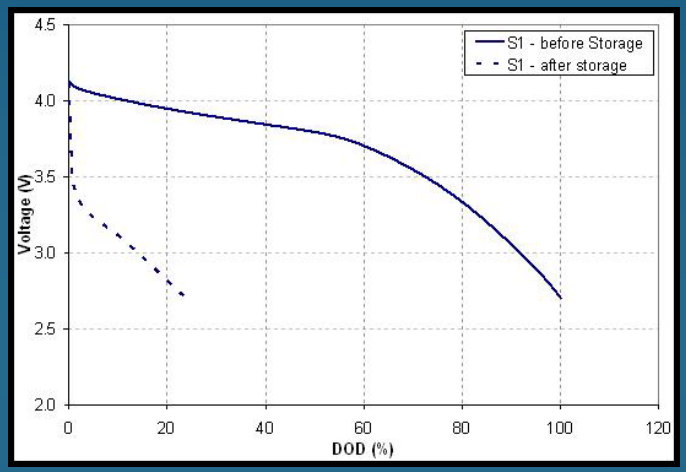
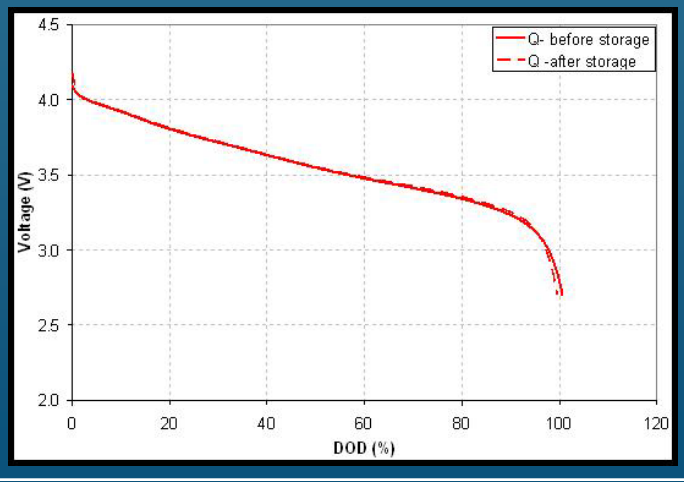
Commercial cell vs. Quallion Zero-Volt cells

-Before and After 3 days Storage at Zero Volt-

Room temperature storage



Commercial 18650



Quallion Zero-Volt 18650

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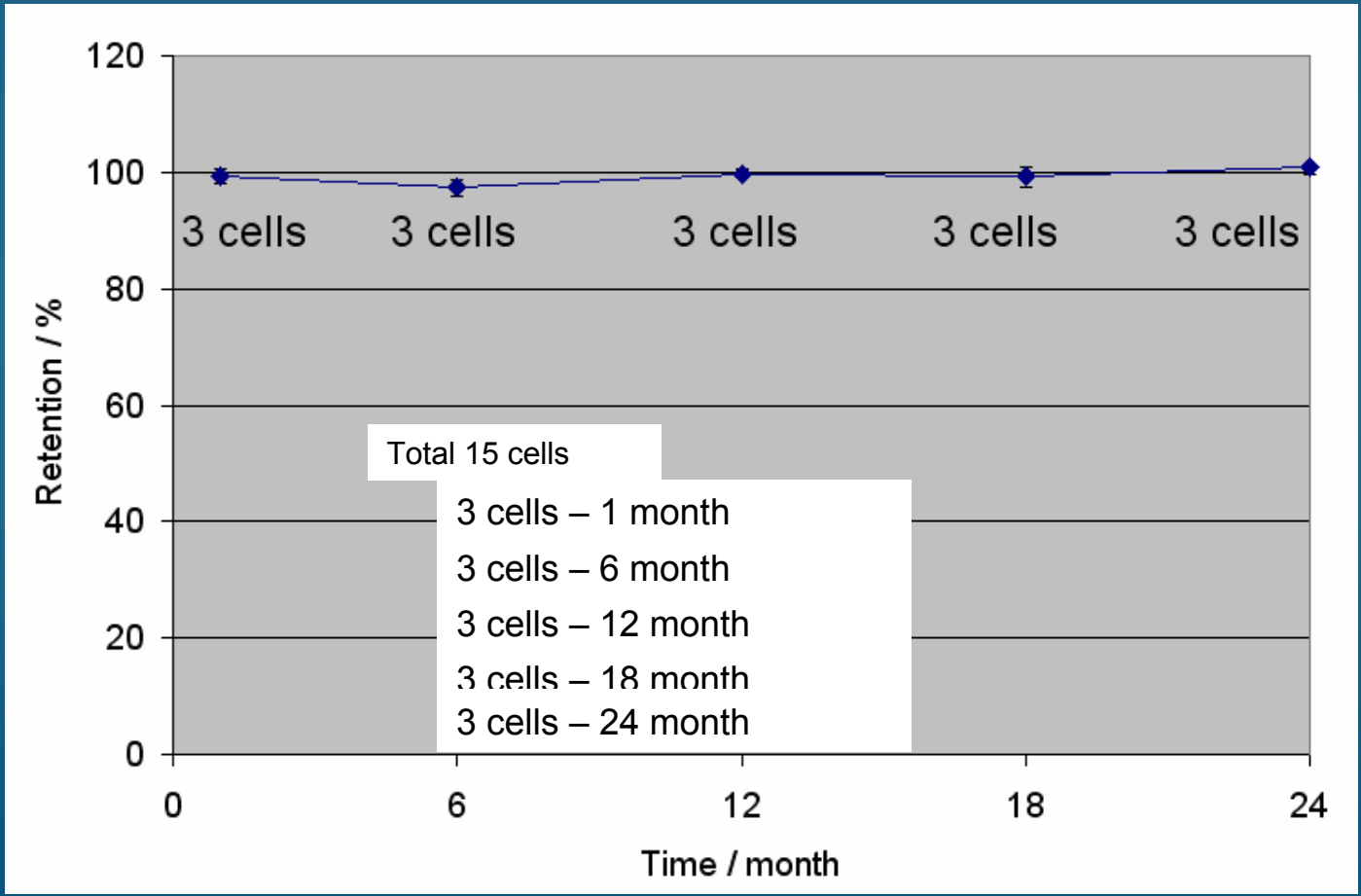
Quallion cell: Zero volt storage test at 37C for 24 months



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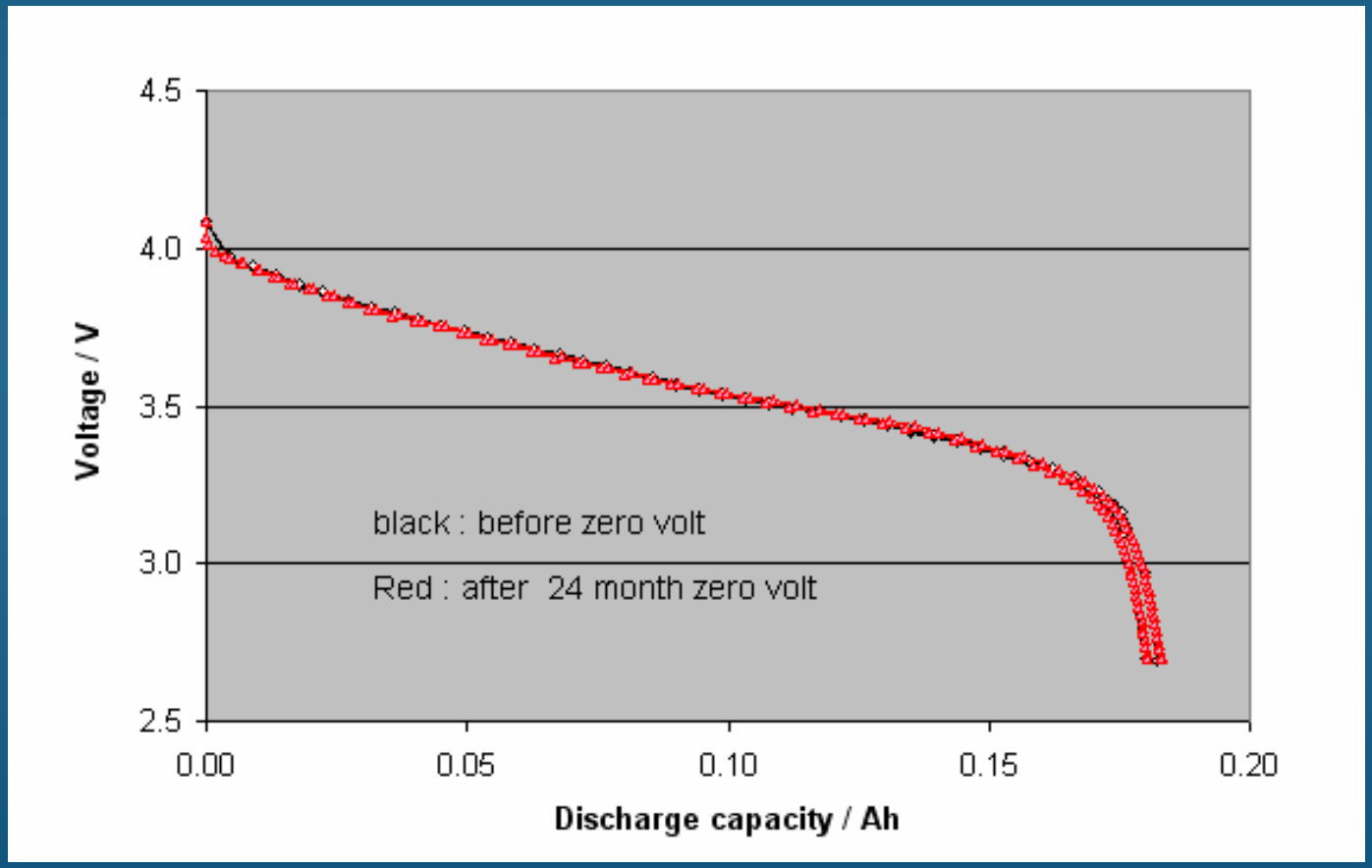
Discharge curve comparison before and after zero volt storage for 24 months at 37C



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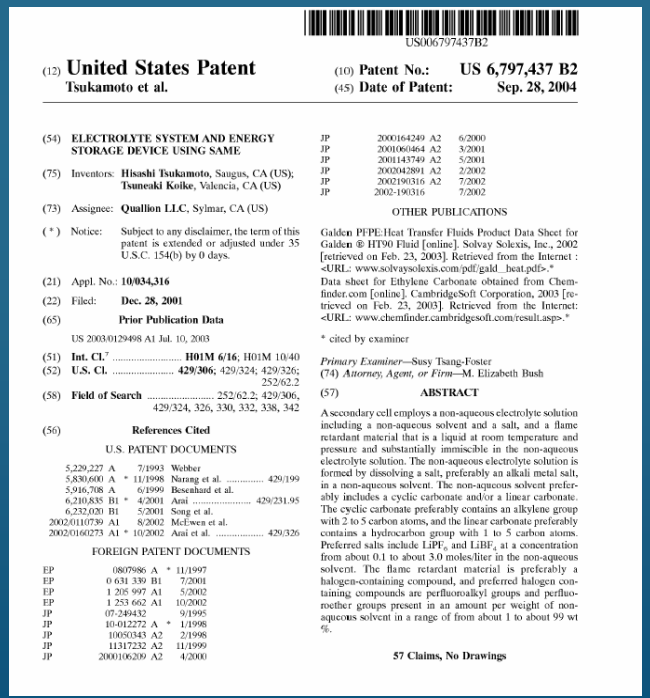
SaFE-LYTE™ Technology

Issued on 9/28/04,
Patent No. 6,797,437



US006797437B2

(12) **United States Patent**
Tsukamoto et al.

(10) **Patent No.: US 6,797,437 B2**
(45) **Date of Patent: Sep. 28, 2004**

(54) **ELECTROLYTE SYSTEM AND ENERGY STORAGE DEVICE USING SAME**

(75) Inventors: **Hisashi Tsukamoto**, Saugus, CA (US); **Tsuneaki Koike**, Valencia, CA (US)

(73) Assignee: **Quallion LLC**, Sylmar, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/034,316**

(22) Filed: **Dec. 28, 2001**

(65) **Prior Publication Data**

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(51) **Int. Cl.**[7] **H01M 6/16**; H01M 10/40

(52) **U.S. Cl.** **429/306**; 429/324; 429/326; 252/62.2

(58) **Field of Search** 252/62.2; 429/306, 429/324, 326, 330, 332, 338, 342

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(57) **ABSTRACT**

A secondary cell employs a non-aqueous electrolyte solution including a non-aqueous solvent and a salt, and a flame retardant material that is a liquid at room temperature and pressure and substantially immiscible in the non-aqueous electrolyte solution. The non-aqueous electrolyte solution is formed by dissolving a salt, preferably an alkali metal salt, in a non-aqueous solvent. The non-aqueous solvent preferably includes a cyclic carbonate and/or a linear carbonate. The cyclic carbonate preferably contains an alkylene group with 2 to 5 carbon atoms, and the linear carbonate preferably contains a hydrocarbon group with 1 to 5 carbon atoms. Preferred salts include $LiPF_6$ and $LiBF_4$ at a concentration from about 0.1 to about 3.0 moles/liter in the non-aqueous solvent. The flame retardant material is preferably a halogen-containing compound, and preferred halogen containing compounds are perfluoroalkyl groups and perfluoroether groups present in an amount per weight of non-aqueous solvent in a range of from about 1 to about 99 wt %.

57 Claims, No Drawings

The Problem:

Develop non-flammable, organic-electrolyte by adding non-flammable compounds to electrolyte.

Limited success with suppressing fire.

Additives negatively impacted cell performance.

The Solution:

Add non-aqueous flame retardant solvent which is non-miscible with electrolyte.

Significant reduction in thermal runaway with no effect on general cell performance

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SaFE-LYTE™

- Flame Retardant Additive
- Non-miscible with Electrolyte
- Non-miscible with Water
- Non-Conductive
- Non-Corrosive
- Chemically and Electrochemically stable

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Commercial 523450 cells
- "Over Charge + Nail" Tests Results-

Cell charged to 4.4V

No SaFE-LYTE™

Cell charged to 4.4V

With SaFE-LYTE™

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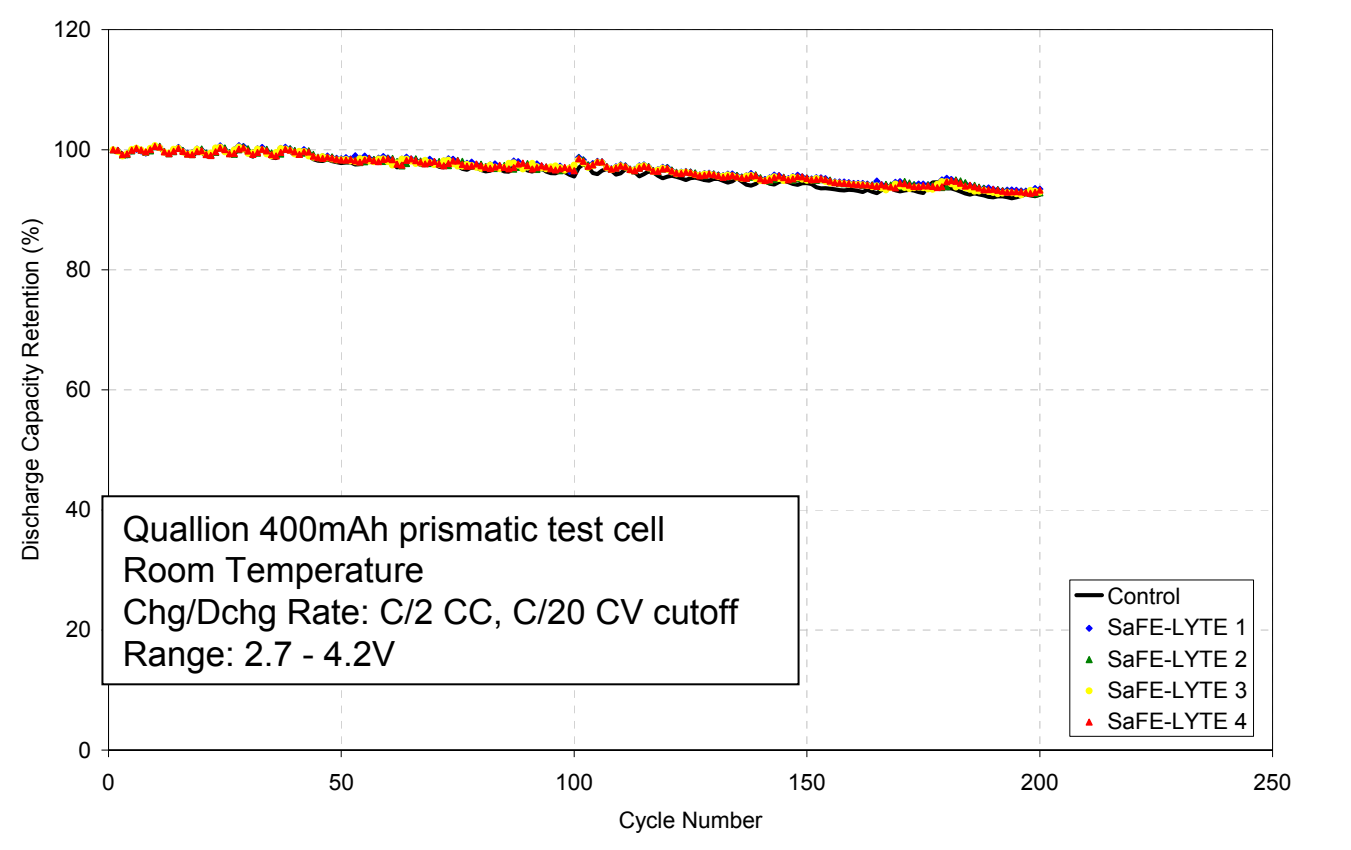
SaFE-LYTE™

SaFE-LYTE™ does not affect cycling performance because it is immiscible



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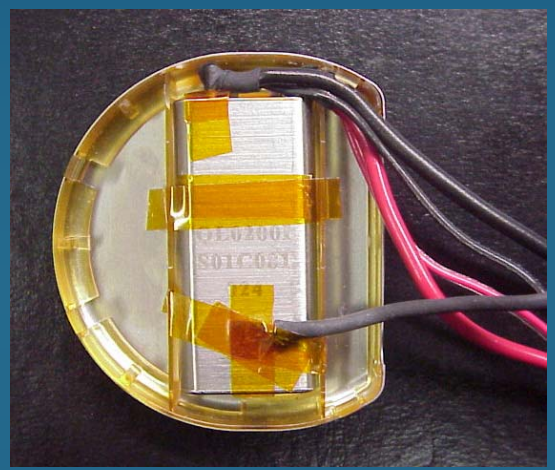
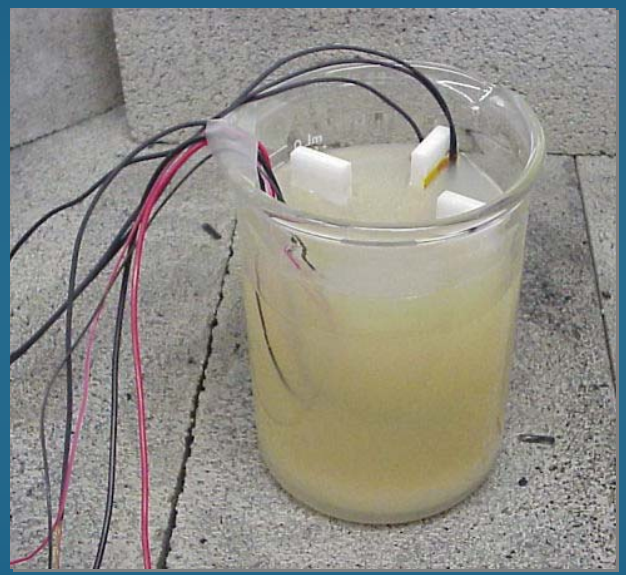
Development of HAM
External Cell Short Test in Agar





The Agar was placed into an oven and heated up to 37C, internal body temperature.
The battery was then externally shorted and the test was run until the temperature of the battery returned to 37° C.

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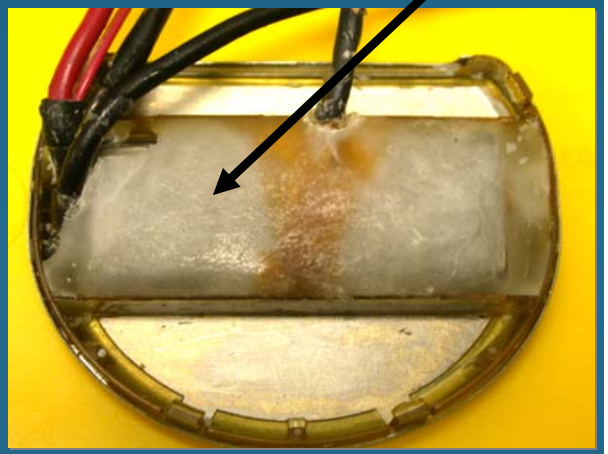
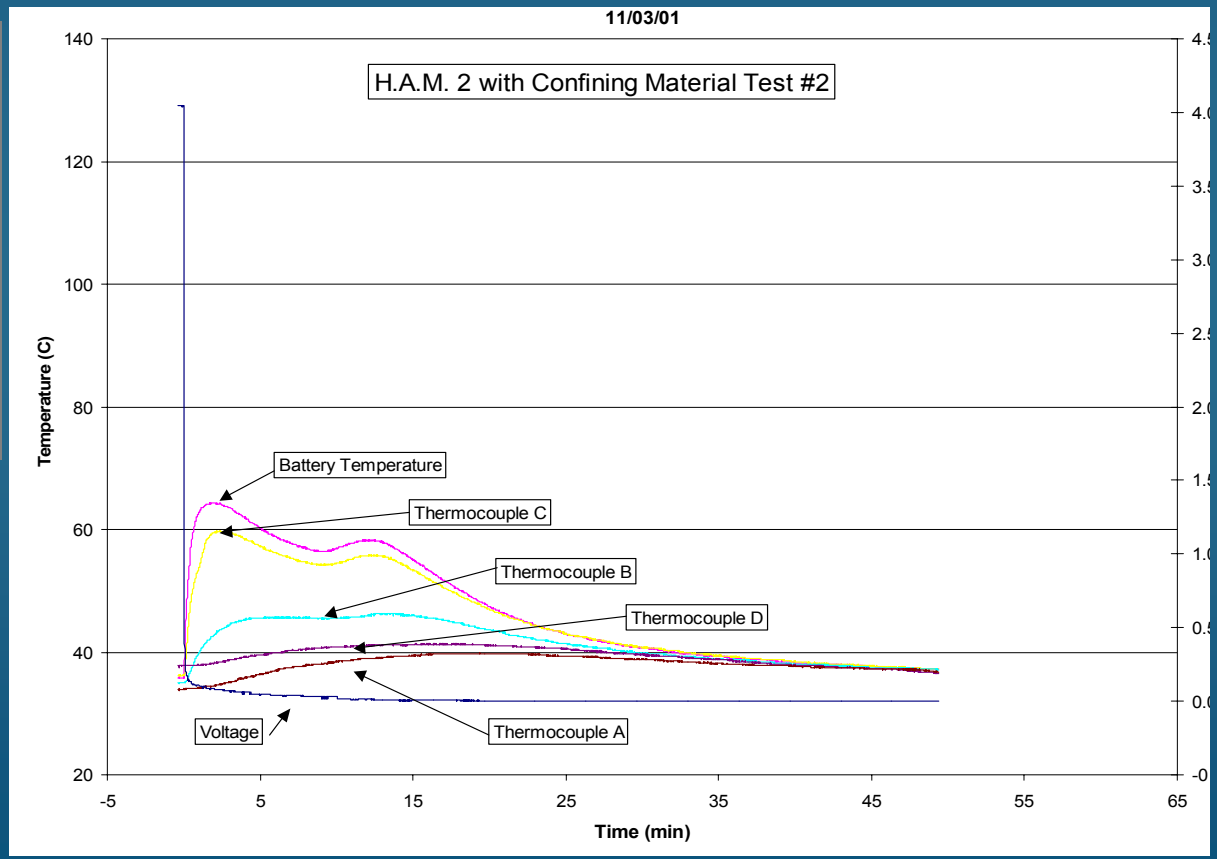
H.A.M. Reduces Peak temperature

HAM (Heat Absorption Material)





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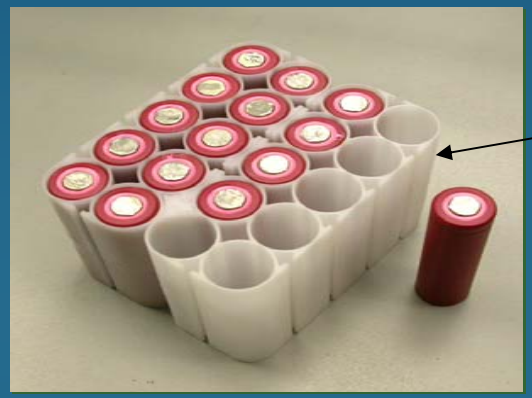
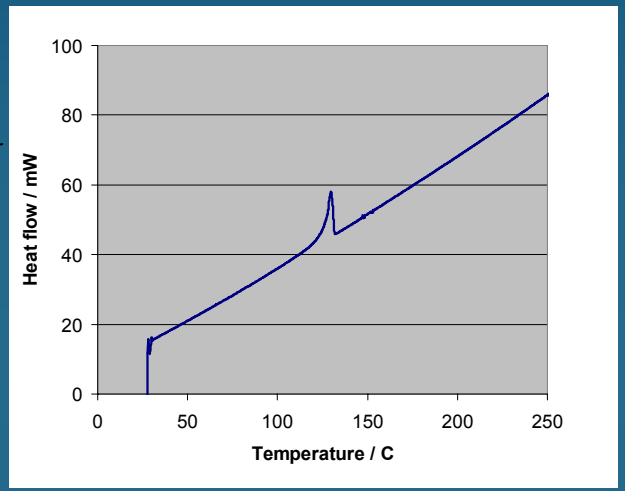
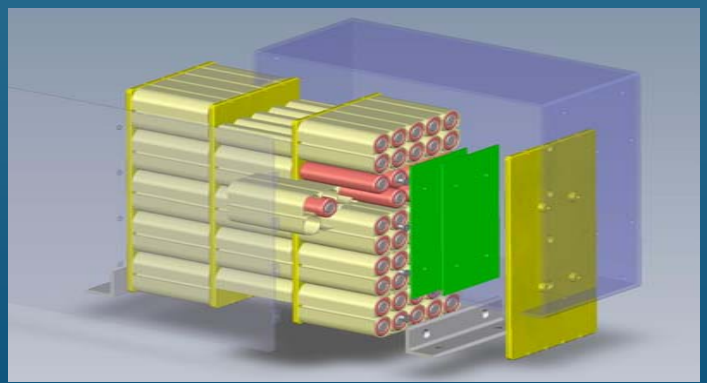
Use of HAM (Heat Absorption Material)







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HAM test Set up

Test Battery-

Sanyo 18650W cell, 10 cells in Parallel connection.

Capacity- 15.0 Ah

Overcharge test condition-

Charge battery pack @6A to 12V, hold voltage @12V till temperature dropping

Without HAM sleeve

With HAM sleeve

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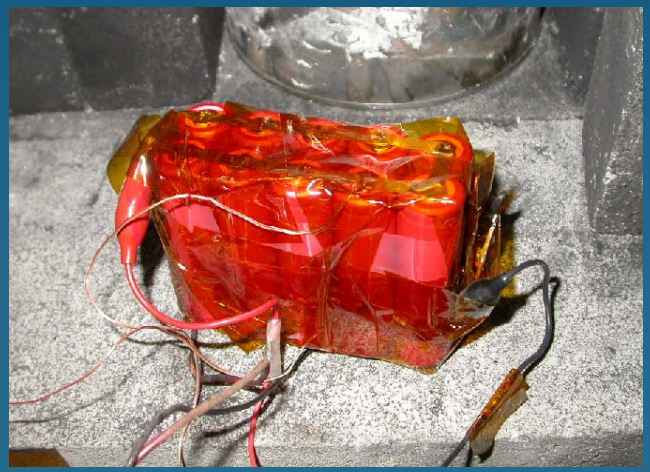
Test Result- Without HAM



Connection

After Test

Insulation

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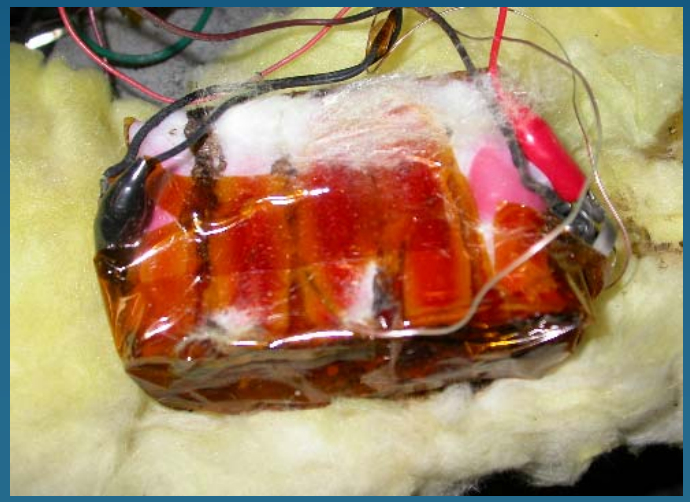
Test Result- With HAM

Connection



After Test

Insulation

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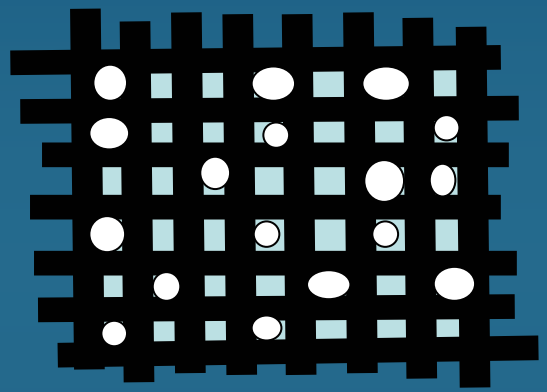
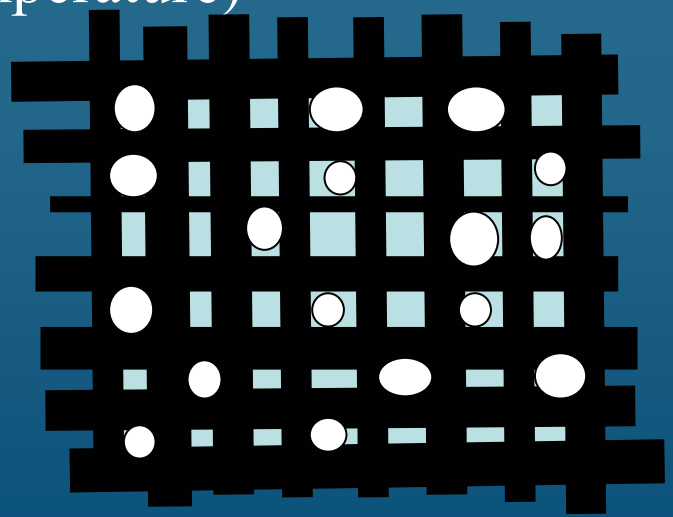
Electron Beam Treatment



Micro porous separator

Enhances crystallinity of crystalline area (improve thermal stability) and does not affect to amorphous area (same shut down temperature)



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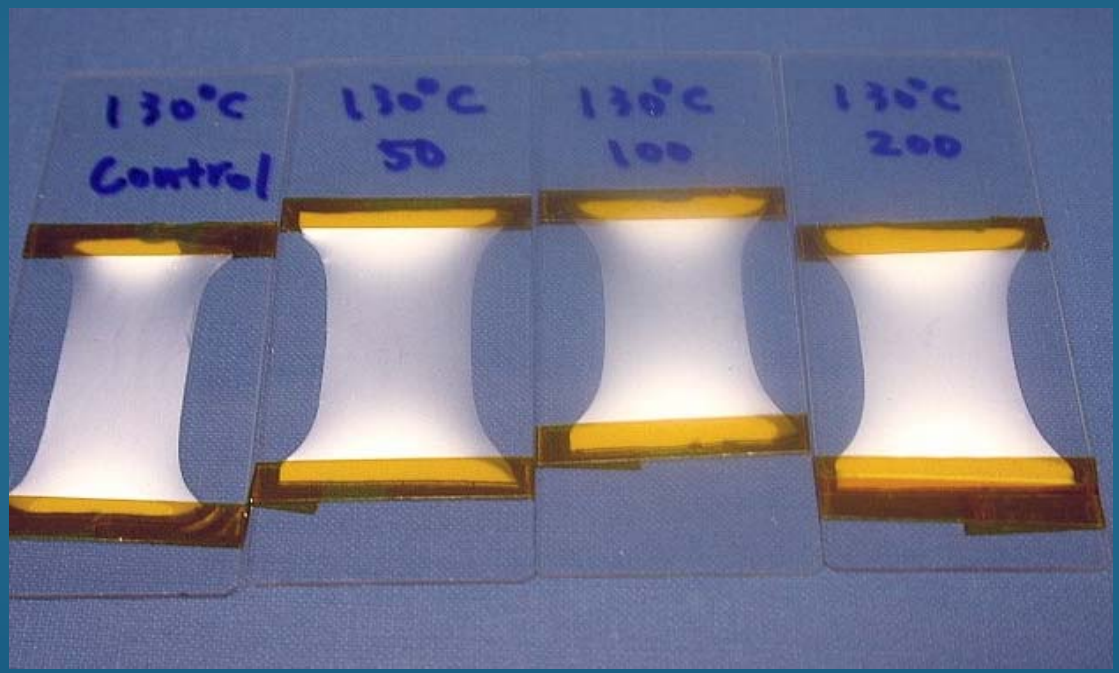
Shrinkage and break down comparison (130C)



All samples show certain degree of shrinkage. The control sample shows more shrinkage than the electron beam treated sample

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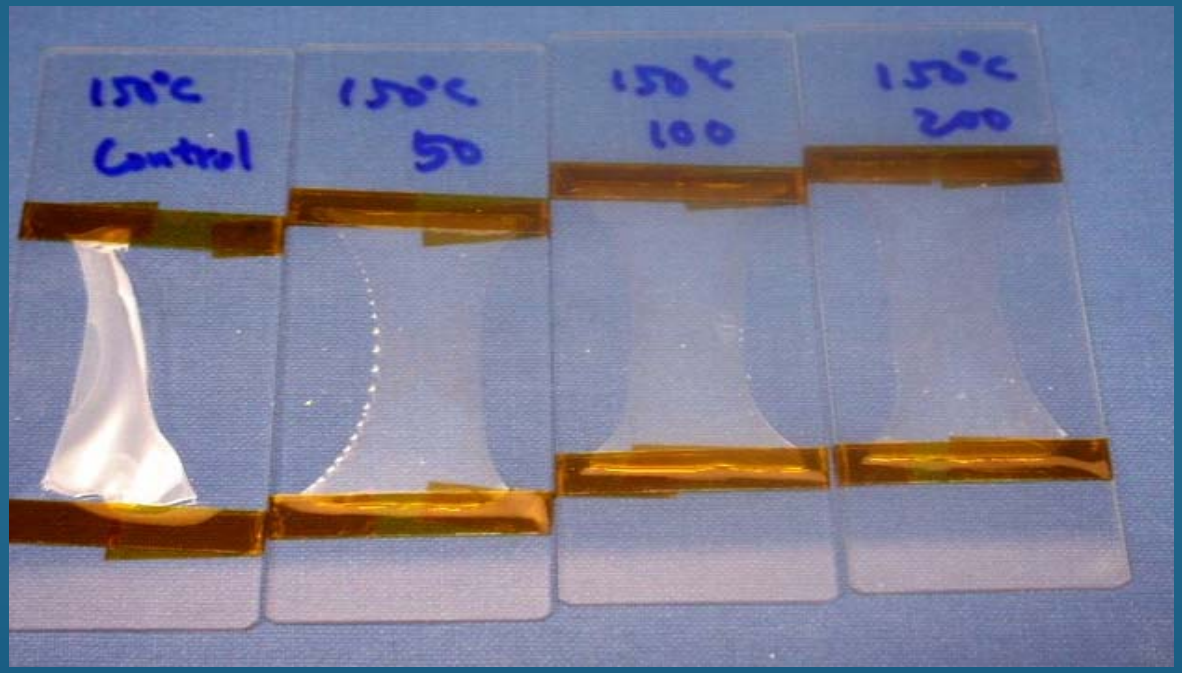
Shrinkage and break down comparison (150⁰C)



The control sample almost melts away. The electron beam treated samples stay as melted status with further shrinkage.

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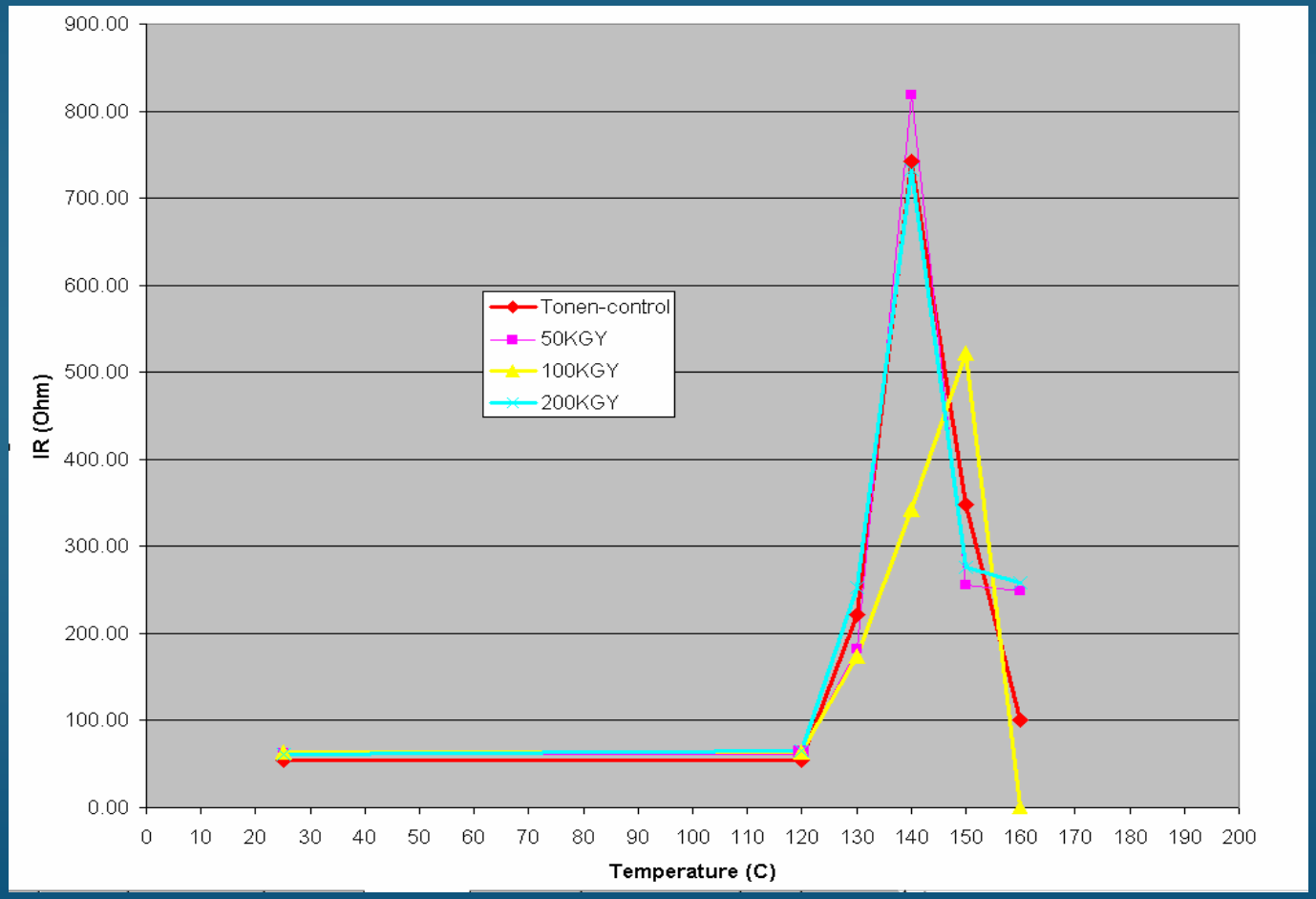
Shut down test (Coin Cells)



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High reliable battery production capability

+

Strong material capability

+

Advanced safety technology

=

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