

# **Used Lithium Battery Management Current Issues**

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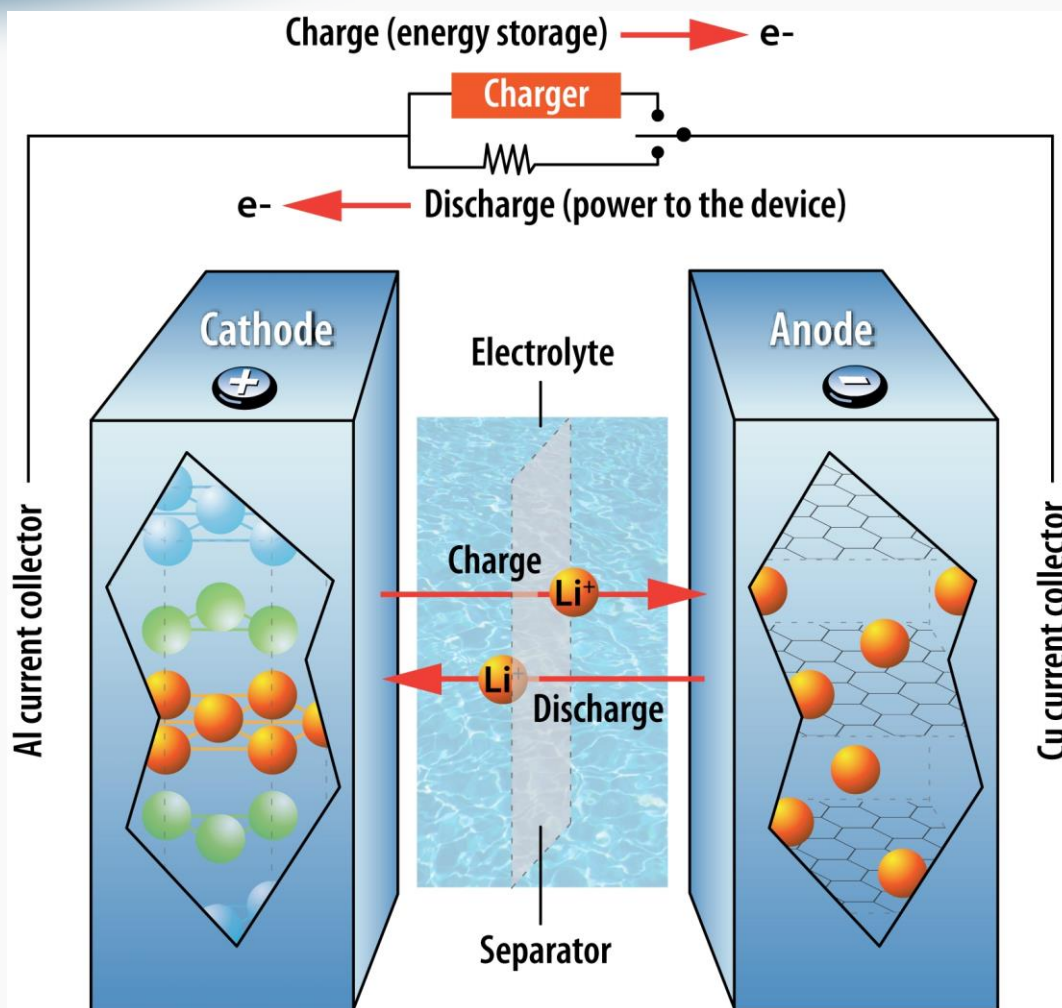
# Lithium Batteries

Two types of lithium batteries

- Non-rechargeable, primary batteries that use lithium metal in the AA or 9V format.
- Rechargeable lithium-polymer cells which uses a lithium electrolyte that passes through a porous membrane, creating a voltage

Compared to other batteries, lithium batteries have:

- High charge density (more energy)
- Lighter weights
- Potentially higher voltages (over 3 V compared to 1.5 V for alkaline batteries)



Rechargeable Lithium Cell - [Argonne National Lab](#)

# What do Lithium Batteries Look Like?

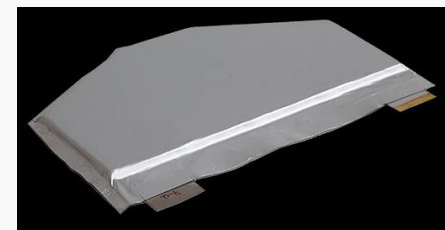
- These are from a variety of devices:
  - Everyday devices that use removable batteries, such as 'AA', 'AAA' or '9V'.
  - Automobiles (accessory, starting, and motive power)
  - Handheld devices
  - Portable computers
  - Cellular phones
  - Appliances
- Batteries can be hard to find and identify in the device
- Sales are increasing by double digits annually



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<https://en.wikipedia.org/wiki/User:Krause6>

## The Concern



[https://www.reddit.com/r/techsupportgore/comments/5eiorf/the\\_struggle\\_of\\_dealing\\_with\\_iphone\\_battery/](https://www.reddit.com/r/techsupportgore/comments/5eiorf/the_struggle_of_dealing_with_iphone_battery/)

- Product safety is important to both the user *and* repairer, refurbisher or end-of-life manager
- Lithium batteries are safely used everyday; with more in use we gain more experience
- Fires and the rapid release of energy from lithium batteries is becoming a risk in the electronics recycling and waste management industries
  - Batteries bent during removal from the product can result in an internal short which causes an event at an electronics recycler. This could be swelling, heating, or fire
  - Batteries in the trash, curbside recycling bin, or collection points, can electrically short or be broken causing the recycling or waste streams to catch fire



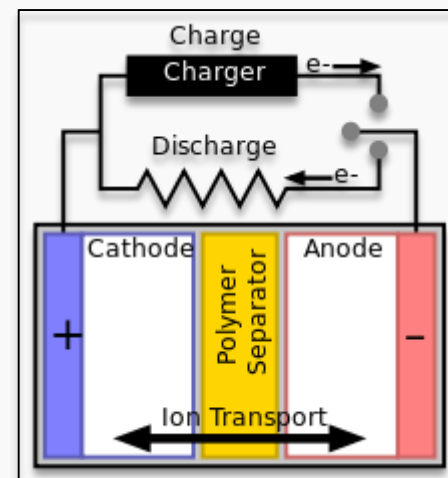
## Battery Fire at a Maine Material Recovery Facility (December 2017)





# How can Lithium Batteries Start Fires?

- The polymer separator can become damaged, allowing more  $\text{Li}^+$  through, which can lead to overheating
  - Polymer cells can swell, making them more susceptible to further damage
  - Batteries can develop age or use related issues (dendrites)
- They can be 'bruised' during removal from the product during reuse or recycling
- They can break (e.g., be crushed) exposing the lithium to moisture in the air, starting fires



## One Recycler's Story

- A pouch type lithium-ion tablet battery was punctured while attempting to pry the device apart to remove the battery.
- The battery got very hot, swelled, and then the plastic started smoking from the heat.
- The device was slid to the floor and allowed to burn out while the area was evacuated and ventilated.
- It was moved outside when it stopped burning and left to vent/cool and then was disposed in the trash.
- Employees involved reported not having inhaled enough of the fumes to have a reaction.





# Why is this 'New' News?

- According to Call2Recycle, until recently safety/fire incidents have been very isolated.
- The stories were often told quietly so electronics recyclers don't bring attention to the issue (could cause increased insurance costs, OSHA oversight, and doesn't look good to clients).
- Fires are making the news and are more talked about now
- Anecdotal information:
  - EPA staff spoke with numerous (electronics and solid waste) recyclers and repairers, all which have experienced battery fires; the Institute of Scrap Recycling Industries and Call2Recycle are aware of the issue
  - One recycler stated this happens frequently enough that they have buckets of sand at work stations to bury smoking batteries
  - There have been 'near misses'. A lithium battery '...triggered an explosion and the blast [blew a] door off a shredder. [It] Missed a worker by two feet. No injury, no report.'
  - Another recycler said that even the manufacturers are having these events with equipment they or their service providers recycle.
- Battery ignited fires have also occurred in the waste industry, such as material recovery facilities, auto shredders and white goods recyclers. Equipment and facilities have been damaged or destroyed.





# Headlines

- **Fire at Jamaica [NY] recycling plant caused by improperly disposed-of lithium battery: FDNY**
  - AMNewYork, (3/18/18)
- **Cell phones thrown in the trash are exploding, causing 5-alarm fires in garbage trucks**
  - USA Today, (5/18/18)
- **Train car carrying Lithium batteries explodes near downtown Houston**
  - KOHU11, Houston (April 2017)
- **iPad Battery Malfunction Leads To Apple Store Evacuation In Amsterdam**
  - NPR (August 2018)
- **Fire Surge: Why Are We Seeing A 77% Increase In Waste & Recycling Facility Fires In The First Half Of 2018?**
  - Ryan Fogleman, Fire Rover
  - Lithium batteries may be one of several causes

## Is this a sustainability issue or a safety issue?

- BOTH!

If batteries are difficult to remove:

- **Safety issue:**
  - may bend or puncture, posing a risk of fire or other danger.
- **Sustainability issues:**
  - may be less reuse of electronics because batteries can't be replaced, reducing the economic value to the recycler and decreasing the use of the product
  - may be less recycling/recovery of materials because a determination must be made on how to recycle combined units
  - Burnt products are generally not recyclable





# How do batteries get recycled?

- Collection points receive used batteries, or possibly the devices they are in:
  - Retail
  - Private
  - Recyclers
- Electrical terminals should be covered (preferably bagged)
- Batteries are shipped to either a sorting facility or a processor
- This path is for batteries in good condition, Department of Transportation reg's apply.
- For batteries that are reusable, there is a thriving reuse industry



Example of a Call2Recycle drop-off box

# How do Batteries Get Recycled?

- Damaged, defective or recalled require special handling
  - Limited quantities per package
  - Inert fillers
  - US Department of Transportation regs apply
- There are three processing methods that we've identified for all batteries
  - Cryogenic
  - Pyro-metallurgical
  - Hydro-metallurgical



[www.Call2Recycle.org](http://www.Call2Recycle.org)



# Confusing Product Labels



- The products and batteries are sold worldwide
  - Labels are for multijurisdictional compliance
  - A battery may have information in many different languages
- The EU requires the 'no trash' symbol
- Japan has a lithium-ion recycling symbol, with the chasing arrows
- There is no mandatory U.S. labeling
  - Products may carry the voluntary Call2Recycle label
  - Labeling depends on if the manufacturer/brand owner is participating in the stewardship program
- Non-accessible cells may have no information internally or externally





# Groups Involved in Finding Solutions

- IEEE 1680.1 (EPEAT)
- The PBRA - Rechargeable Battery Association has a working group underway on the issue on safe handling of batteries
- Call2Recycle
  - Rechargeable battery recycling drop-off boxes ([www.call2recycle.org](http://www.call2recycle.org))
  - Charge up safely, battery safety campaign - [www.Call2Recycle.org/safety](http://www.Call2Recycle.org/safety)
  - S.F. Bay area outreach on battery management - Avoid the Spark Campaign (<https://www.call2recycle.org/california-campaign-release/>)



# Groups Involved in Finding Solutions

- The Recycling Partnership
  - Campaign Builder -  
<https://recyclingpartnership.org/pdf-builder-login/>
  - Lithium batteries are part of their recycling contamination messaging tools
- Development of new battery chemistries
  - Solid state lithium
  - Zinc base chemistries

Courtesy of the Recycling Partnership





# EPA Activities

- EPA's hosted two webinars on lithium batteries
  - 'An Introduction to Lithium Batteries and the Challenges that they Pose to the Waste and Recycling Industry' (March 2018)
  - 'Management Challenges for Lithium Batteries at Electronics Recyclers' (April 2018)
- Hosting Call2Recycle on a webinar with tribal solid waste managers
- Participating in the Institute for Electrical and Electronics Engineers 1680.1 standard development process.
  - EPA advocated for a criteria that would support batteries that are easily removable.
- Visit to Argonne National Laboratory's battery program
- Encouraging the issue to be brought up at different meetings and conferences: (e.g., e-Scrap, Electronics Reuse Conference)





## Possible Solutions

- More clearly identify devices that have lithium cells and proper end-of-life management for the battery and device
- Increase outreach and education to consumers about proper lithium battery management
- Increase access to collection programs and drop-off locations
- Adjust battery or product labeling to reduce confusion between correct and incorrect information for each market
- Building markets for used batteries to incentivize removal and proper management



## Possible Solutions

- Provide information and training resources to recyclers and refurbishers about how to remove batteries safely and without bending.
  - Note: Events are happening at facilities with highly trained and skilled workers that work slowly/ carefully
- Provide information to recyclers and refurbishers about risks that bent or leaking batteries pose and how to safely manage them.
- Increase communication between recyclers and designers, focusing on end-of-life management
- Continue development of alternative batteries, such as solid state lithium and zinc based cells.



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