

What Causes Thermal Runaway?

Identifying the problem to develop solutions

Underwriters Laboratories is at the forefront of electrochemical safety science. At a time when potentially risky energy storage technologies can be found in everything from consumer products to transportation and grid storage, Underwriters Laboratories helps to lay the groundwork for energy storage designs that are safe and reliable.

Problem

One of the primary risks related to lithium-ion batteries is thermal runaway. Thermal runaway is a phenomenon in which the lithium-ion cell enters an uncontrollable, self-heating state. Thermal runaway can result in extremely high temperatures, violent cell venting, smoke and fire.

Background

Faults in a lithium-ion cell can result in a thermal runaway. These faults can be caused by internal failure or external conditions.

One example of such internal failure is an internal short circuit. In a lithium-ion cell, the cathode and anode electrodes are physically separated by a component called the separator. Defects in the cell that compromise the separator's integrity can cause an internal short circuit condition that can result in thermal runaway. This is especially likely in cells of poor quality.

External, off-nominal conditions can also cause thermal runaway. Examples of off-nominal conditions include overcharge; multiple overdischarges followed by charge; external short circuit; and high- and low-temperature environments. These external off-nominal conditions can also lead to an internal short circuit.

Where are lithium-ion batteries?

Lithium-ion batteries empower us to be flexible with energy storage. They make it easier to use on-the-go energy in portable products. They also enable us to store more energy from renewable sources, including wind and solar power.

Examples of devices that use lithium-ion batteries include:

- Mobile phones
- Laptops
- Electric vehicles
- Power banks
- Drones
- Satellites
- Public transit
- Wearable tech
- Headphones
- Medical devices

Batteries are manufactured with controls intended to protect against off-nominal conditions. However, these conditions can be encountered if the proper controls are not incorporated, eventually leading to thermal runaway.