

WHAT MAKES LITHIUM BATTERIES SPECIAL?

LITHIUM BATTERIES POWER A WIDE RANGE OF CONSUMER PRODUCTS, INCLUDING:

- Notebook computers
- Tablets
- Cell phones
- Cameras
- Power tools

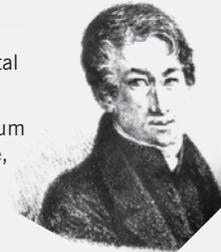


With all the attention lithium batteries have received in the news lately, and the revised regulations for shipping them as **Dangerous Goods**, you might wonder, "What makes these batteries so different that they warrant special treatment?"

Lithium, chemical symbol "Li," is a soft, silvery alkali metal that was first discovered by **Johan Arfvedson** in 1817.¹

Because lithium is the third-smallest element (only hydrogen and helium are smaller), a lithium ion can carry a positive charge in a very small space, which gives lithium a high degree of energy density.²

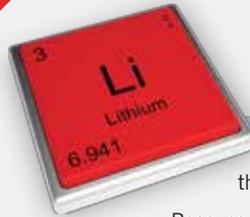
It's this **high energy density** that makes lithium such an excellent material for use in batteries, but it's also why these batteries must be treated with care.



Johan Arfvedson

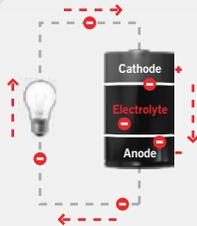


Pieces of lithium metal



BATTERY BASICS

In the simplest terms, batteries provide power when an **electrochemical reaction** occurs between the anode (-) and the cathode (+). The reaction causes a buildup of electrons at the anode, which can then flow in a circuit to the cathode. The amount of power, and whether the battery can be recharged, depend on the construction of the battery and the materials used.

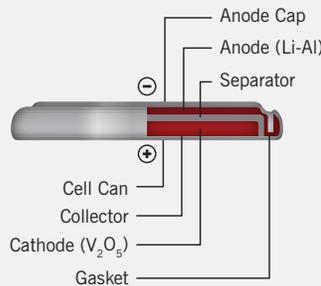


A note about "cells" vs. "batteries"

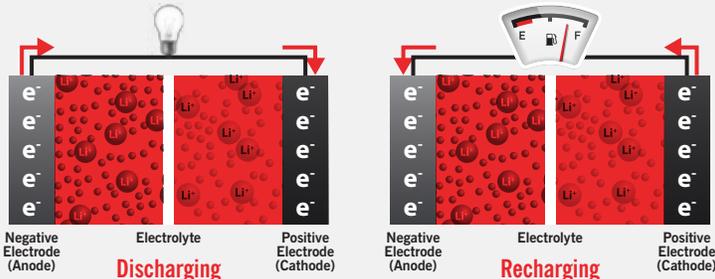
A "cell" describes a single unit with a cathode and anode for storing and delivering power. A "battery" can be made up of a single cell, as with AA, C or D batteries, or it can be multiple cells connected together to deliver more power, as in the case of laptop batteries.

In **lithium ion batteries**, lithium on the anode ionizes to form Li^+ and an electron. The lithium ions then travel through the electrolyte to the cathode. When recharging, the process is reversed.

A typical lithium metal "coin" cell:



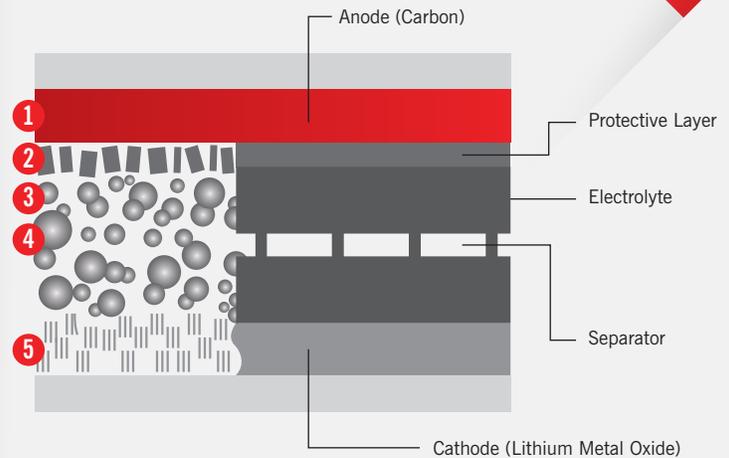
How lithium-ion batteries work



If a lithium battery is damaged, either through physical abuse, excessive heat or short-circuiting, it can enter what's called "**thermal runaway**."

THERMAL RUNAWAY

Thermal runaway in a lithium-ion battery



1. Heating starts.
2. Protective layer breaks down.
3. Electrolyte breaks down into flammable gasses.
4. Separator melts, possibly causing a short circuit.
5. Cathode breaks down, generating oxygen.

This fiery chain reaction is fueled by lithium's reactive nature and can be very difficult to extinguish as the amount of available lithium increases.

SEE MORE ON THE NEXT PAGE

SAFETY STARTS AT THE SOURCE



The first key to safe shipment is sourcing lithium batteries from only **trusted, reputable manufacturers**. The manufacturing process is extremely complex. Any contamination can result in the potential for internal short circuits.

Lithium cells and batteries must be tested and certified according to UN specifications.³

1. Altitude simulation	To simulate air transport under low-pressure conditions	There is no mass loss, no leakage, no venting, no disassembly, no rupture and no fire; and the open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately before this procedure. The voltage requirement does not apply to test cells and batteries at fully discharged states.
2. Thermal test	To assess cell and battery seal, confirm integrity and internal electrical connections	
3. Vibration	To simulate vibration during transport	
4. Shock	To simulate possible impacts during transport	
5. External short circuit	To simulate an external short circuit	The external temperature does not exceed 170°C and there is no disassembly, no rupture and no fire within six hours of this test.
6. Impact/crush	To simulate an impact	There is no disassembly and no fire within seven days of the test.
7. Overcharge	To evaluate the ability of a rechargeable battery to withstand an overcharge condition	
8. Forced discharge	To evaluate the ability of a rechargeable cell to withstand a forced discharge condition	



In recent years, both U.S. and international agencies have made significant changes to the regulations governing the shipping of lithium batteries by **land, sea and especially air**.

There are also limitations on the total electrical capacity of the batteries in the shipment (measured in **watt-hours**) and what modes of transportation are allowable. For example, lithium metal batteries not contained in equipment are not allowed as cargo on passenger aircraft.

For lithium batteries shipped by themselves, the packaging must protect the batteries from damage and the terminals on the batteries must be protected against short circuits.

For lithium batteries contained in equipment, the equipment must be protected from accidental activation.

Labelmaster offers a complete line of shipping products, services and software that can help you comply with the latest regulations and help ensure your lithium battery shipments arrive safely.

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SOURCES:

- ¹ <http://www.chemicool.com/elements/lithium.html>
- ² <http://www.physicscentral.com/explore/action/lithium.cfm>
- ³ <https://www.tc.gc.ca/eng/tdg/lithium-batteries-are-dangerous-goods-1162.html>

SOURCE FOR THERMAL RUNAWAY IMAGE:

<http://spectrum.ieee.org/aerospace/aviation/boeings-battery-blues>



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