Caring for your Li-ion battery

Li-ion batteries are relatively new and many people are not familiar with the proper routine to safely maximize their life and performance. This short article is intended to outline the basics.

For many years the nickel-cadmium (Ni-Cd) battery was the work horse of rechargeable batteries. It was replaced in the early 90's with the Nickel-metal-hydride (Ni-MH) battery which had a 30 – 40% higher energy density. Today the Li-ion battery is quickly becoming the standard as it can pack almost twice as much power per ounce of battery as the Ni-MH cell. This has allowed runtimes to become longer and battery packs to become smaller and lighter.

This increased performance is not without some drawbacks. The Li-ion battery cannot withstand the "abuse" that the nickel batteries can. Without proper care their life will be greatly shortened and in the worst cases they can become unstable. You should know the conditions to avoid and precautions to take. However, with proper care they will deliver long life and exceptional performance.

1. One limitation of Li-ion batteries is their relatively low discharge current when compared to Ni-MH or Ni-Cd's. The 18650 cells used in the MagicShine battery packs are limited to 2.2A (amps). Because the pack has 2 pair in series/parallel it can deliver 4.4A. The MagicShine MJ-808 draws up to 2A, the MJ-816 3A. From these figures you can see that running 2 lights off one battery by way of a Y-cable is pushing the limits of the pack and will shorten their life. Additionally, as the battery ages its current capacity drops. When running 2 headlights it is best to use 2 battery packs. This also provides a redundant light source when you're on that deep woods trail or out on a country road. (The Y-cable is appropriate for the MagicShine tail-light as it only draws ½ A.)
2. Another factor is the Li-ion's sensitivity to over-charging or over-discharging. If over-charged beyond a voltage of 8.4V or discharged below 5.5V permanent damage will result. To prevent this a safety circuit is built into the pack which cuts off charging at 8.4V and turns the battery pack off when it reaches a discharge voltage of 5.5V. A related factor is "Self Discharge". All batteries will slowly lose charge with time. If the battery is stored without putting some charge back in it, it will drop below the 5.5V cutoff. Letting a pack go completely dead can result in internal shorts in the cells, which when attempting to recharge can result in overheating and the potential for a runaway reaction.
3. A third factor is physical damage. If the battery cells become dented in any way an internal short can also result.

If a runaway reaction occurs all the energy stored in the battery is quickly released. The result can be a great amount of heat, even enough to start a **fire**. **Because of this a damaged battery pack should be drained flat and disposed of in a safe location**. A sure way to "decommission" a pack would be to remove its cover and submerge in a bucket of salt water.

Other misconceptions about Li-ion batteries:

1. They do not have a "memory effect." It is best to charge them after every use.
2. They do not need to be periodically discharged to maintain full capacity.
3. They do not need to be broken in. They have full capacity after the first charge.
4. They cannot be fast charged. The charger supplied with the set will fully charge a pack in about 4 hours. Attempting to push the charge faster will decrease the life of the pack and do very little to increase the full charge time. (If you need a quick charge it is good to know that the stock charger will bring the pack to 80% charge after only 2 hours)

Other Information about Li-ion batteries:

1. They have a relatively low self-discharge; self-discharge is less than half that of nickel-based batteries. (i.e. they will hold a charge for a long time)
2. They are subject to aging even if not in use. Even with good care capacity will drop to half or fail after 2 – 3 years.
3. The nominal or average voltage is 3.6V per cell. (7.2V for the pack) At full charge they are 4.2V per cell (8.4V/pack) They can safely deliver power down to 2.75V (5.5V/pack)

Summary:

Maximizing the life of your Li-ion battery pack

1. Charge your battery pack after every use. Do not allow to become fully discharged.
2. Do not leave on the charger for more than 24 hours. (The protection circuit will cut off the charge but a small amount of current still leaks through.)
3. Do not attempt to fast charge your battery pack.
4. Avoid excessive heat. (Leaving it on the dash of your car on a hot summer day will shorten it's life)
5. The best conditions for long term storage (over the summer) are in a cool place and with a 40% charge. (A full charge puts more strain on the cells) You can even store the pack in a zip-lock in the refrigerator if you have the space. The charge state of your battery can easily be checked if you have one of the lights with the 5 stage fuel gauge. Discharge to a yellow light for storage. If stored for more than 3 or 4 months you should check the charge state and top up if necessary. (It's too low if the gauge is red)
6. Do not over work your pack. One light or light/tail-light pair per battery will result in longer life.
7. Do not allow your battery to be short-circuited. If the wire becomes damaged, repair before use.
8. A battery that has been over charged or discharged can become unstable and result in high temperatures or even fire. For safety sake, when charging the battery-pack, remove from the bike, and place in a fire proof container. Always charge in an isolated area, away from other flammable materials. For instance a wooden work bench, carpet etc.
9. Another safety issue is cold temperature charging. Li-ion batteries cannot be charged when they are below 0°C (32°F). Although the packs appear to be charging normally, plating of metallic lithium occurs on the anode while on a sub-freezing charge. The plating is permanent and cannot be removed. If done repeatedly, such damage can compromise the safety of the pack.
10. The battery will become more vulnerable to failure if subjected to impact, crush or high rate charging.

I hope this helps all to get the most out of your lights.
Ride hard, ride safe.

Jim Harger
Action LED Lights

For more information on Li-ion or any type of battery see: www.batteryuniversity.com