



Electrochemical versus lithium-ion cells

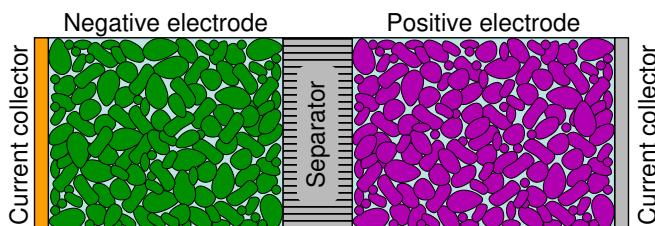
- In this lesson, you will learn the primary functional components of an electrochemical cell
- I will make a distinction in this specialization between standard (traditional) electrochemical cells and lithium-ion cells, since they work a little differently
- The focus of the specialization is on managing lithium-ion cells; however, you will need a foundational understanding of standard electrochemical cells to do so
 - Lithium-ion cells have all the component parts introduced here as well
- Next week, we our focus will shift to understanding lithium-ion cells in specific



Functional components of an electrochemical cell

- The drawing below shows a schematic cross-section of an electrochemical cell (the structure of a lithium-ion cell is shown, but electrochemical cells have the same components):

- Negative electrode
- Positive electrode
- Electrolyte
- Separator
- Current collectors



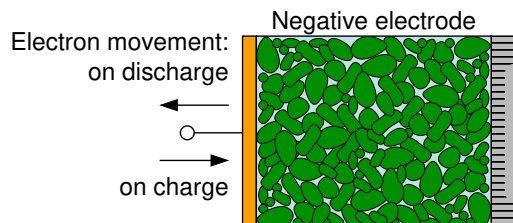
- We will talk about these components in the next slides



The function of the negative electrode

- In an electrochemical cell, the negative electrode is often a metal or an alloy or hydrogen (lead metal or paste for PbA)

- During discharge, it gives up electrons to external circuit, is oxidized (OIL: "Oxidation is Loss (of electrons)")
- During charge, accepts electrons from external circuit, is reduced (RIG: "Reduction is Gain (of electrons)")



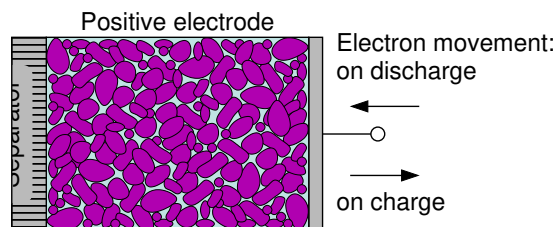
- During discharge, it is the anode
- Technically, during charge it is the cathode, but most people still call it the anode



The function of the positive electrode

- In an electrochemical cell, the positive electrode is often a metallic oxide, sulfide, or oxygen (lead oxide for PbA)

- During discharge, accepts electrons from circuit, is reduced
- During charge, gives up electrons to external circuit, is oxidized

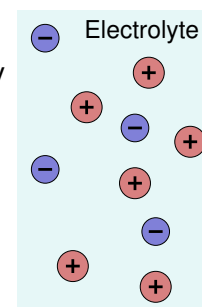


- During discharge, it is the cathode
- Technically, during charge it is the anode, but most people still call it the cathode



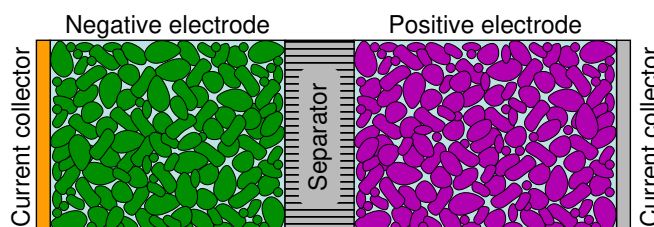
The function of the electrolyte

- As electrons move in the external circuit, compensating ions must move internal to the cell
 - Cations are ions with net positive charge: during discharge they move through the electrolyte toward the positive electrode
 - Anions are ions with net negative charge: during discharge they move through the electrolyte toward the negative electrode
- The electrolyte provides the medium for internal ion charge transfer between the electrodes (sulfuric acid for PbA)
 - The electrolyte is typically a solvent containing dissolved chemicals—an acid, base, or salt—providing ionic conductivity
 - It must be an electronic insulator to avoid self discharge



The functions of the separator & current collectors

- The separator electrically isolates the positive and negative electrodes to avoid short circuit and self discharge of the cell
- Often made from glass mat or fiber, or polyethylene, or a polymer



- Since electrodes are often made from powders, current collectors are metal foils—to which electrodes are adhered—that conduct electrical current to cell terminals



Some example electrochemical cells

- The table below shows components for commonly used electrochemical cells:

| Electrochemistry | Negative electrode | Positive electrode | Electrolyte | Nominal voltage |
|------------------|--------------------|--------------------|--------------------------------|-----------------|
| Lead acid | Pb | PbO ₂ | H ₂ SO ₄ | 2.1 V |
| Dry cell | Zn | MnO ₂ | ZnCl ₂ | 1.6 V |
| Alkaline | Zn | MnO ₂ | KOH | 1.5 V |
| Nickel cadmium | Cd | NiOOH | KOH | 1.35 V |
| Nickel zinc | Zn | NiOOH | KOH | 1.73 V |
| Zinc air | Zn | O ₂ | KOH | 1.65 V |



Summary

- The major functional components of an electrochemical cell are: the negative and positive electrodes, the electrolyte, the separator, and the current collectors
 - The negative electrode sources electrons on discharge; sinks electrons on charge
 - The positive electrode sinks electrons on discharge; sources electrons on charge
 - The electrolyte provides a medium for ion transport internal to the cell
 - The separator prevents internal short circuit
 - The current collectors conduct electronic current to the cell terminals
- As an example: a lead-acid cell has a lead negative electrode, lead oxide positive electrode, sulfuric acid electrolyte, and often a glass mat separator