



**“WHAT DREAMS MAY COME”;  
ONLY IF IT WORKS RIGHT!!!**

# **SOME HIGH ENERGY DENSITY LITHIUM BATTERY SAFETY CONCERNS.**

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**ARTIN**  
ENGINEERING

# INTRODUCTION TO ARTIN ENGINEERING

- Specializes in the design, development, testing and certification of cells, battery packs and devices equipped with electrochemical energy storage capabilities. (lithium, NiMH, NiCd, Alkaline, lead acid etc..)

- We are:

- ISO17025 compliant
- CTIA approved test lab
- accredited by A2LA



- Our A2LA accreditation includes IEEE 1725, IEEE1625, IEC 61000-4-2, IEC 61000-4-5, ISO 7637-2 and National Motor Freight Classification 180; ASTM D5276.

- Additional capabilities;

- Forensic analysis (x-ray, SECM, elemental analysis etc..)
- Energy efficiency measurement: California Battery Mandate, IEC62301
- Consulting

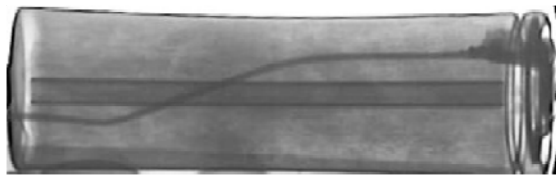
# OUTLINE

- This presentation pertains to high energy density secondary lithium batteries (rechargeable).
- Will focus on batteries made with common cathode materials:
  - Lithium cobalt oxide
  - Lithium manganese oxide
  - Lithium nickel manganese oxide
- Some new trends in lithium battery chemistries and design will be discussed.
  - “High Voltage” 4.35V cells
- Q & A

# CELL

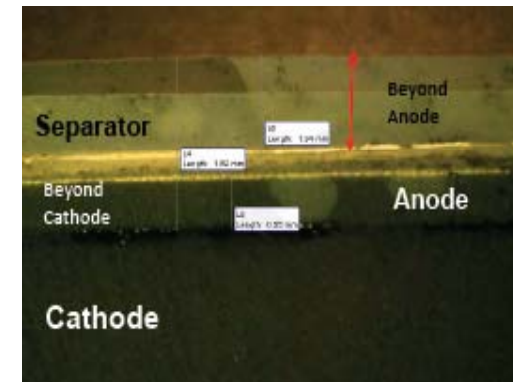
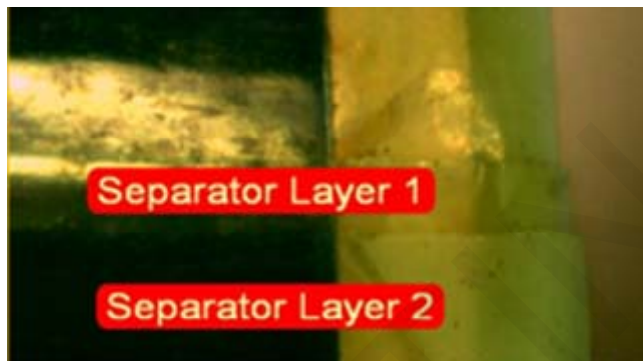
# CELL CONSTRUCTION

Predominantly cylindrical or prismatic (lithium ion, polymer)



Concept is the same:

- Current collectors
- Anode
- Cathode
- Separator
- Electrolyte

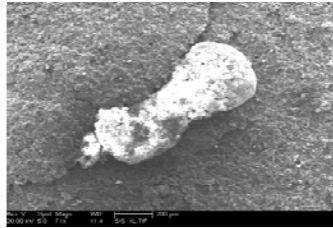


# SOME SUGGESTED CELL SAFETY CHARACTERIZATION:

- Isolation Properties
- Separator Shrinkage @ Room Temperature
- Separator Shrinkage @ Elevated Temperature
- Electrode Capacity Balance and Geometry
- Electrode Tabs (connection to cell terminals)
- Application of Insulation
- Cell Vent Mechanism
- Internal Short Avoidance
- Positioning of Insulating Plate
- Cell Thermal Test
- Evaluation of Excess Lithium Plating and Short-Circuit Test on Cycled Cells
- External Shorting of Cell Terminals

# SOME MANUFACTURING PROBLEMS

–Contamination



–Lack of process control



–Lack of general know-how and experience





# BATTERY PACK



# SOME SUGGESTED BP PERFORMANCE CHARACTERIZATION:

- Life cycle
- Capacity (%SOC)
- Thermal (Room Temp., Hot, Cold, Thermal shock)
- Impedance
- Altitude
- Mechanical (drop, shock, crush, vibration and impact)
- Nail Penetration
- Force test
- ESD (IEC 61000-4-2)
- Surge (IEC 61000-4-5, 4-11, 4-4)
- Short circuit
- Power

**These are performance related but may have long-term safety effects.**

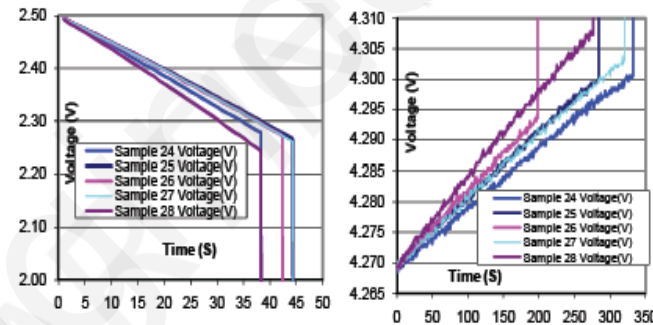
# SOME SUGGESTED BP SAFETY CHARACTERIZATION:

- Chemistry (Is it suitable for the application??)
- Protection Device:
  - Current (Over and Under-current)
  - Voltage (Over and Under-voltage)
  - Limit Output Current (External Short-Circuit Considerations)
  - Thermal Protection Design
- Mechanical Considerations
  - Drop Test
- ESD
- Pack Manufacturer / Supplier Traceability (Minimize recall liability)

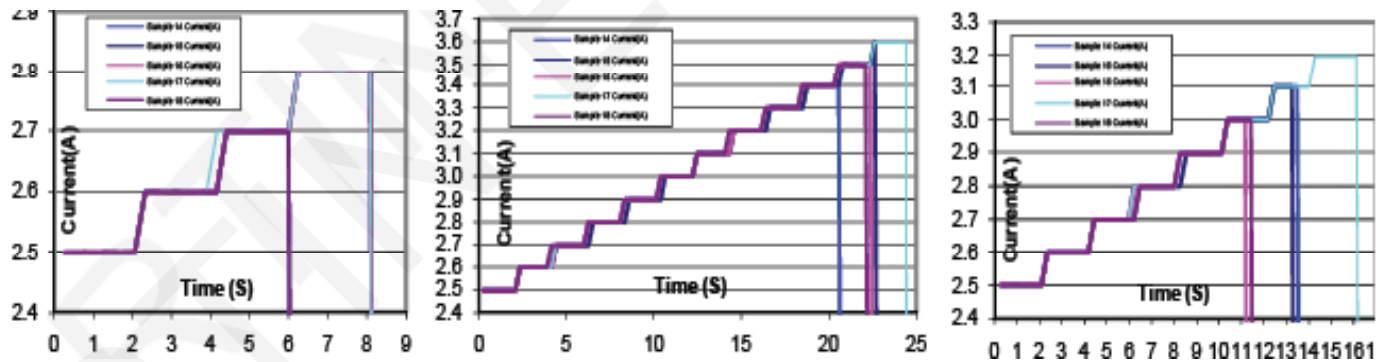
# SOME BATTERY PACK PROTECTION NEEDS

(NEED LOTS MORE; ONLY A FEW ARE DISCUSSED)

- Under and Over-voltage protection



- Pack Over-current protection at various temperatures (-20, 25 & 60 °C)



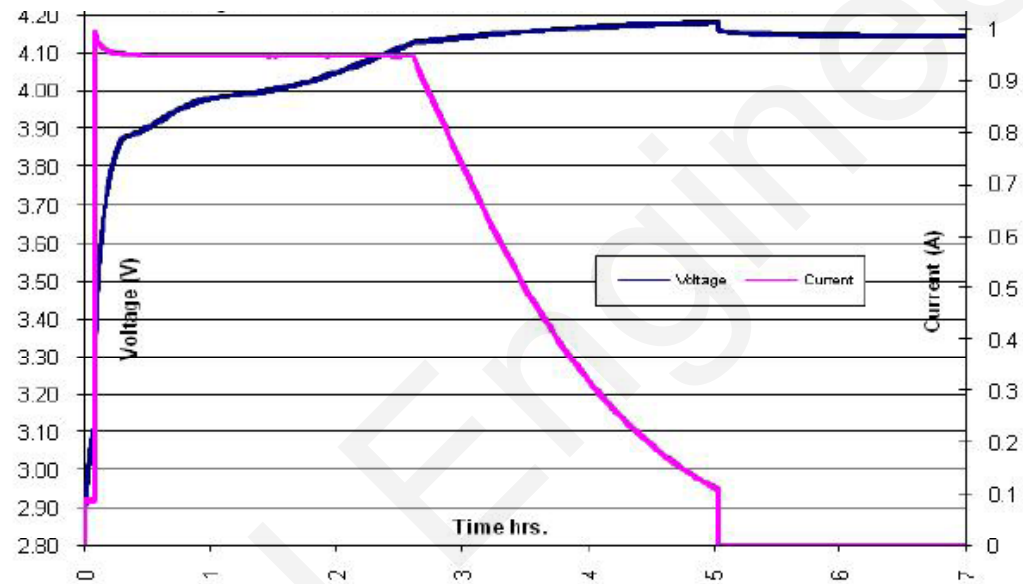
# HOST LEVEL VERIFICATION

# SOME SUGGESTED HOST LEVEL VERIFICATION TESTING:

- Charge/Discharge Algorithm
- I and V characteristics
- Thermal (Room Temp., Hot, Cold)
  - Is the cell being heated? Or portion of the cell heated?
- Mechanical (drop, shock, crush, vibration and impact)
- How does the host behave after ESD and Surge testing?
  - ESD (IEC 61000-4-2)
  - Surge (IEC 61000-4-5, 4-11, 4-4)
- Short circuit
- Pack ID
  - Is the system smart enough to detect a knockoff battery?
  - What action does the system take?

**These are performance related but may have long-term safety effects.**

# CHARGE ALGORITHM VERIFICATION



Play within the manufacturer recommended operational window.....  
Do not allow overcharge, overdischarge, over-temperature etc...

# DEVELOPMENTS ALLOWING SAFER LITHIUM CELLS



# MOSTLY PROPRIETARY BUT.....:

- Low Power ...  
e.g.  $\text{LiFePO}_4$
- High Power
  - Active material protected
  - in order to decrease the probability of thermal runaway and Electrolyte decomposition

**These are performance related but may have long-term safety effects.**



# Q&A