

Common Battery Technologies

Rechargeable Batteries

Lead Acid



Nickel-Cadmium (NiCd)



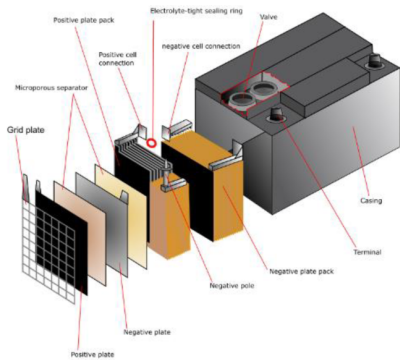
Nickel-Metal Hydride (NiMH)



Lithium-ion (Li-ion)



Lead Acid



History

The lead-acid battery was invented in 1859 by French physicist Gaston Planté. It is the oldest type of rechargeable battery.

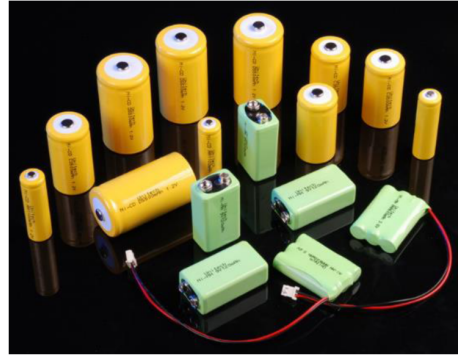
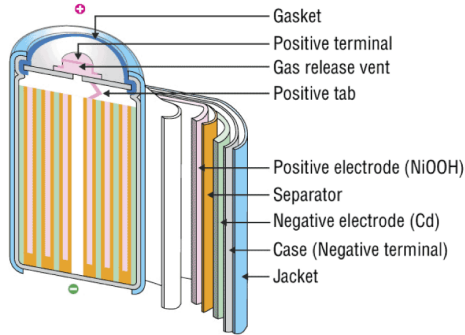
Advantages

- Very cheap to manufacture and one of the lowest cost per watt hour of rechargeable batteries
- Can produce very high discharge currents, so they are also used as automotive SLI or starting batteries
- Have very low self-discharge rate
- Good low temperature tolerance
- Do not develop a memory effect
- Experienced and reliable technology that has been known for over 100 years

Disadvantages

- Usually come in a large size and are pretty heavy, which limits their usability in smaller portable devices
- Low energy density
- Need to be charged using slow charge and are not intended to be fast charged
- Can have short cycle life (approx. 300-500 cycles) depending on the type of lead acid battery
- Can't be stored in a discharged state - can form a sulfation, if battery is stored fully or close to fully discharged state for longer periods of time
- Not environmentally friendly

Nickel-Cadmium (NiCd)



History

The first Ni-Cd battery was created by Waldemar Jungner of Sweden in 1899. At that time, the only direct competitor was the lead-acid battery, which was less physically and chemically robust.

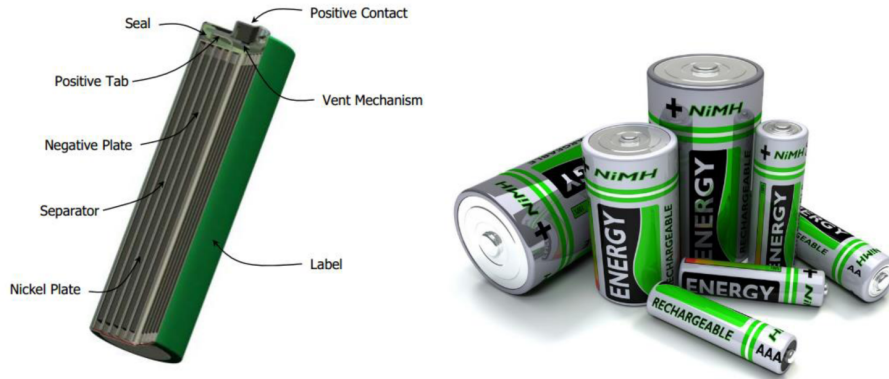
Advantages

- Can be quickly charged and discharged
- Better cycle life than Ni-MH, lead acid and some types of li-ion batteries; Can provide even 3 times more charge/discharge cycles than Ni-MH batteries
- Can deliver their full capacity at discharge
- Good low temperature tolerance and can perform well in temperatures below -4°F
- Cheaper than Ni-MH and li-ion batteries, but more expensive than lead acid batteries

Disadvantages

- Higher self-discharge rate than lead acid and li-ion batteries
- Lower energy density than Ni-MH (approx. 2 times) and li-ion (approx. 3 times) batteries, but higher than lead acid batteries
- Suffer from a “memory effect” - if battery gets discharged to the same level for multiple times, it will start to act like that is the lowest discharge level of the battery, so Ni-Cd battery will lose some of its capacity
- Use toxic metal cadmium, which is dangerous for environment

Nickel-Metal Hydride (NiMH)



History

Work on NiMH batteries began at the Battelle-Geneva Research Center following the technology's invention in 1967. Development was sponsored over nearly two decades by Daimler-Benz and by Volkswagen AG.

Advantages

- High capacity, more than two times higher than Ni-Cd and lead acid batteries
- Environmentally friendly
- Do not suffer from a memory effect that Ni-Cd batteries have - can be charged and discharged at any rate

Disadvantages

- Cost more than Ni-Cd and lead acid batteries, but are cheaper than lithium-ion batteries
- Have very high self-discharge rate, up to 3 times higher than Ni-Cd batteries and even more times higher than li-ion and lead acid batteries, will lose approximately third of its charge a month
- Are not suited for high charge and discharge rates as Ni-Cd batteries
- Suffer from risk of over-charging and over-discharging, also generate a lot of heat when charging

Lithium-ion (Li-ion)



History

Lithium batteries were proposed by M. S. Whittingham while working for Exxon in the 1970s. However, this rechargeable lithium battery could never be made practical and research moved to develop batteries where, instead of metallic lithium, only lithium compounds are present.

Advantages

- High specific energy
- Low self-discharge rate, lower than Ni-Cd and Ni-MH batteries
- Do not develop a memory effect
- Practically maintenance-free
- Long cycle life
- Environmentally friendly
- Lightweight and can be made in small size
- Allow fast charging to full capacity
- Safe - very good thermal and chemical stability

Disadvantages

- High manufacturing costs resulting in high sale prices
- Requires protection circuits to limit voltage and currents and ensure better safety
- Some provide low discharge rates
- Suffer from aging even when they are not in use
- Can lose capacity and cycle life when stored in higher temperatures for longer periods of time