



# Lithium-ion Batteries Technology Introduction

**EVB Technology (HK) Limited**

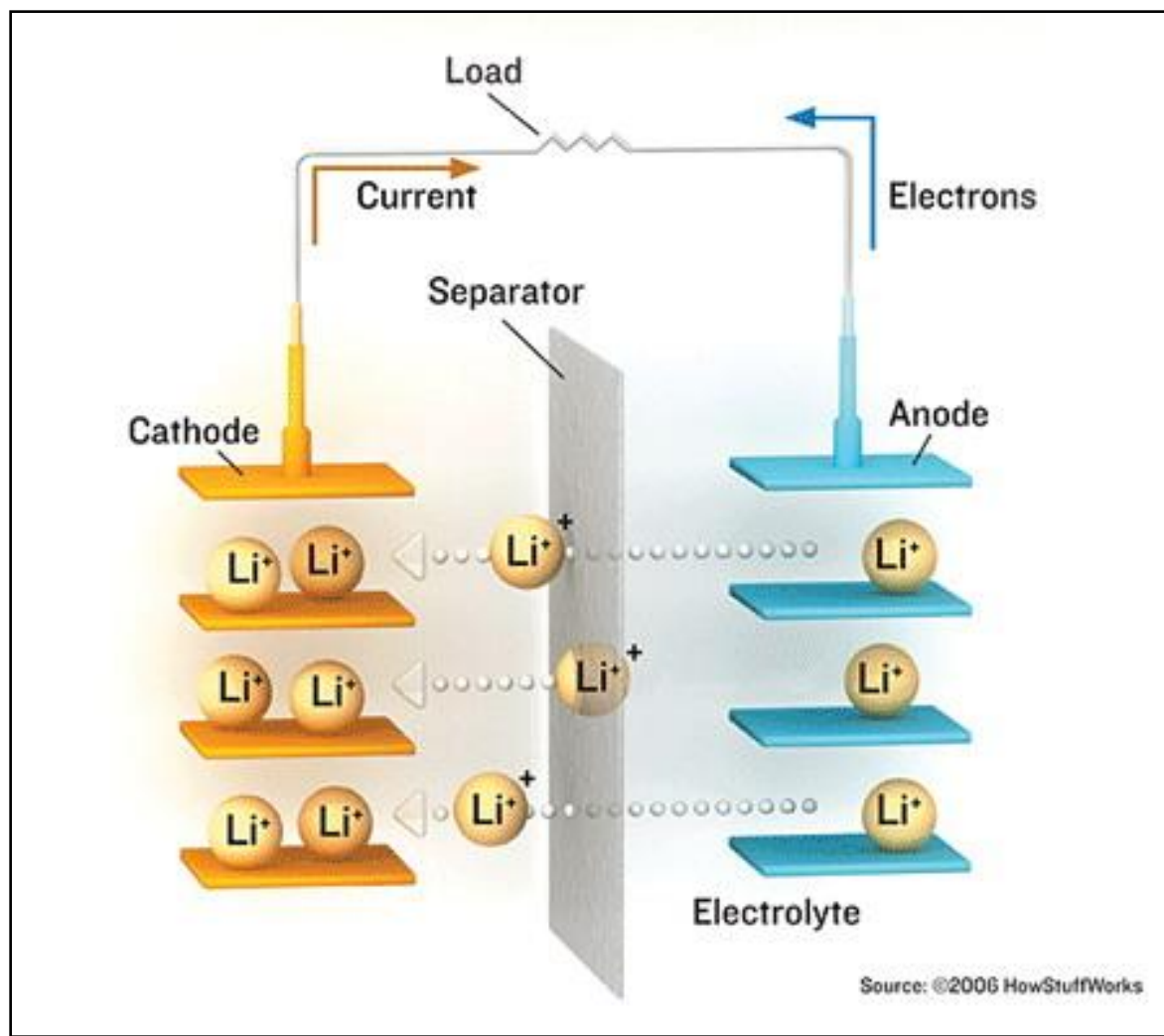
# Lithium Ion Technology

- Lithium-ion batteries are common in portable consumer electronics because of their high energy-to-weight ratios, lack of memory effect, and slow self-discharge when not in use.
- In addition to consumer electronics, lithium-ion batteries are increasingly used in defense, automotive, and aerospace applications due to their high energy density.

# Lithium Ion Technology

- A variety of positive electrode materials has been developed for satisfying number of application requirement.
- All the Li-ion cells operate by reversibly incorporating lithium in an intercalation process.

# Lithium Ion Technology

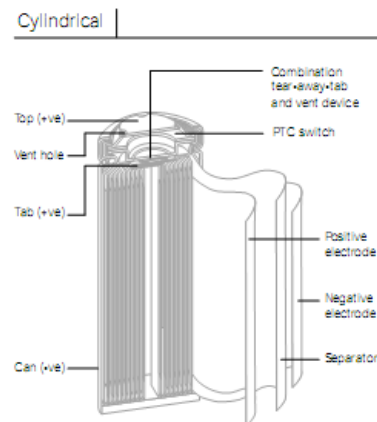


# Characteristics of different Cathode Materials

	Li(NiMnCo)O <sub>2</sub>	LiMn <sub>2</sub> O <sub>4</sub>	LiFePO <sub>4</sub>
Voltage (V)	3.6	3.8	3.2
Energy density (Wh/kg)	150	140	115
Volumetric energy density (Wh/L)	330	300	240
Cycle life	1000	1000	2000
Safety	Good	Good	Very good
High-Temp stability	45°C	40°C	60°C
High-rate capability	Good	Good	Moderate
Unit cell cost (raw material + manufacturing cost)	Moderate	Low	Moderate to low
Battery management system	1 PT/cell		

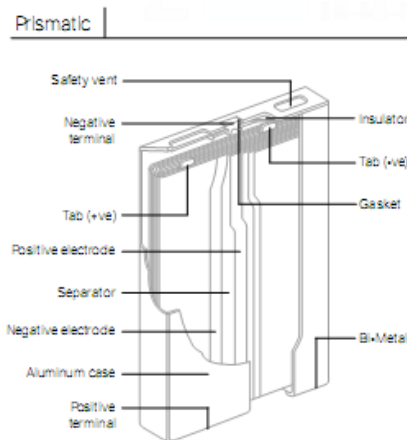
# Prismatic vs Cylindrical

- Cylindrical: Robust design, structurally strong for handling, shock and vibration. However, as their size gets larger, their external surface area to volume decreases and thus the heat transfer abilities goes down. The temperature gradient from inside to outside goes up.



# Prismatic vs Cylindrical

- Prismatic: Higher heat transfer surface area to volume and can be thermally managed easier. Also, prismatic cells could be packaged with better volume efficiency than cylindrical cells.



# EVB Prismatic Product Table



Model	GP18EVLF	GP30EVLF	GP45EVLF
Capacity (min)	16Ah	30Ah	42Ah
Voltage	3.2V	3.2V	3.2V
Specific power at 5C	396W/kg	427W/kg	459W/kg
Specific energy at 0.5C	78Wh/kg	87Wh/kg	96Wh/kg
Dimensions	181(H)x95(W)x18(Th) mm <sup>3</sup>	176(H)x95(W)x30(Th) mm <sup>3</sup>	226(H)x95(W)x30(Th) mm <sup>3</sup>
Weight	0.66kg	1.1kg	1.4kg
Cycle life	>1500 cycles	>1500 cycles	>1500 cycles

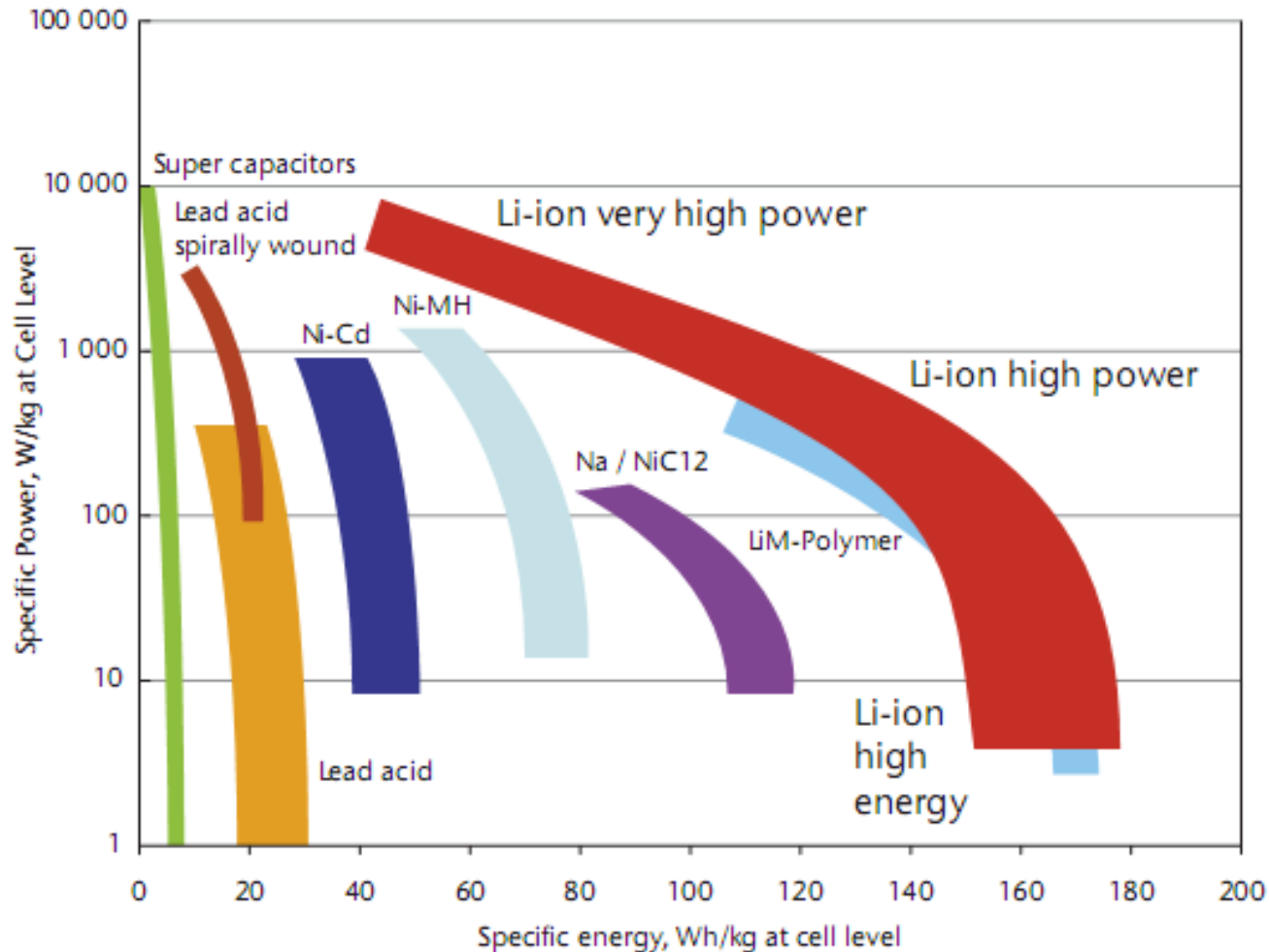


# GP18650 Table

<b>Description</b>	<b>LiCoO2</b>	<b>Li(NMC)O2</b>	<b>LiFePO4</b>
<b>Model</b>	<b>GP1865L220</b>	<b>GP1865T220</b>	<b>GP1865A 120</b>
<b>Cell Capacity (mAh)</b>	<b>2200</b>	<b>2200</b>	<b>1200</b>
<b>Nominal Voltage</b>	<b>3.70</b>	<b>3.65</b>	<b>3.20</b>
<b>Max Charging Voltage</b>	<b>4.20</b>	<b>4.20</b>	<b>3.65</b>
<b>Volumetric Energy Density (Wh/Ltr)</b>	<b>492</b>	<b>492</b>	<b>232</b>
<b>Gravimetric Energy Density (Wh/Kg)</b>	<b>185</b>	<b>185</b>	<b>100</b>
<b>Cycle Life</b>	<b>500</b>	<b>500</b>	<b>1000</b>
<b>Max. Discharging Current (A)</b>	<b>2.2</b>	<b>2.2</b>	<b>10</b>



# Specific Energy and Specific Power of different battery types



# Pack Configuration

# Small Capacity Cell vs Large Capacity Cell

- Small Capacity Cell:

Advantages: lower cell cost (commodity market), improved safety (faster heat rejection), and higher quality production

Disadvantages: many interconnects, much higher integration and assembly cost, lower weight and volume efficiency, lower reliability as well as the costly electrical management.



# Small Capacity Cell vs Large Capacity Cell

- Large Capacity Cell:

Advantages: lower assembly cost, higher weight and volume efficiency, better reliability (lower number of components)

Disadvantages: higher cell cost, tougher thermal management



# Charging Methodology

- Stage 1 : Apply charging current limit until the voltage limit per cell is reached.
- Stage 2 : Apply maximum voltage per cell limit until the current declines below 1-3% of rated charge current.
- Stage 3 : Balancing

# Discharging Methodology

- Different discharge modes
  - Constant Current: A battery discharge regime whereby the current drawn during the discharge remains constant
  - Constant Power: the amount of current will increase as the battery discharges electricity in order to maintain constant power
  - Constant Resistance: A battery discharge regime whereby the resistance of the equipment load remains constant throughout discharge

# Balancing Technology

- Balancing can be **active** or **passive**
- In passive balancing, energy is drawn from the most charged cell and is wasted it as heat, usually through resistors
- In active balancing, energy is drawn from the most charged cell and transferred to the least charged cells, usually through DC-DC converters
- Active balancing is usually more efficient than passive balancing

# BMS

- BMS should design for
  - Protect the cells or the battery from damage
  - Prolong the life of the battery
  - Maintain the battery in a state in which it can fulfill the functional requirements of the application for which it was specified

# Example: Parameters we are looking at

The screenshot shows the 'GP Battery Management Builder' software interface. The top navigation bar includes tabs for Hardware, Charging, Monitoring, Calibration, Button, and Cycles. The interface is divided into two main columns of parameter settings. The left column contains sections for Counters, Charge-control, Life-span, Total mAh, Voltage, and Temperature. The right column contains sections for Usage environment, Temperature, and Block voltage. A 'Read' button (green gear) and a 'Write' button (red gear) are located on the right side. An 'Access password' field is at the bottom right. Red arrows point to the 'Write' buttons for various parameters. Callouts A through M are placed around the interface to highlight specific elements.

Section	Parameter	Value	Action
Counters	Counter	123	Write
	Abort on error	3	Write
Life-span	Reconnections	1	Write
	Total mAh		
Total mAh	Charge	198853	Write
	Discharge	188326	Write
Voltage	Limit	21000	
	mV-hours below limit	25	Write
Temperature	Limit	35	
	°C-hours above limit	1	Write
Usage environment	Upper battery limit	55	
	Lower battery limit	-5	
Temperature	Upper ambient limit	45	
	Lower ambient limit	-10	
Block voltage	Lower limit	10000	
	Lowest load cut-off	9800	Write
	Low power-save	9500	Write

# Large capacity cell pack spec and photo (Vectrix)

## LiFePO<sub>4</sub> System

- Acceleration (0-80km): 5.8sec
- Capacity: 3.84kWh
- Battery Pack Weight: 45kgs
- Cells/System: 40
- Configuration: 10s1p
- Number of Layers: Single

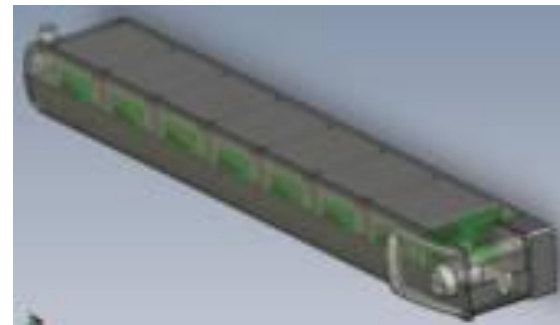
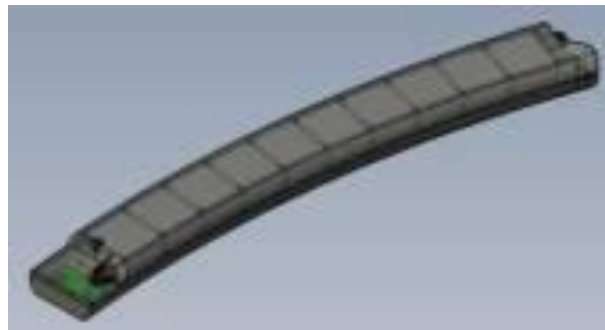


# Small capacity cell pack spec and photo (Sparta)



## Li(NMC)O<sub>2</sub> System

- Configure : 7S / 10S
- Capacity : 10Ah
- Weight : 3.5Kg / 2.8Kg





# Contact Information

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