HARVARD
Campus Services
ENVIRONMENTAL HEALTH & SAFETY

LABORATORY SAFETY GUIDELINE

Lithium-Ion Batteries

All users of stand-alone Lithium-Ion (Li-Ion) Batteries must review this document before use. When designed, manufactured, and used properly, lithium-ion batteries are a safe, high energy density power source. They may generate heat, catch fire, or even explode if they have design defects, are made of low quality materials, are assembled incorrectly, are used or recharged improperly, or are damaged during transport or handling. Users should contact their EHS Laboratory Safety Advisor and department safety officer if they have questions before beginning work.

HAZARDS

	Lithium is an alkali metal that reacts with water. To prevent reaction with moisture in ambient air, it must be encased in a compatible substance such as oil. Lithium is flammable and can spontaneously ignite, however, Lithium compounds contained in Li-Ion batteries are different from pure lithium metal and tend to be more stable.
	Most incidents with lithium batteries happen when the battery's shell is damaged and the lithium is exposed to air/moisture. As mentioned above, Lithium compounds contained in Li-Ion batteries tend to be more stable, though they can still be corrosive, irritating or toxic, depending on the exact chemistry of your battery.
	Short circuits and electrical shock can cause injury, blindness, and death, and permanently damage equipment. They can cause excess heat, fire, and arcing – where energy 'jumps' through the air to a nearby conductive material. This is especially dangerous with batteries that supply continuous strong current.

Damage to lithium-ion batteries can occur immediately or over a period of time, from physical impact, exposure to certain temperatures, and/or improper charging:

- Physical impacts: dropping, knocking, crushing, excessive vibration, and puncturing.
- Temperature
    - High temp. (e.g., above 100°F/38°C) can accelerate failure in cells with defects or damage from other causes.
    - Low temp. (e.g., below freezing (32 °F /0°C) during charging can lead to permanent metallic lithium buildup on the anode, increasing the risk for failure.
- Charging a device or battery without following the manufacturer's instructions may cause damage to rechargeable Li-Ion batteries:
    - Some manufacturer-authorized chargers will cycle the power to the battery on and off before it is fully charged to avoid overcharging.
    - Ultra-fast chargers may not cycle power – thus causing overcharging. Do not use them unless the manufacturer has specified that these types of chargers are compatible with your battery.
- As with any battery, do not use it if it is bulging, hissing, leaking, or feels hot to the touch.

Short Circuits

Current will take the path of least resistance, which is usually through a short-circuit instead of the load, delivering a high, unrestricted current flow in a short period of time.

- Short circuits can cause injury, blindness, and death to the user, and permanently damage equipment. They can cause excess heat, fire, and arcing. This is especially dangerous with batteries that supply continuous strong current.
- Never touch both battery terminals with your bare hands at the same time. Don't wear rings, watches, or jewelry made of conductive materials (e.g., silver, gold, copper, or steel). Only use non-conductive tools to remove terminal or cell caps.

Thermal Runaway

Thermal Runaway is when the heat and pressure inside of a battery cell rise faster than can be dissipated and can cause fires and the release of toxic fumes.

- The increased heat in the battery may destabilize the active materials, starting a self-sustaining exothermic reaction, i.e., the release of heat.
- External heat sources, internal shorts, or other malfunctions can disintegrate cells and destroy a battery pack over several hours or within seconds. Some packs are fitted with dividers to protect against this chain reaction.
- Increasing pressure or heat can cause uncontrolled chemical and combustion reactions between the electrolyte solution and electrodes, which can lead cell walls to expand and byproducts to leak out. Chemical byproducts frequently include combustible or flammable substances, which is why it is important to understand the chemistry of your battery.

Soldering

- **DO NOT solder to batteries.**
- **DO NOT solder near batteries.**
- Heat generated from the soldering iron can destabilize and damage the battery, causing it to bulge, hiss, leak, catch fire, and even explode.
- If you must solder to a battery, use a battery holder. Make sure the battery is elsewhere while connecting the holder to the device.

PRECAUTIONS

Before starting work:

- Review manufacturer's Safety Data Sheet and additional chemical information at ehs.harvard.edu/safety-data-sheets-sds;
- Ensure that a written experimental protocol including safety information is available;
- Make sure your Li-Ion batteries, chargers, and associated equipment are tested in accordance with an appropriate test standard (e.g., UL 2054), certified by a Nationally Recognized Testing Laboratory (NRTL), and rated for their intended uses.
- Inspect your battery for signs of damage prior to each use: bulging, hissing, leaking, or smoking. Do not use your battery if it displays any of these characteristics.
- If applicable, understand one-hand working techniques.
- Remove watches, metal rings, and other metal jewelry when working with or near large batteries or power supplies. If the metal from your jewelry comes into contact with a terminal, you become part of the circuit. Effects can vary from a small electric shock to burns or even electrocution, depending on the power of the battery.
- If you are designing wearables using lithium-ion batteries, make sure they are easily removeable if they start to react while being worn.
- Be familiar with general University emergency procedures in the EHS Lab Emergency Response Guide.
- Identify the location of the nearest eyewash and shower and verify that they are accessible.
- Locate and verify that appropriate fire response and spill cleanup materials are available, including the following:
    - Bucket of sand
    - Fire extinguisher
    - Non-conductive vessel
- Ensure another person who knows emergency procedures is in the area.

Charging

Rechargeable batteries cannot be recharged at arbitrary rates. The fire potential increases when you charge or discharge a battery faster than recommended by the manufacturer. The maximum charging rate on some types of batteries is limited by the speed at which active material can diffuse through a liquid electrolyte. High charging rates may also produce excess gas or other side-reactions that permanently lower the battery capacity.

- **DO NOT make or build your own charging circuit.**
- Only use chargers provided by and/or approved by the manufacturer.
- Charge on non-conductive, non-combustible surfaces.
- Remove Li-Ion powered devices and batteries from the charger once they are fully charged.
- Prevent arcing by turning the charger off before disconnecting the battery.

Storage

- Store Li-Ion batteries and devices in dry, cool locations and in fire-resistant containers.
- LiPo safe bags help contain heat and flames that results if a Li-Ion battery combusts during charging or while in storage.

Disposal

- Intact batteries can be disposed of as Universal Waste. If the battery is greater than 9V, tape the terminals before disposal.
- Reacting and leaking batteries are considered hazardous waste. Please consult Emergency Procedures below.

Transport and Shipping

- Please contact EHS for advice regarding transport and shipping of Li-Ion batteries.

EMERGENCY PROCEDURES

SHOCK

- Know where your nearest AED is. The heart icons that appear when you zoom in to your building on this campus map show AED locations.

FIRE

- Pull the fire alarm before attempting to extinguish a fire. Only use a fire extinguisher is you have been trained to do so. EHS offers fire extinguisher training online through the Harvard Training Portal.
- Keep a bucket of sand and an appropriate fire extinguisher on-hand. ABC, CO_2, or Halon are all appropriate options. Contact EHS to discuss which is the best option for your application.
- Call the Operations Center at 617-495-5560. By law, even extinguished fires must be reported.

REACTING BATTERY

- If your battery is overheating, hissing, or bulging, and it is safe to do so, immediately move it away from any flammable or combustible materials, and place it in a non-conductive vessel (e.g., ceramic pot) or non-conductive surface, and allow it to react fully.
- Contact the University Operations Center at (617) 49**5-5560** [HMS/HSDM (617) 43**2-1901**] if you need support or technical assistance.

LEAKING BATTERY

- Leaking batteries can pose significant contact and inhalation hazards. Only handle if you are confident in your knowledge of the battery chemistry, properly trained, and wearing appropriate PPE.
- If trained and confident, are wearing the appropriate PPE for the hazards of your battery's unique chemistry, and have the appropriate spill supplies:
    - Collect debris in appropriate container and move to your Satellite Accumulation Area. Label with appropriately completed hazardous waste tag and request a waste pickup.

- Contact the University Operations Center at (617) 49**5-5560** [HMS/HSDM (617) 43**2-1901**] if you need support or technical assistance.
- Leaking batteries cannot be recycled.

SKIN CONTACT

- Wash with plenty of tepid water for at least 15 minutes using the closest available sink, safety shower, or drench hose. Remove any exposed clothing as well as any jewelry.
- Seek medical attention; call 911 on a landline phone for medical assistance (or provide location if calling on a mobile phone).

EYE CONTACT

- Using eyewash, flush eyes while holding eyelids open.
- Seek medical attention; call 911 on a landline phone for medical assistance (or provide location if calling on a mobile phone).

INHALATION

- Seek medical attention; call 911 on a landline phone for medical assistance (or provide location if calling on a mobile phone).

INGESTION

- Never give anything by mouth to an unconscious person.
- Seek medical attention; call 911 on a landline phone for medical assistance (or provide location if calling on a mobile phone).