Why do batteries catch fire

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This article overviews the causes of lithium-ion battery fires, examines the associated risks, and discusses preventive measures and industry contributions toward improving lithium battery safety.

Lithium-ion batteries (LIBs) are integral to modern technology, powering consumer electronics, electric vehicles (EVs), and renewable energy systems due to their high energy density, low self-discharge, rapid charging, and long lifespan. However, due to the volatility of their internal components, LIBs also present safety risks, notably the potential for fires and explosions.

Even though the reported incidents of LIB fires are low—ranging from one in one million to one in ten million units—understanding the causes of these incidents is crucial for improving battery safety in consumer and industrial applications.1

This happens when the battery's internal temperature exceeds 90-120 °C, triggering exothermic reactions in the electrolyte that decompose the solid electrolyte interface (SEI) and other components, releasing more heat.

Internal short circuits, caused by manufacturing defects, physical damage, or improper handling, can cause the separator to collapse and allow direct contact between the anode and cathode. This contact generates localized heating, triggering a thermal reaction and igniting the flammable electrolyte.

Overcharging a LIB beyond its voltage limit causes excess lithium ions to accumulate on the anode, forming metallic lithium. This can lead to dendrites—needle-like structures that may pierce the separator and cause internal short circuits.

Additionally, prolonged exposure to high temperatures accelerates material degradation, increasing fire risk; even ambient temperatures above 40 °C can harm battery health, while extreme temperatures may lead to rapid failure and combustion.

External physical damage, such as impact, puncture, or bending, can compromise battery safety by deforming the casing and exposing internal components. This can lead to electrolyte exposure to oxygen, resulting in increased fire risk.2,3

Modern LIBs have protective devices like safety vents, current interrupt devices (CID), and positive temperature coefficient (PTC) elements that help prevent thermal runaway by releasing pressure, interrupting current flow during overheating, and increasing resistance to limit heat generation.

The International Electrotechnical Commission (IEC) 62133 and UL 1642 are prominent standards that enforce testing protocols to prevent overcharging, short-circuiting, and overheating. They also mandate proper labeling and safety features for batteries used in consumer electronics and electric vehicles.

Additionally, countries and regions, such as the United States and the European Union, have established further testing and certification requirements, such as RoHS directives and UL certifications, for commercial use and transportation of LIBs.5-7

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