

LITHIUM ION BATTERIES

Project done by:

Lucia Dolz Edo

Daniel Serrano Guzmán

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Introduction

This kind of batteries appears for the first time in 1912, but until the '70 decade there weren't commercial and at this time this type of batteries were not rechargeable.

Was decided to use only lithium compound being capable of accepting and releasing lithium ions instead of metallic lithium

Due to the high temperature, a lot of time the device turns up in flames.

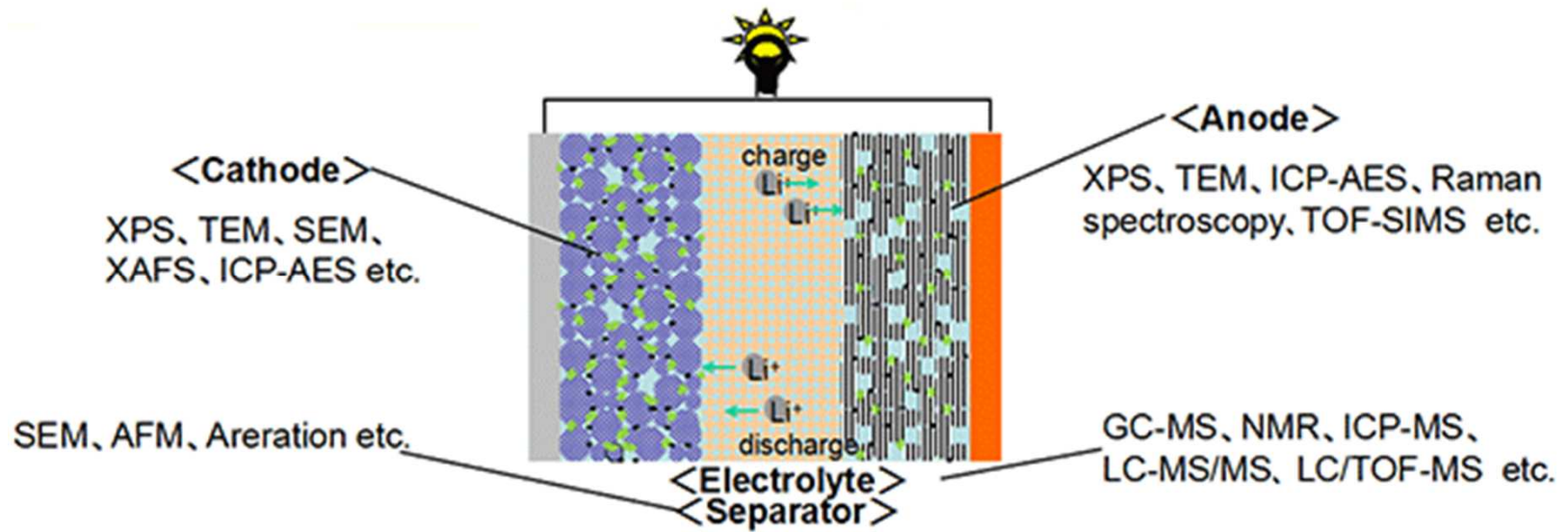
For this reason it was researched a non-metallic solution and in 1991 Sony company launched to the market the first Li-Ion batteries.

Construction

Construction of the cell of the Li-Ion batteries.

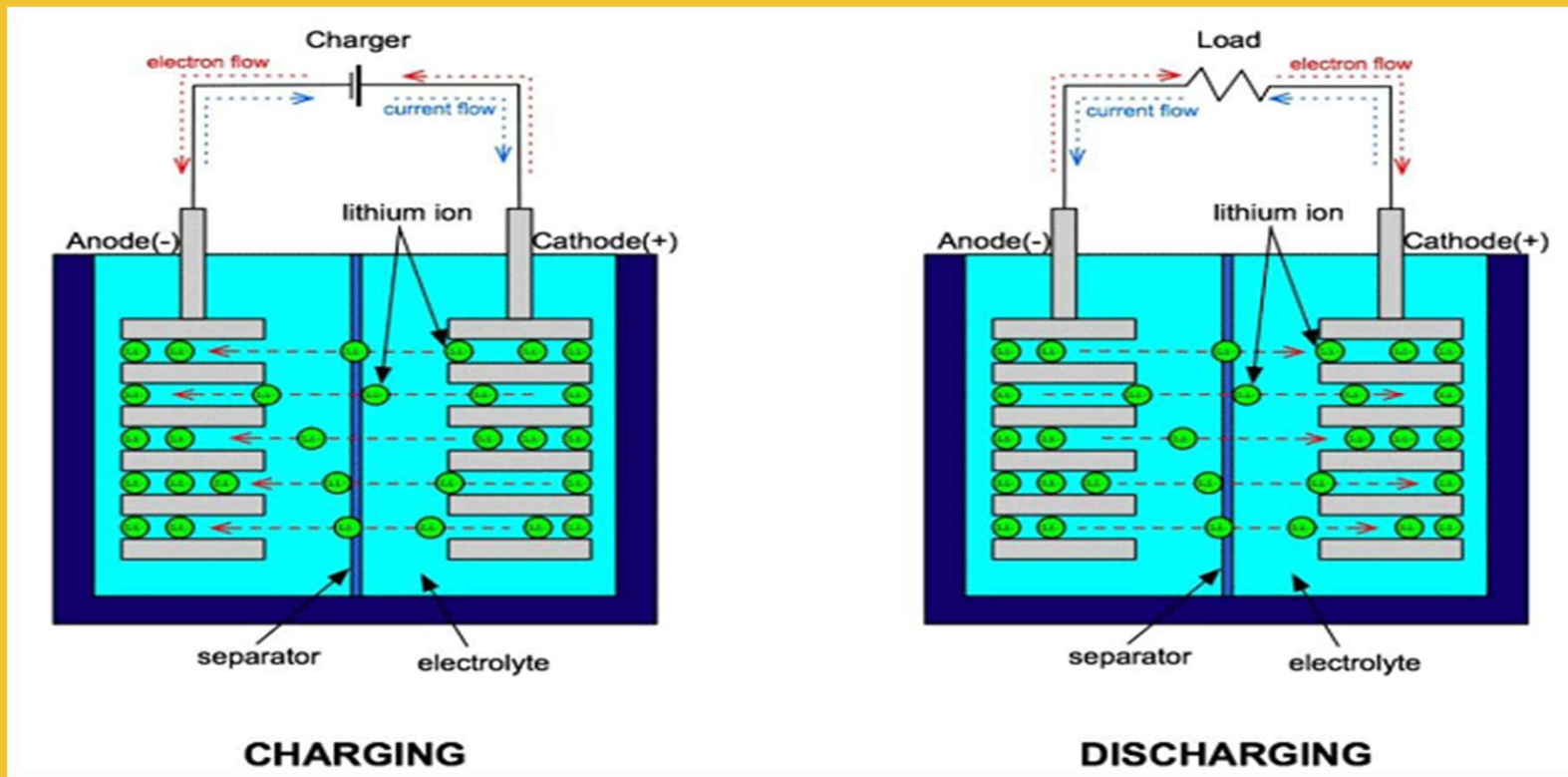
- Cathode: the cathode is made of a chemical compound, this type of material has to have a high potential of intercalation with respect to Lithium. (LiCoO₂ or LiFePO₄)
- Anode: Use of abundant materials abundant and electrically conducting (graphite or other carbon)
- Electrolyte: is a liquid that acts as a conductive pathway for the movement of cations passing from the anode to the cathode during the discharge.
- Separator: Is a semipermeable membrane which allow the pass of certain molecules or ions by diffusion.

Construction of the cell of the Li-Ion batteries.



How it works?

How it works?



Advantages and disadvantages

ADVANTAGES

- 3 Times more energy density per unit of weight than lead-acid
- Greater voltage.
- Greater speed in loading and unloading
- Without optimal load.
- Longer life.

DISADVANTAGES

- They are more expensive compared to their equivalent in lead acid for the same capacity.
- They are more unstable
- Worse cold working capacity
- Transportation regulations required when shipping in larger quantities.

**Why are so important in our
society?**

The importance of nanotechnology in Lithium-Ion batteries.

In nowadays are so important due to this type of batteries can store the same amount of power as other batteries, but accomplish this in a lighter and smaller package.

Using nanomaterials in the electrodes increases their surface area, which provides more places for the lithium ions to make contact. For this reason, this kind of batteries improve their efficiency and make their recharge faster with nanotechnology

Applications of Li-Ion batteries

Applications

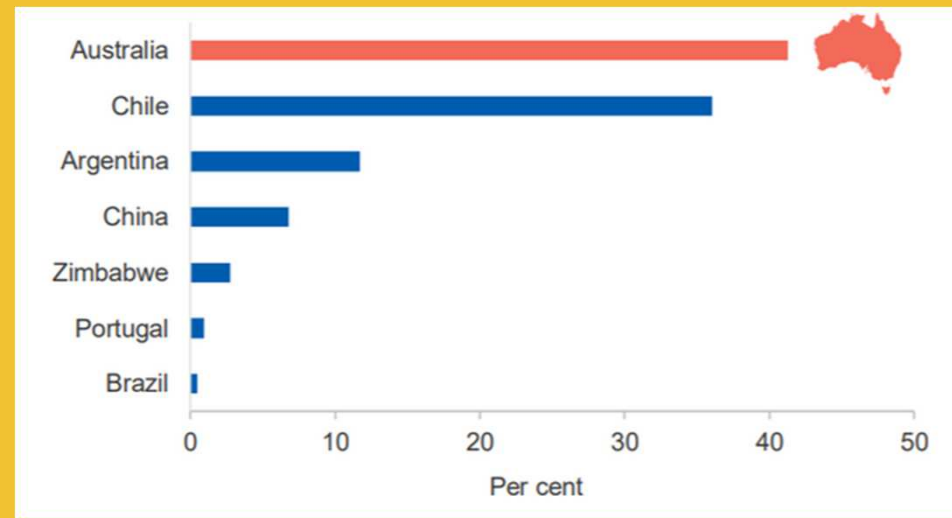
- Smartphones
- Tablets
- Electric cars
- Hybrid cars
- Hydraulic propulsion of boats or yachts
- Smartwatches



Batería de Iones de litio (Li-on) en un Nissan Leaf

Curiosities

- The lithium batteries haven't memory.
- Don't need long loads the first time.
- Incorporate several electronic protection circuits.



Characteristics

Before buying a battery you have to take into account...

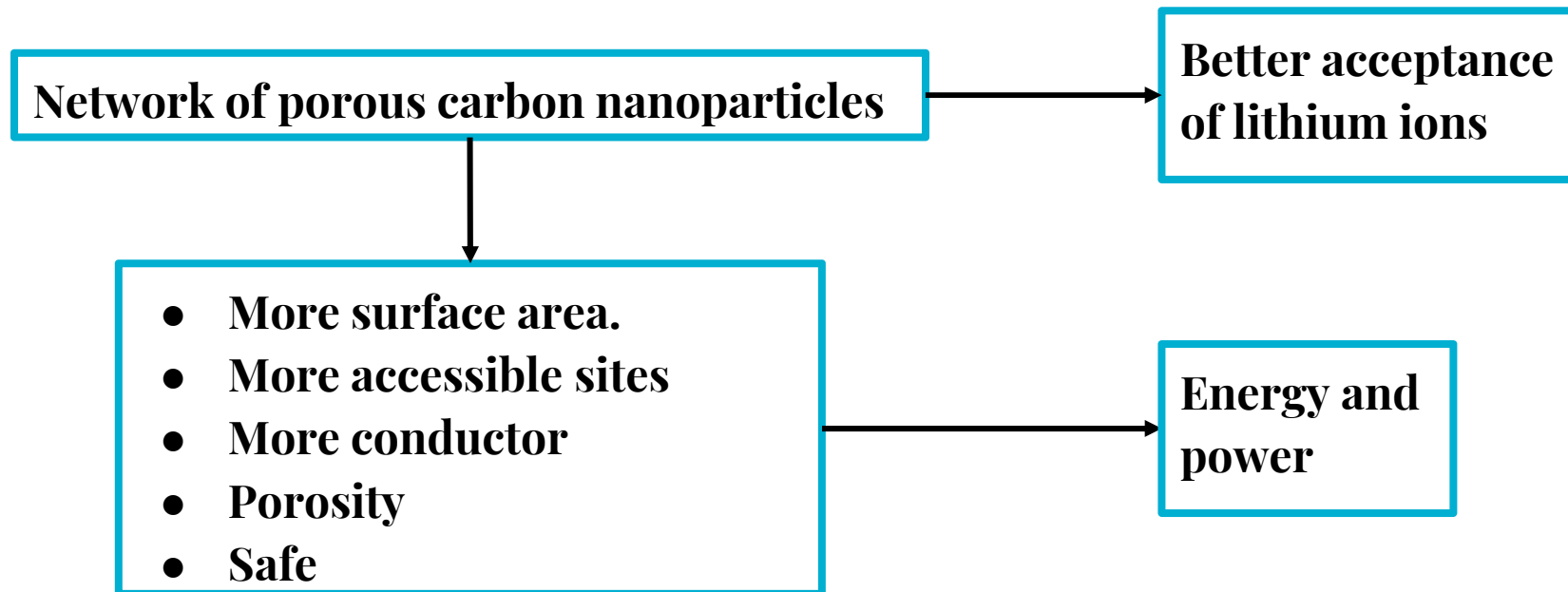
- **Voltage (V)** \longrightarrow Power of the equipment.
- **Power:** capacity of a cell to supply energy for unit of time.
 - **Current (A or mA)**
 - **Internal resistance** \longrightarrow Temperature
- **Load capacity (mAh):**
 - Capacity to deliver load with respect to time.
 - Battery duration before it is downloaded.
- **Energy (Wh or J)**
- **Performance:** % of energy supplied to charge the battery.

Comparative of lithium-ion batteries

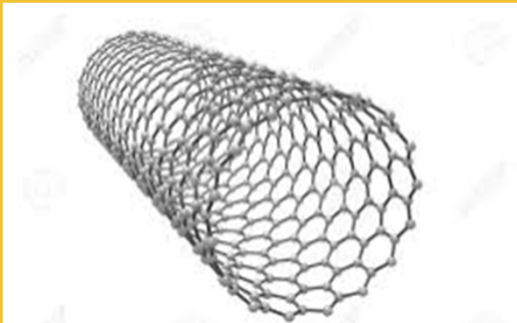
	Lithium Cobalt Oxide	Lithium Iron Phosphate	Lithium Manganese Oxide	Lithium Nickel Manganese Cobalt Oxide	Lithium Nickel Cobalt Aluminum Oxide
Anode	Graphite	Graphite	Graphite	Graphite	Graphite
Cathode	Lithium Cobalt Oxide	Lithium Iron Phosphate	Lithium Manganese Oxide	Lithium Nickel Manganese Cobalt Oxide	Lithium Nickel Cobalt Aluminum Oxide
Chemistry	LiCoO ₂	LiFePO ₄	LiMn ₂ O ₄	LiNiMnCoO ₂	LiNiCoAlO ₂
Other Name	LCO	LFP	LMO	NMC	NCA
Nominal Voltage	3.6V	3.2V	3.7V	3.6V	3.6V
Energy Density	High	Low	Low	High	High
Cycle Life	Medium	High	Low	Medium	Medium
Example Cell	SDI ICR18650-22F	Sony US18650FTC1	Moli IMR18650E	Sony US18650VTC4	Panasonic NCR18650B
Safety	Highest safety concern	Safest Li-ion cell chemistry	Good safety	Good safety	Some Safety Concern
Cost	Low	High	Medium	Medium	Medium

Nanostructures

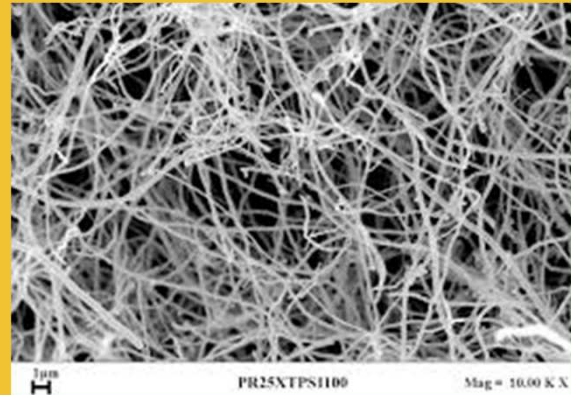
The importance of nanotechnology in this sector



- **Carbon nanotubes**



- **Carbon nanofibers**

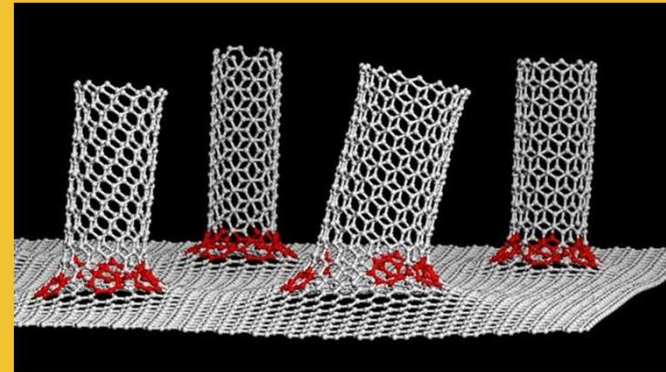


- **Graphene as anodes**

Future batteries

New concepts of batteries with active, inert materials and with better cell designs.

- **Lithium battery with graphene and carbon nanotubes.**
- **Silicon coated carbon nanotubes for in anodes**



Bibliography

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