

Powering the future of safety

Lithium-ion batteries power the world; their safety is critical.

Each year, innovations and new end products emerge to provide creative ways to interact with the world. Lithium-ion (li-ion) batteries power the heart of many products. A 2021 report from Research and Markets projects that the global li-ion battery market will grow from \$41.1 billion (USD) in 2021 to \$116.6 billion (USD) by 2030 with a compound annual growth rate of 12.3%.

The growing popularity of Li-ion batteries is a result of various factors. Users can recharge them hundreds to thousands of times, and they cost relatively low, have high energy density and are portable. They are used in a wide array of consumer electronics, mobility products like e-bikes and e-scooters, electric vehicles (EVs), consumer/commercial robots and energy storage systems.

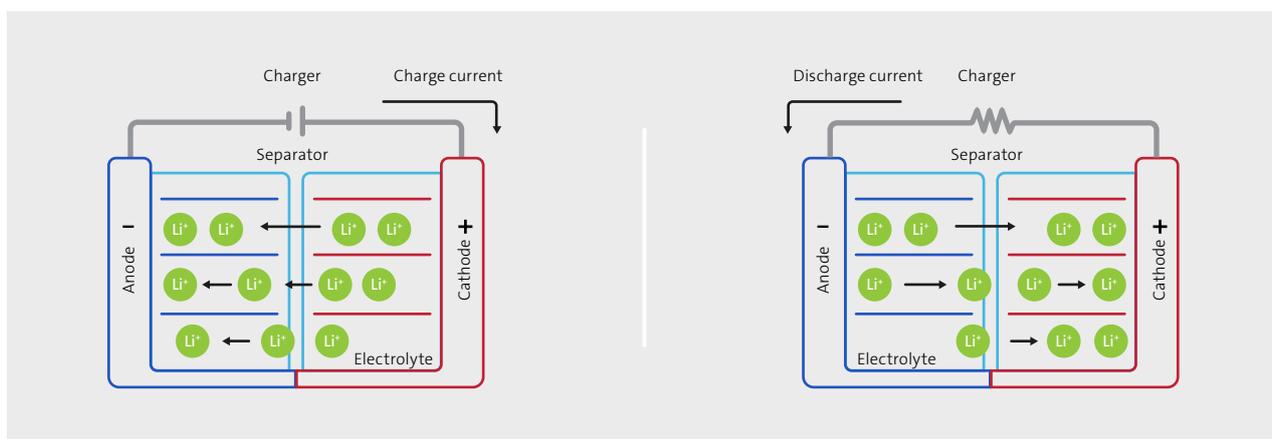
Li-ion batteries store energy by cycling lithium between metallic and saline states. When the lithium is in a metallic state, the battery charges. When the lithium is in a saline state, the battery discharges.

During battery discharge, as the lithium moves from the metallic state to the saline state, electrons move from the battery's positive side (cathode) to the negative side (anode), powering the device.

What do they power?

Today, these batteries play an essential role in many everyday devices, including:

- Augmented and virtual reality equipment, consumer electronics, power banks and e-cigarettes
- Wearable technology such as wireless headphones, rechargeable smartwatches and clothing
- Micromobility (e-bikes, e-scooters) and e-mobility aids for disabled people
- Hospitals and medical applications
- Consumer and commercial robots
- Appliances, power tools, backup and lighting systems
- Drones, portable power packs, EVs and energy storage



Lithium-ion battery energy storage process



Product Testing

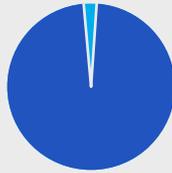
BELIEF



96%

of Americans believe products they buy for their home must adhere to a required safety standard.

REALITY



<1%

of product categories overseen by the CPSC must comply with a mandatory safety standard.

How safe are they?

Batteries pose a specific safety hazard called thermal runaway, an overheating of the battery system that may lead to an exothermic reaction that causes device breakdown or even an explosion. Design changes help reduce this risk by including a current interrupting device to terminate battery operation. A separator senses increased cell temperature and electronic circuitry to control charge/discharge. However, safety risks remain. Repeated dropping of a device over time, leaving a device in a hot car or wrapped in a blanket, can cause the battery to overheat, and can lead to thermal runaway.

According to Energy & Environmental Science, a journal from the Royal Society of Chemistry, manufacturers have quadrupled the energy density of li-ion cells since 1991. Pressure from the surrounding hardware can cause damage to the electrodes or separator. In addition, production flaws may cause microscopic metallic particles to come into contact with parts of a battery cell, leading to a short circuit within the cell.

Batteries and battery-operated end products that have not undergone sufficient evaluation, testing

and certification to known safety standards present a threat to consumer safety. The technology is generally safe when manufacturers take deliberate steps to minimize design flaws, vet material suppliers, control production quality and utilize best practices in product construction, including electronic circuits. However, the consumer perception is that products on the market have been reviewed for safety by regulatory agencies. But the truth is that fewer than 1% of products on the market overseen by the Consumer Product Safety Commission (CPSC), must comply with a mandatory safety standard according to statistics cited in 2021 by Consumer Reports.

Manufacturers of battery-powered products need to ensure that they integrate certified batteries safely into their products while also taking deliberate steps to ensure that their end products meet known safety standard requirements. However, some companies and consumers continue to purchase and use self-declared products without independent, third-party certification of the battery, electronics and end-product construction.

One of the simplest ways to reduce risk and product liability is to involve an independent, third-party, accredited certification organization to check the battery and battery-operated end products' conformance to known safety standards and issue product certification. As a required part of certification, manufacturers should participate in ongoing factory surveillance which verifies that the product still meets the original requirements it was certified under. From a consumer standpoint, looking for the UL Mark offers an easy way to know that the product has undergone thorough evaluation and testing prior to being launched on the market.

In March 2020, the CPSC released a report titled, "Updated Status Report on High Energy Density Batteries Project" which reported more than 25,000 incidents involving Li-ion battery-operated products since 2012. The CPSC has issued more than 70 product recalls representing more than 7 million batteries and products to protect the public from explosions, fire and electric shocks.

Such accidents can lead to the dramatic erosion of consumer trust in products, the retailers who sell them, and the brands that manufacture them.



How to build trust in your brand

With careful attention to established safety standards and the involvement of a safety science leader, manufacturers can reduce the risks their products pose and strengthen their reputations. Manufacturers should seek compliance to applicable standards and also partner with an accredited, independent, third-party certification organization. Self-declaring or only doing independent testing leaves considerable key safety-critical items unaddressed, such as construction, design and material review. These steps can help reduce the likelihood of safety concerns:



Risk assesment

- Evaluate potential safety risks and hazards associated with the power source.
- Identify necessary design changes to address risks and hazards.
- Pinpoint other necessary safety evaluation and testing criteria.



Understand the regulatory landscape

- Identify target markets and relevant regulations in each geographic location.
- Investigate and outline baseline requirements.
- Map evaluation, testing and/or certification plans based on regulatory requirements.



Consider marketplace requirements and customer expectations

- Identify requirements or measures that could result in competitive advantage.
- Map any evaluations, tests and/or certifications required to validate product claims, enhance product acceptance or differentiate offerings.



Seek expert advice and counsel

- Identify independent accredited ISO 17065 certification organizations to facilitate planning.
- Outline cost-effective evaluation, testing and certification strategies for long-term savings.
- Ask questions about international requirements.

Why UL?

Underwriters Laboratories Inc. has published more than 20 standards covering battery cells, battery packs and battery-powered end products, while UL offers more than 30 years of experience in battery evaluation and testing. Thousands of products have demonstrated their ability to earn UL certification, a key step toward safeguarding brand reputation and public trust.

We work with many stakeholders to drive standard development, industry adoption and ongoing market support. In addition, we help battery and end-product manufacturers gain fast, unrestricted access to the global market.



Some of the expertise our customers rely on include:

 **Safety** – We serve as a leader in safety testing and certification for battery technology, including safety compliance testing, inspection and certification for accessing and achieving differentiation in global markets. A comprehensive battery safety program needs to include cell safety, pack safety and end-product safety.

 **Performance** – We offer performance testing across the value chain, from competitive benchmarking for materials to charge/discharge and overcharge tests for cell and battery pack manufacturers as well as environmental and altitude simulation for system integrators. We also offer performance certification Marks for battery products compliant to relevant International Electrotechnical Commission (IEC) and European Norm (EN) standards.

 **Sustainability** – UL's Environmental Claim Validation provides manufacturers with credibility for their environmental sustainability claims such as battery recycling programs. Our publicly available UL SPOT Product Database features validated products.

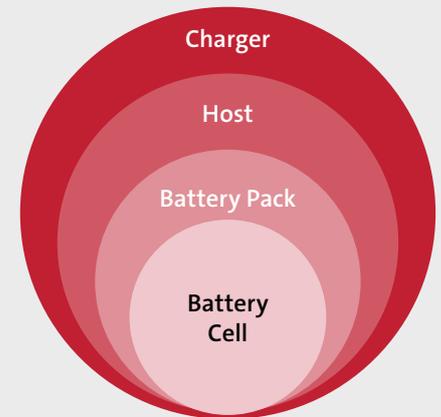


The UL Mark

Making sure your system components have achieved certification and that

batteries and battery operated products feature the UL Mark is a good way to help reduce safety risks. Our expert engineers apply their decades of experience toward testing and evaluating battery systems, providing you with electrical and fire safety certification signified by the UL Mark. The UL Mark represents a commitment to safety that can set your brand apart. The recognizable UL Mark allows consumers to verify that your device complies with UL's applicable safety standard requirements, enhancing consumer safety and building trust with your brand. Work with a partner that can help you enhance your products' safety with a deep understanding of the science behind the technology that powers our world.

System approach to battery safety



Battery Cell

- Electrical or environmental susceptibility
- Mechanical integrity

Battery Pack

- Prevention of fire propagation
- Balance between cells

Host

- Charging and discharging within battery limits
- Susceptible to adverse conditions from application and environment
- Interrupt charging when error with host or charger

Charger

- No electric shock or fire hazard
- Compatible to power requirement of the host

To learn more about UL's battery safety testing and certification services, visit us at www.UL.com/batt or contact us at UL.com/contact-us



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