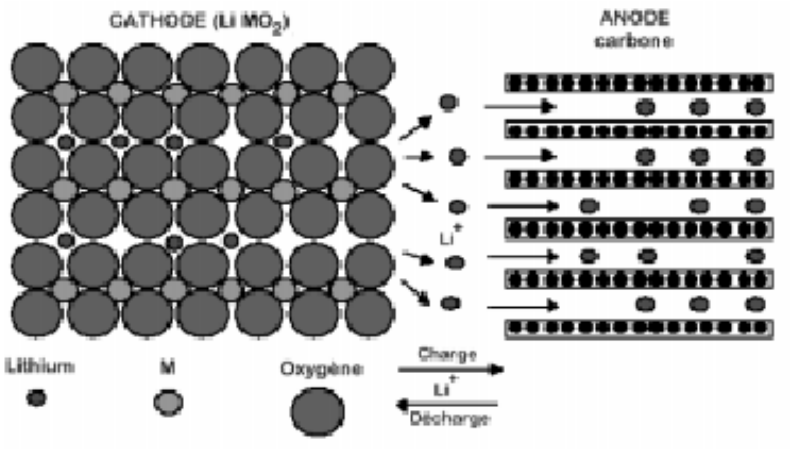
Lithium battery

The different types

	Negative	Electrolyte	Positive
Lithium-metal cells	Lithium-metal	Organic liquid electrolyte and lithium salt	Oxyde : often MnO_2
Lithium-ion cells	Insertion compounds : Carbon /Graphite	Organic liquid electrolyte and lithium salt	$LiCoO_2$, $Li\ NiO_2$, $LiMn_2O_4$
Lithium-metal-polymer cells	Lithium-metal	Conductive polymer with lithium salt	Vanadium Oxyde : VO_x i.e. V_2O_5
Lithium-ion-polymer cells	Insertion compounds : Carbon /Graphite	Conductive polymer with plasticiser and lithium salt	$LiCoO_2$, $Li\ NiO_2$, $LiMn_2O_4$

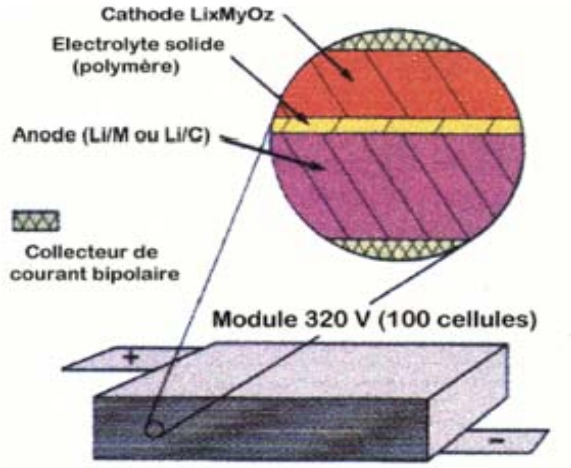
Principle of operation

Lithium Ion Battery:



$Li_{(1-x)}MO_2 + LixC_6 \leftrightarrow LiMO_2 + 6\ C$

Lithium Polymer Battery:



$x\ Li + MyOz \leftrightarrow LixMyOz$

Technical data

Type	Temperature of operation	Energy	Number of deep cycles	Power at steady state/ 30s	Charge/discharge efficiency	Self discharge
Li Ion cells (4V)	**-30 to +60 ° C**	**80/150Wh/kg 150/300 Wh/dm^3**	**> 1500**	**500/2000 W/kg**	**energetic: 90 to 100% faradic : 95% to 100%**	**1% /month**
Li polymer cells (3V)	**+60 to +90 °C**	**100/150 Wh/kg 150/220 Wh/dm^3**	**300/600**	**50/250 W/kg**	**energy : 90 to 100% faradic : 90% to 100%**	**2 weeks (warm) a few % /year (cold)**

Maintenance	Environmental impact	Safety
None	Lithium oxides and salt are recycled Polymer solvents and carbon are inerted	Risk of fumes or flames in case of deep overcharge (about 200 %)

Lithium battery

Applications

Application	Voltage	Power	Capacity	State
Mobiles	3.6V	0 ..1W	1.5-4Wh	Production
Laptops	7.2 – 14.4V	0.. 50W	40-80Wh	
Hybrid Vehicles	42V 300V	8-20 kW 40-70 kW	500 Wh 1-3 kWh	Development
Electric vehicles	300V	40-70 kW	20 kWh	Development
Telecom	48V	-	1-2 kWh	Development
distribution and storage (UPS...etc)	300 - 800V	10 kVA à 1 MVA	A few sec to a few min	Development

R&D Perspectives

+ Costs reduction (use of cheaper materials)
+ Improvement of the security regarding self inflammability
+ Lifetime increase of the elements using:
+ Production costs reduction when acting on :
  - Manganese oxydes
  - Metallic lithium

Li-ion :

- Research on new oxydes materials for the negative plate

Li-polymer :

- Increase of the ionic conductivity et of the electrolytes stability
- Improvement of the mechanical properties at high temperature
- Research of more efficient materials for the battery plates

Economical data

Current costs: from 700 to 1 000 € /kWh.

Targeted prices for industrial applications (stationary, transportation, storage) considering a production amount of 2000 to 3000 MWh/an :
150-250 €/kWh (high energy)
35 €/kW (high power)

For Li –polymer batteries (metallic type) : 200 €/kWh

Manufacturers active on the market:
USA : AVESTOR / Lithium Power Technologies / LTC (with Gaia / Germany)
Europe: Saft / Varta / Gaia
Japan (1st Li-ion battery manufacturer) : Japan Storage Battery (JSB) / Sanyo / Sony / Mitsubishi Batteries / Panasonic (Matsushita) /Hitachi (Shin-Kobe) / Yuasa / DENSO Corporation
China : Thunder Sky Green Power Source / Beijing Continental Battery / Tianjin Lishen Battery Holding
Korea : LG chemical / Samsung / Kokam

World market en 2000 :
5500 Millions $