Pyrophobic®

E-MOBILITY FIRE SAFETY

Lithium-Ion Battery Fires and E-Mobility: Why Passive Fire Protection Is the Missing Layer

E-bike and e-scooter battery fires are rising fast while regulation lags. Here's why testing alone isn't enough — and where passive fire protection fits in.

Pyrophobic Systems • pyrophobic.com

It starts quietly. A delivery rider parks an e-bike in the hallway of an apartment building and plugs it in overnight. The same thing he has done every night for two years. The battery is a replacement pack, bought online, cheaper than the original. At 3 a.m. a single cell inside it fails.

There is no warning. No smoke alarm has anything to detect yet. Within seconds that one cell ignites and drives its neighbours past their own thermal limits. The reaction feeds itself. By the time anyone smells smoke, the pack is a self-sustaining fire in an enclosed corridor, the exact path residents would use to escape.

This scenario is not hypothetical, and it is not rare anymore.

The numbers moved faster than anyone planned for

Toronto Fire Services has watched this curve bend sharply upward. The city recorded around 9 lithium-ion battery fires in 2021. By 2025 that figure had climbed to roughly 90 — a tenfold increase in five years. Halfway through 2026, crews had already responded to about 50 such calls, putting the city on pace for roughly 100 by year's end.

Fires involving e-bikes and e-scooters specifically tell an even starker story: 3 incidents in 2023, 25 in 2024, and 29 recorded partway through the following year. Toronto's fire chief has publicly called e-bike batteries the fastest-growing fire safety risk in the city.

And these fires are not property-damage statistics alone. At least one person has died in a lithium-ion battery fire in Toronto every year since 2023.

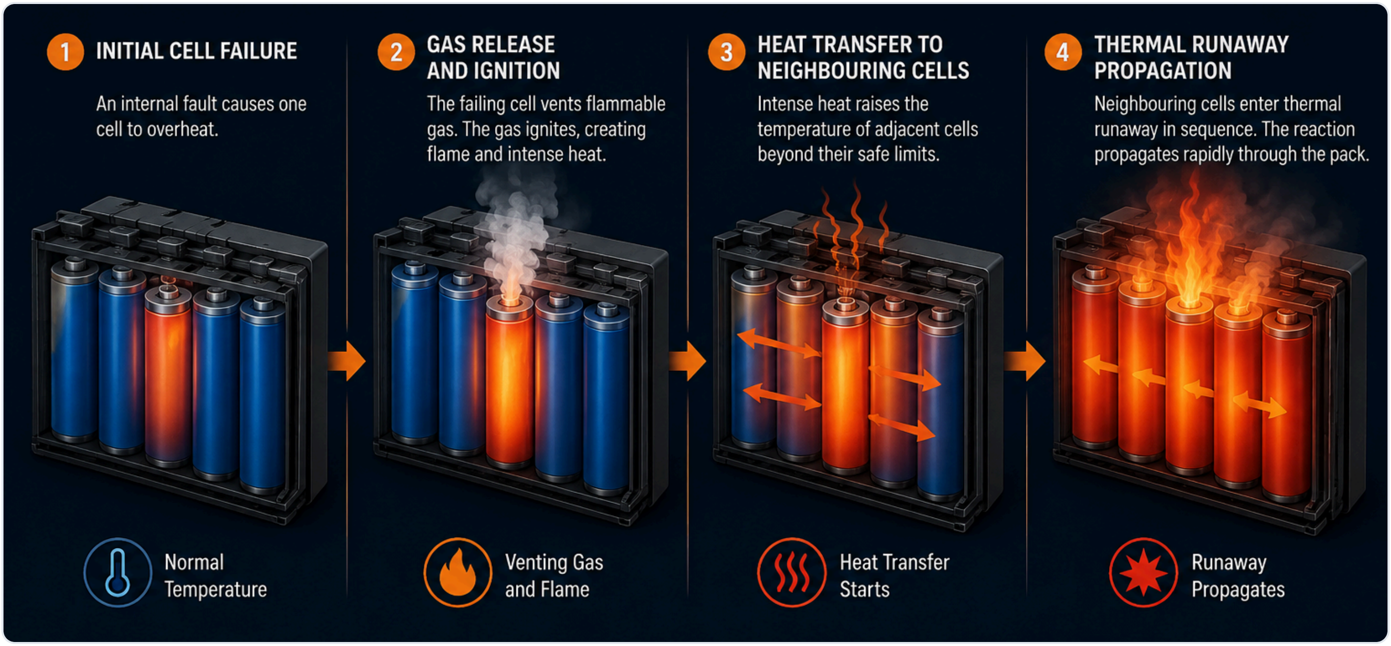
Toronto simply happens to be well documented. London, New York, Sydney, and cities across Europe and Asia are reporting the same pattern, for the same reason: e-mobility adoption has been extraordinary, and the safety infrastructure underneath it has not kept pace. For example, the Fire Department of the City of New York (FDNY) investigated 292 lithium-ion battery fires in all of 2025 that caused 51 injuries and one death.

What is e-mobility?

E-mobility, short for electric mobility, covers battery-powered personal transport: e-bikes, e-scooters, e-mopeds, e-skateboards, electric unicycles, and light electric vehicles. Unlike cars, these devices are typically charged indoors, stored in living spaces, and often carried into elevators and stairwells. That single behavioural difference is what turns a battery fault into a life-safety event.

Why these fires behave differently

The mechanism at the centre of every one of these incidents is thermal runaway.



Thermal runaway can begin with a single cell failure and rapidly propagate through a lithium-ion battery pack in seconds.

What is thermal runaway?

Thermal runaway is a self-accelerating chain reaction inside a lithium-ion cell. Once a cell reaches a critical temperature, internal chemical reactions generate more heat than the cell can shed. The cell vents flammable, toxic gases and ignites, and the released heat pushes adjacent cells over the same threshold. The failure then propagates through the pack.

Three characteristics make thermal runaway uniquely dangerous in e-mobility settings:

- **It supplies its own oxygen.** Decomposition of the cathode releases oxygen internally, which is why smothering a lithium-ion fire often fails.
- **It reignites.** A pack that appears extinguished can re-enter runaway minutes or hours later as heat migrates to untriggered cells.
- **It is fast.** Propagation across a pack can take seconds, far shorter than any realistic detection-plus-evacuation window in a corridor, elevator, or stairwell.

This is why conventional fire strategy struggles here. Most building fire protection assumes a fire that grows gradually enough for detection, alarm, and response to work in sequence. Thermal runaway compresses that timeline until the sequence no longer fits.

The regulatory gap: recommended, not required

Here is the part that surprises most engineers and specifiers when they first look closely.

In Canada, there is currently no mandatory, e-mobility-specific safety regulation for lithium-ion batteries. Health Canada and Transport Canada recommend that devices and packs comply with ANSI/CAN/UL 2272 and ANSI/CAN/UL 2849, but a recommendation is not a requirement. Nothing stops a non-certified replacement pack from being imported, sold online, and charged tonight in a residential hallway.

The relevant standards do exist and are well constructed:

Standard	What it covers
UL 1642	Individual lithium cells
UL 2271	Battery packs for light electric vehicle (LEV) applications
UL 2272	Complete electrical systems for personal e-mobility devices (scooters, hoverboards, EUCs)
UL 2849	The complete e-bike electrical system as an assembly, including the pack
EN 50604-1 / -2	European equivalent for LEV battery systems

Regulators are moving. In the United States, the Consumer Product Safety Commission has advanced rulemaking to make micromobility battery standards mandatory, and notably, in doing so, the CPSC stated that none of the existing standards is adequate on its own to eliminate or adequately reduce the risk of injury. Its proposals include tamper-resistant enclosure requirements and additional post-discharge charge testing.

That conclusion deserves emphasis, because it reframes the whole problem:

> **Certification is necessary. It is not sufficient.**

A certified pack is a pack that passed a defined test sequence in a controlled condition, at the moment of manufacture. It is not a guarantee against a cell defect three years later, a drop-impact in a stairwell, water ingress, a counterfeit charger, or a pack modified after purchase. Regulation raises the floor. It does not remove the failure mode.

Which leaves a question that OEMs, assemblers, and specifiers all have to answer independently of whatever the regulation eventually says: when a cell does fail, what is physically in the pack to stop it from becoming a building fire?

Active vs. passive fire protection, and why the distinction matters here

Active fire protection requires something to happen. It detects, triggers, and then acts: sprinklers, alarms, gaseous suppression, extinguishers. It depends on detection speed, a power or pressure source, and correct activation.

Passive fire protection (PFP) is built into the structure or product itself. It requires no trigger, no power, and no human intervention. It works by containing, insulating, or slowing fire and heat spread by material behaviour alone: fire-rated walls, firestop seals, intumescent coatings, thermal barriers.

For thermal runaway, passive protection has a structural advantage: it is already in place when the event begins. There is no detection lag to lose, no activation to fail, no service interval to have been missed. In a sealed battery enclosure, where an active system would need to detect, deploy, and reach the interior of a pack in the seconds available, that advantage is decisive.

The goal of passive protection in a battery is specific and achievable: stop propagation. Contain the failure to the originating cell or module, absorb and block the heat flux to its neighbours, and manage the vented gas path. A single-cell failure that stays a single-cell failure is a warranty claim. The same failure allowed to propagate is a fatality risk and major property damage.

Comparing the passive options

Engineers evaluating thermal barrier materials generally weigh four candidate families. Each has real strengths and real limits.

- **Aerogel blankets** offer outstanding insulation per millimetre and are well proven thermally. In practice, teams cite dust and handling issues during assembly, compression set over time, cost at volume, and the fact that they insulate but do not respond — the barrier at minute five is the same barrier it was at minute zero.
- **Mica sheet** is dimensionally stable, dielectrically strong, and inexpensive. It is also rigid and brittle, which makes complex or curved geometry difficult, adds part count for anything non-planar, and leaves it vulnerable to cracking under vibration — a genuine concern in e-mobility duty cycles.
- **Ceramic fibre and ceramic blankets** perform at very high temperatures but bring bulk, weight, and the same passive-insulation-only behaviour, with fibre handling considerations.
- **Encapsulants and potting compounds** provide good mechanical protection and heat sinking, but add significant mass and can complicate serviceability and end-of-life recycling.

The common limitation across the first three is that they are static insulators. They resist heat transfer, which is valuable, but they do not change state to seal a gas path, they do not expand to close the gaps that open as a pack deforms during a runaway event, and they do not add protective mass exactly where and when heat appears.

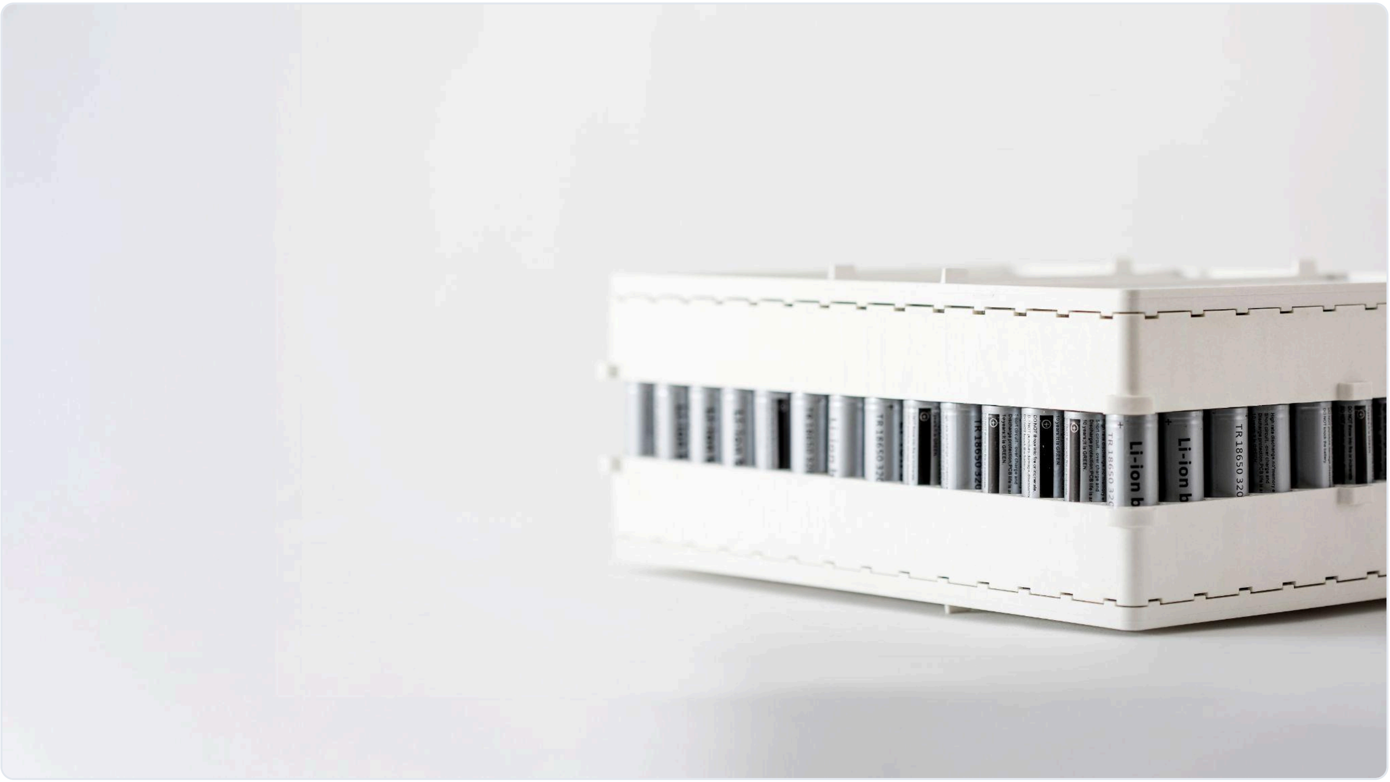
Intumescent materials work differently.

What is an intumescent?

An intumescent material expands when exposed to heat, typically 5–20 times its original thickness, forming a thick insulating char layer. It is reactive by design: it stays thin and unobtrusive at operating temperature, then activates at the temperature threshold that matters.

That behaviour maps unusually well onto thermal runaway. The material occupies minimal packaging volume during normal service, then, triggered by the heat of a failing cell, expands to fill voids, block the heat path to adjacent cells, and seal openings through which flame and hot gas would otherwise travel. It responds to the event rather than merely resisting it.

Where LithiumPrevent fits



Injection molded LithiumPrevent lithium-ion battery cell holder.

LithiumPrevent is an intumescent polymer developed specifically to contain lithium-ion thermal runaway. Because it is a moldable intumescent thermoplastic, it can be produced as cell holders, spacers, module walls, enclosure liners, and other geometry-specific parts, rather than as a blanket or sheet that has to be cut, fitted, and retained.

Additional information about Pyrophobic LithiumPrevent.

Learn about LithiumPrevent
pyrophobic.com/products

Why does it matter?

For OEM engineers: Protection becomes a component with defined geometry, not a fitted consumable. Thermoplastic processing means conventional moulding, repeatable parts, and integration into existing pack architecture without a bespoke assembly step. Volume and mass budgets are usually where aerogel and ceramic options struggle; a moulded intumescent part can carry structural and protective function in the same piece.

For battery assemblers: Fewer hand-fitted layers, no fibre or dust handling, and parts that arrive to spec and drop into the fixture. Assembly time and rework rate are where thermal barrier decisions quietly cost money, and a moulded part is far easier to control than a cut blanket.

For fire protection engineers and specifiers: The relevant question is propagation containment, and passive containment is defensible in a way that reliance on a recommended-but-not-required certification is not. LithiumPrevent has been evaluated through internal testing, independent testing, and assessment at NASA, the FAA, and DNV — bodies whose acceptance criteria are considerably harder to satisfy than consumer-product baselines.

For architects and building designers: You are increasingly the party who has to answer where e-bikes charge in a residential or mixed-use building, and whether that location sits on an egress path. Room-level measures matter, but the most reliable containment is the one inside the device before it ever enters the building. Specifying or preferring devices with designed-in passive protection is now a legitimate life-safety consideration at the design stage, not an afterthought.

What responsible practice looks like now

The realistic path forward is layered, and none of the layers is optional:

1. **Mandatory certification, not recommendation.** UL 2271, UL 2272, and UL 2849 compliance should be a condition of sale, including for aftermarket and replacement packs — the category driving a disproportionate share of incidents.
2. **Standards that test propagation, not just cells.** Pack-level and system-level propagation testing needs to sit alongside cell testing, because propagation is the mechanism that kills.
3. **Enforcement at the point of import and online sale.** A standard nobody checks is a standard nobody meets.
4. **Designed-in passive fire protection.** The layer that works when everything else has already failed: no power, no detection, no intervention required.
5. **Charging and storage guidance in buildings.** Necessary, but the weakest layer, because it depends entirely on human behaviour.

Regulation will arrive. It will take years, it will apply to new products, and it will not retire the millions of packs already in service. Passive protection is the layer manufacturers can add now, on their own initiative, ahead of being told to.

Request a sample of LithiumPrevent or speak with our engineering team.

Contact our team
pyrophobic.com/contact

Frequently Asked Questions

Q What causes lithium-ion battery fires in e-bikes and e-scooters?

Most incidents trace to one of five causes: manufacturing defects in the cells, physical damage from impact or vibration, water ingress, use of non-matched or counterfeit chargers, and after-purchase modification of the pack. Any of these can trigger thermal runaway, a self-sustaining chain reaction in which one overheating cell drives its neighbours past their thermal limits.

Q Why are e-bike battery fires more dangerous than other fires?

Because of where they happen and how fast they develop. E-mobility devices are charged and stored indoors, frequently in hallways, elevators, and near exits, meaning the fire starts on the escape route. Thermal runaway also propagates in seconds, releases its own oxygen internally, produces toxic gas, and can reignite hours after appearing extinguished.

Q Are e-bike and e-scooter batteries required to be certified in Canada?

No. As of now there is no mandatory e-mobility-specific lithium-ion battery regulation in Canada. Health Canada and Transport Canada recommend compliance with ANSI/CAN/UL 2272 and ANSI/CAN/UL 2849, but compliance is voluntary. This is why non-certified replacement packs remain widely available online.

Q What is the difference between UL 2271, UL 2272, and UL 2849?

UL 2271 covers battery packs for light electric vehicle applications. UL 2272 covers the complete electrical system of personal e-mobility devices such as e-scooters and hoverboards. UL 2849 covers the entire e-bike electrical system as an assembly, and includes UL 2271 pack requirements within its scope.

Q Does UL certification prevent battery fires?

It substantially reduces risk but does not eliminate it. Certification verifies that a design passed a defined test sequence at the time of manufacture. It cannot account for a latent cell defect, later impact damage, water ingress, a counterfeit charger, or post-sale modification. The US CPSC has explicitly stated that no existing standard is adequate on its own to eliminate or adequately reduce the risk of injury.

Q What is passive fire protection for lithium-ion batteries?

Passive fire protection is built into the battery pack and requires no trigger, power source, or human action to work. It contains a fire by material behaviour alone, insulating adjacent cells, blocking heat transfer, and sealing the paths flame and hot gas would travel. It is already in place at the moment a cell fails, which is why it suits an event that propagates in seconds.

Q How is passive fire protection different from active fire protection?

Active systems must detect a fire and then activate sprinklers, alarms, and gaseous suppression. They depend on detection speed, a working power or pressure source, and correct operation. Passive protection is inherent to the product or structure and works without activation. For thermal runaway inside a sealed pack, active systems face a timing and access problem that passive materials do not.

Q What is an intumescent material and how does it stop thermal runaway?

An intumescent material expands significantly when heated, forming a thick insulating char. Inside a battery pack it stays thin during normal operation, then activates at the heat of a failing cell, expanding to fill voids, block heat transfer to adjacent cells, and seal gas and flame paths. Unlike static insulators such as mica or aerogel, it responds to the event.

Q How does LithiumPrevent compare to aerogel or mica?

Aerogel and mica are static insulators: effective at resisting heat transfer but unchanged by the event, with practical trade-offs in dust and handling, compression set, rigidity, brittleness under vibration, and geometric flexibility. LithiumPrevent is a mouldable intumescent thermoplastic, so it can be produced as geometry-specific parts, cell holders, spacers, enclosure liners, and it expands on heating to actively seal and contain rather than only insulate.

Q Can passive fire protection be retrofitted into existing battery designs?

Integration is most effective when designed at the pack architecture stage, where protective geometry can share space and function with structural components. Some configurations can accommodate liners or barriers in existing enclosures. The practical answer depends on your pack layout, thermal budget, and volume constraints, which is what a sample evaluation is for.

ABOUT

Pyrophobic Systems

Pyrophobic Systems develops engineered passive fire protection materials that help OEM engineers meet demanding fire safety requirements. For electric vehicles and e-mobility, our LithiumPrevent family is a patented intumescent thermoplastic engineered for lithium-ion battery protection. When exposed to heat, LithiumPrevent expands 2–3x and forms an insulating char, helping contain thermal runaway and reduce thermal propagation at the cell and module levels. Unlike conventional flat barriers, LithiumPrevent can be injection molded into complex 3D components, including cell holders, spacers and module separators, or extruded into continuous profiles and sheets. This gives EV and e-mobility engineers a multifunctional material platform that combines passive fire protection, electrical insulation and manufacturing flexibility within the battery architecture. Pyrophobic works closely with OEMs and integrators to develop, validate and scale application-specific solutions from concept through production for demanding applications.