B8 BATTERIES

LITHIUM TECHNOLOGY

CHEMICAL INDUSTRIES
RESOURCE PACK

Lithium cells

Lithium is an excellent material for making storage cell anodes, since it gives up electrons very easily and is very light. Lithium cells can provide an order of magnitude better energy density than lead-acid cells. One of the big problems with lithium is that it reacts violently with moisture, and manufacturing lithium cells requires a moisture-free environment.

Lithium cells also require venting and other safety systems to keep them from exploding if moisture does infiltrate the case, or if such cells are heated. The safety issues delayed their use for a long time. There is a large range of lithium cell technologies. They can be basically divided into non-rechargeable lithium cells, and rechargeable "lithium-ion" cells.

The conceptually simplest and most common non-rechargeable lithium cell is the "lithium-manganese" cell. This has a lithium anode, a manganese dioxide cathode, and a carbonate electrolyte.

The **anode** reaction is: $Li \rightarrow Li^+ + e^-$

The **cathode** reaction is: $MnO_2 + Li^+ + e^- \rightarrow MnO_2(Li)$

The cell voltage is about 3 volts. Such cells are constructed in a jelly roll configuration, with a sheet of lithium foil, a separator sheet containing electrolytic salts, and a sheet of manganese dioxide rolled up together. They have an indefinite shelf life.

There are many other non-rechargeable lithium cell configurations, such as "lithium sulfur dioxide", "lithium thionyl chloride", and "lithium polycarbonate monofluoride", with complicated constructions and chemistries that are substantially more capable than lithium-manganese but not as cheap, and so not in as widespread use. The latest generation of non-rechargeable lithium cells uses a polymeric electrolyte. Such "lithium polymer" cells have electrical characteristics similar to those of the predecessors, but they can be more easily built in flat or rectangular configurations that are very useful for lightweight portable equipment.

The latest generation of rechargeable lithium-ion cells feature electrodes made of phosphides of manganese and iron, made of "nano-sized" particles. These new cells are much more robust, have longer lifetimes, and can take a full charge in a matter of minutes.

Lithium-ion technology

Lithium-ion technology has not yet fully matured and is being improved continuously. New metal and chemical combinations are being tried constantly to increase energy density and prolong service life. The improvements in longevity after each change will not be known for a few years.

A lithium-ion battery provides 300-500 discharge/charge cycles. Although lithium-ion is memory-free in terms of performance deterioration, batteries with fuel gauges exhibit what engineers refer to as "digital memory". Here is the reason: short discharges with subsequent recharges do not provide the periodic calibration needed to synchronise the fuel gauge with the battery's state-of-charge. A deliberate full discharge and recharge every 30 charges corrects this problem. Letting the battery run down to the cut-off point in the equipment will do this. If ignored, the fuel gauge will become increasingly less accurate.

All personal computers (and some other electronic devices) contain a battery for memory back up. This battery is commonly a small non-rechargeable lithium cell, which provides a small current when the device is turned off. The PC uses the battery to retain certain information when the power is off.

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Laptop battery

Overcharging can damage batteries

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Counterfeit cell phone batteries (clone batteries)

In the search for low-cost battery replacements, consumers may inadvertently purchase clone cell phone batteries that do not include an approved protection circuit. Lithium-ion packs require a protection circuit to shut off the power source if the charger malfunctions and keeps on charging, or if the pack is put under undue stress (electrical short). Overheating and 'venting with flame' can be the result of such strain.

Cell phone manufacturers strongly advise customers to replace the battery with an approved brand. Failing to do so may void the warranty. Counterfeit cell phone batteries have become visible since the beginning of 2003 when the world was being flooded with cheap replacement batteries from Asia.

Heat is the main killer of batteries. A Canadian manufacturer of lithium-polymer batteries is taking advantage of the heat problem. They offer lithium-polymer for standby applications, a battery that needs heat to operate. The high cost remains a drawback and only a few lithium-polymer batteries are used for stationary applications today.

These batteries may be stored and operated within an extremely wide temperature range. Most of the lithium primary batteries may be stored for 10 to 20 years with negligible self-discharge, so that they still deliver most of their nominal capacity. They are continuously active, i.e. at all times ready for service. Typically, only 5% to 10% self-discharge after 10 years at normal temperature storage. Compared to metals used for common batteries such as lead or nickel and cadmium, lithium is not as poisonous as these to biological systems. Disposal of used lithium batteries is therefore a smaller problem.

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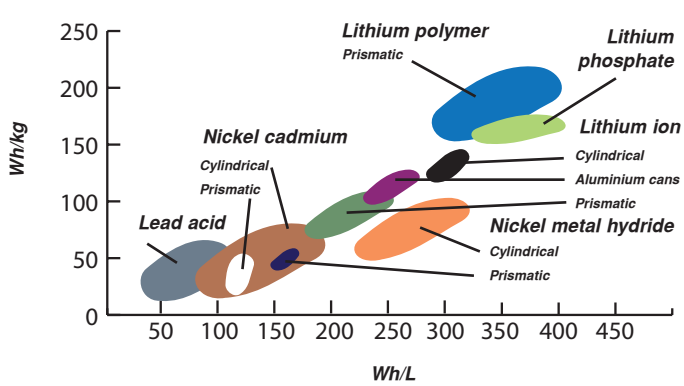
Secondary cell energy densities



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