Technologies

(go directly to "Lithium-ion : Technology, Base element and Category")

Chemistries

A broad range of lithium-ion cell chemistries may be found on the market, as several possibilities exist for the choice of cathode material. The anode material is generally carbon/silicon and graphite (LTO is the exception). The ability to drain high currents, the internal resistance, or some more global characteristics such as the power density will be chemistry-sensitive. Finding out the main chemistry of a cell is not always an easy task, as manufacturers continuously improve their technologies and may change the naming conventions for commercial purposes. However, the main categories are summarized in the table below.

Name	Chemical abbreviation	Cathode	Anode	Convention in PVSyst	Other convention	Nominal Voltage [V]	Power density [Wh/Kg]
Lithium Titanate	$Li_4Ti_5O_{12}$	Graphite	$Li_4Ti_5O_{12}$	**LTO**		2.0	80
Lithium Iron Phosphate	LiFePo4	LiFePo4	Graphite	**LFP**	IFR	3.2	120
Lithium Manganese Oxide	$LiMn_2O_4$	$LiMn_2O_4$	Graphite	**LMO**	IMR	3.6	140
Lithium Manganese Nickel	$LiNiMnCoO_2$	$LiNiMnCoO_2$	Graphite	**NMC**	INR	3.4	200
Lithium Cobalt Oxide	$LiCoO_2$	$LiCoO_2$	Graphite	**LCO**	ICR	3.7	200
Lithium Nickel Cobalt Aluminum Oxide	LiNiCoAl2	LiNiCoAl2	Graphite	**NCA**	NCR	3.6	250

Table 1

One can distinguish 2 main categories for cells, **Energy Cells** (high capacity expected) or **Power Cells** (high drawn currents expected). The chemistry will generally be selected according to the cell usage. A chemistry is always a balance between energy, capacity, cycle life and safety. Even if chemical reactions are often complex phenomena, here is the general picture :

- **Phosphate** brings safety and long cycle life.
- **Manganese** lower the internal resistance. This allows the cell to be discharged at low temperatures and high current.
- **Nickel** brings capacity.
- **Cobalt** brings capacity, but at a cost and with safety concerns.

The **LFP** category is popular for stand alone solar applications due to its enhanced safety, when the power density is not the most important criteria. They successfully replace lead-acid batteries.
For **residential applications**, where available space can be an issue, chemistries such as **NCA** may be preferred. The **NMC** chemistry shows a good balance of properties and covers a wide range of applications.

Lithium Polymer cells use a polymer gel as an electrolyte, whereas all other cells have a liquid electrolyte.

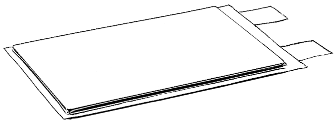
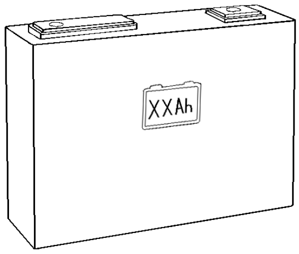
Shapes

Lithium-ion cells may be manufactured as **cylindrical cells**, **pouch cells**, or **prismatic cells.**

- **Cylindrical cells** are identified by a 5 digit number, which refers to the cell dimension. The last digit,0, stands for "cylindrical". There are 2 popular references :
  - the 18650 cell : diameter 18mm, length 65mm, 47 grams.
  - the 26650 cell : diameter 28mm, length 65mm , 82 grams.
- **Pouch cells** are flexible designs with a parallelipipedic shape. They cannot be used as such as they do not retain their shape during usage.
- **Prismatic cells** are rigid designs with a parallelipipedic shape.

Cylindrical cells are produced at low cost but have a lower volumetric efficiency compared to pouch cells and prismatic cells, which, in return, are produced at a higher cost. A continuous effort is done by manufacturer to evacuate the heat, as this is a key point to build efficient and safe systems.

Cylindrical cell	**Pouch cell**	**Prismatic cell**

Protective Circuit Board

Lithium ion cells have built-in safety devices, such as PTC (Positive thermal Coefficient, which creates a high resistance on high current surges) and CID (Current Interrupted Device, which opens the circuit when the pressure increases above 10 bars) for cylindrical cells. Pouch cells integrate a Protective Circuitry Board, which is a an electronic circuit than handles the UVLO (Under Voltage Lock out) and the OVP (Over Voltage Protection).

At the module level, a BMS (Battery Managenemt System) is added to securise the input and output current, the instantaneous voltage and to check the temperature. The BMS also handles the cell balancing, calculates the SOC and cancel the charge below 0°C.

Lithium-ion batteries shall not :

1. be charged below 0°C : this permanently damages the anode.
2. be discharged below the discharge Cut-off voltage (approx. 2.5V) : this damages the cell.
3. be charged above the charge cut-off voltage (approx 4.2V), for security reasons.