



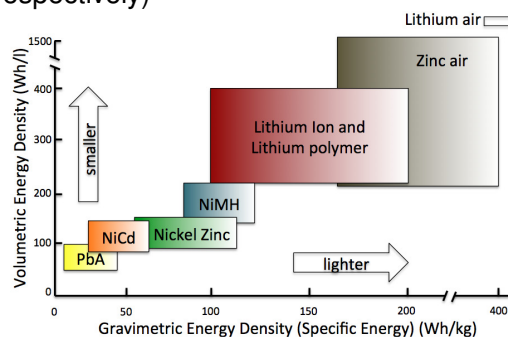
Lithium-ion cell preview

- Last week, we spent most of our effort studying background topics related to how battery cells work, in general
- As concluding examples, we looked at the copper-zinc Daniell cell and lead-acid batteries, both of which are standard electrochemical cells
- We also talked about nickel-metal-hydride cells, for which the negative electrode works on a different principle
 - Recall that the metal hydride absorbs hydrogen much like a sponge absorbs water, without changing its structure or chemical composition
 - This is a far gentler process than a standard chemical reaction, and so NiMH cells tend to have much longer lifetimes than lead-acid cells, for example
- We will see that in lithium-ion cells, both electrodes work on this principle



Specific energy and energy density

- Specific energy and energy density measure the maximum stored energy per unit weight or volume (respectively)
 - For a given weight, higher specific energy stores more energy
 - For a given storage capacity, higher specific energy cells are lighter
 - For a given volume, higher energy density stores more energy
 - For a given storage capacity, higher energy density cells are smaller
- Lithium ion has higher energy density and specific energy than historic chemistries



Advantages of lithium ion

- They have higher energy density than most secondary cells
- Operate at higher voltages than other rechargeable cells, typically about 3.7 V for lithium-ion vs. 1.2 V for NiMH or NiCd
 - Often a single cell can be used rather than multiple NiMH or NiCd cells
- Lower self-discharge rate than other types of rechargeable cells
 - NiMH and NiCd cells can lose anywhere from 1–5 % of their charge per day, even if they are not installed in a device
 - Lithium-ion cells will retain most of their charge even after months of storage
- Long life due to gentler intercalation mechanism in each electrode



Disadvantages of lithium ion

- Lithium-ion batteries are (presently) more expensive than similar capacity NiMH or NiCd batteries
- Are more complex to manufacture, and are (presently) manufactured in much smaller numbers than NiMH or NiCd batteries
- Because high energy densities are obtained by using more reactive chemicals
 - They tend to be less stable and require special safety precautions
 - Need special circuitry to protect battery from damage due to over/undercharge
- Caution: The quality of cell materials and cell construction matters!
 - Impurities limit cell performance that can be achieved
 - Cells from different manufacturers with similar cell chemistries and similar construction may yield different performance



Summary

- The primary benefits offered from lithium-ion cells are:
 - High energy density and specific energy
 - Long life
 - Higher voltage and lower self-discharge rates
- The primary disadvantages of lithium-ion cells are:
 - Need for proper management to guarantee safety (which is what this specialization is all about!)
 - Cost (of the cells, plus the supporting electronics)
- However, lithium-ion cells and electronics are becoming less expensive and over time we should see their price decrease significantly