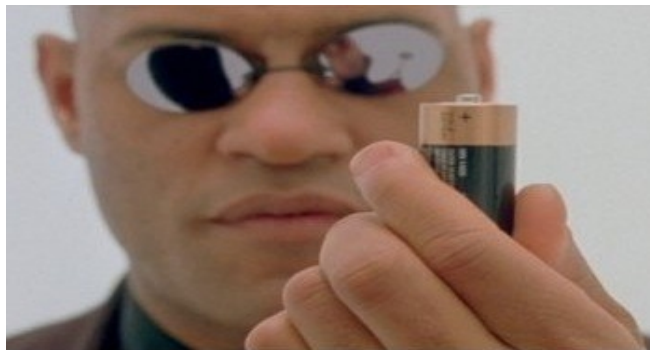


M3D3: Cathode construction

4/26/2018

1. ½ class: Construct cathode material (Belcher Lab)
2. Quiz
3. Prelab Discussion
4. Research Proposal Peer Review Exercise

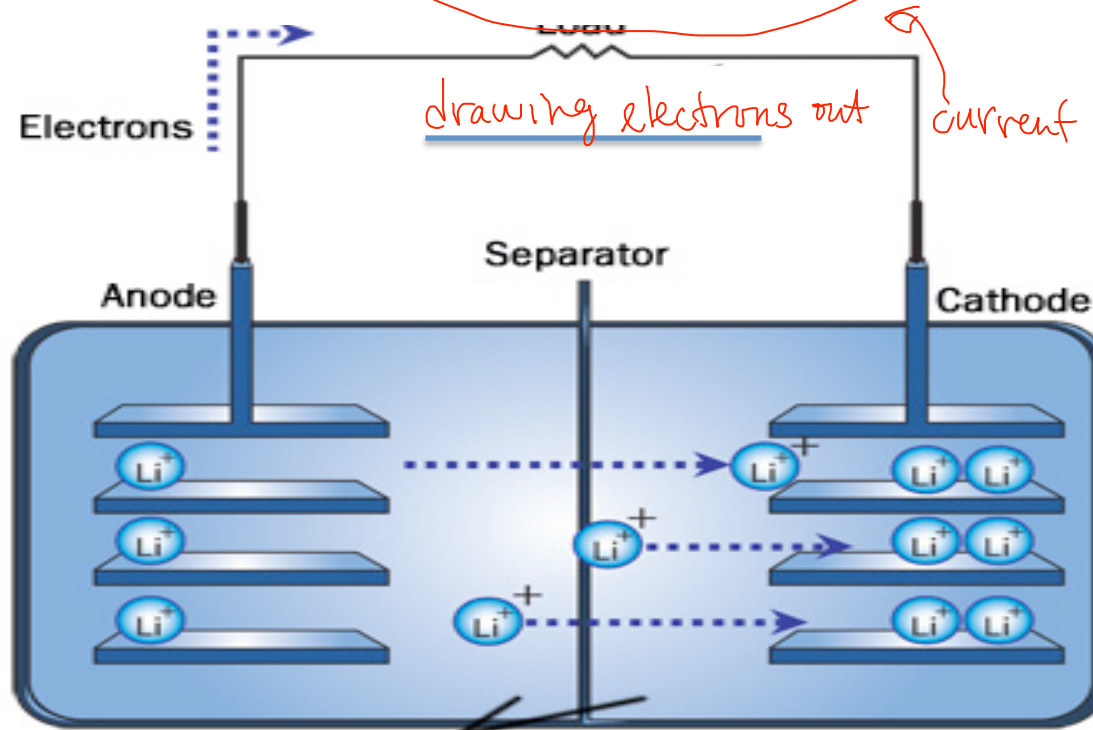


- ***M3 major assignments***
 - Research proposal (20%), slides due 5/10 at 1pm
 - **This is two weeks away**
 - **Work on this Today!**
 - Mini-report (5%), due 5/14 at 10pm
- **M3D4 Homework, Both parts submitted as a team**
 - Research Proposal Presentation outline (wiki, google doc, benchling)
 - ***Address topics in HW prompt for full credit***
 - Outline Background and Approach for mini-report ***with references***
 - <http://belcherlab.mit.edu/publications/>

Is this battery discharging or charging?

Anode:
Lithium

Cathode:
~~Au~~ NPs
Fe(III) PO₄



Li⁺
Fe(II)PO₄

Electrode A

Electrolyte

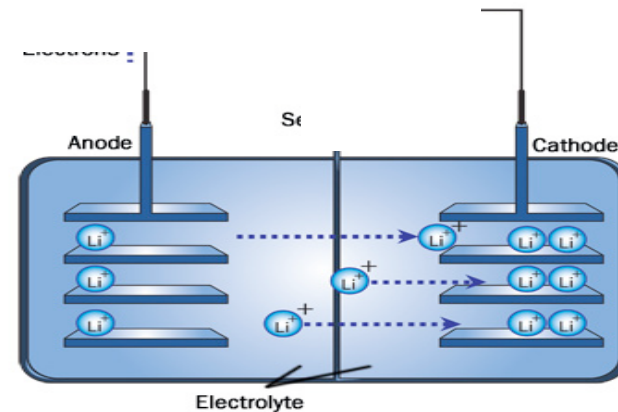
LiPF₆

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Electrode B

Cathode is (+) During Spontaneous Discharge

- Oxidation/Reduction occurs at the cathode (accepts e-)
- Oxidation/Reduction occurs at the anode (donates e-)
- *Electrons* flow from anode = negative electrode to cathode = positive electrode
- During discharge, Electrode B is the cathode and is positively charged.

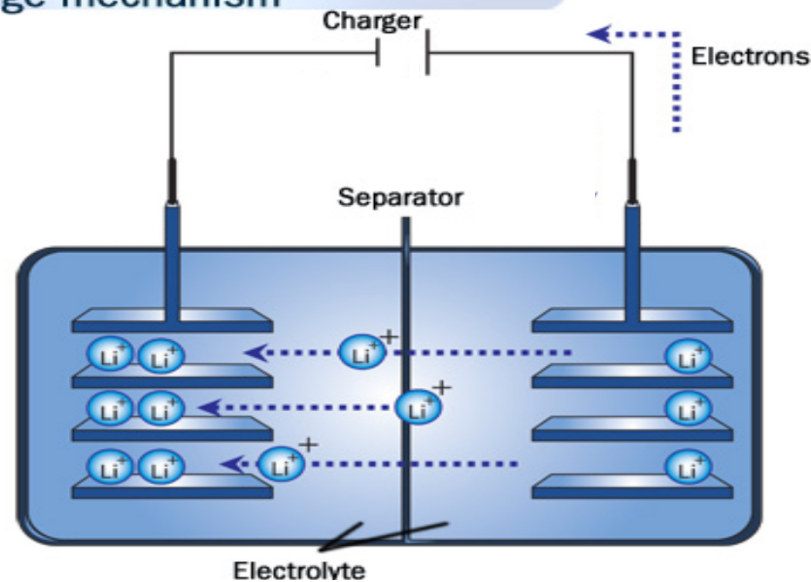


Electrode A

Electrode B

During (re)charge, electron flow is reversed

Lithium-ion rechargeable battery
Charge mechanism



Cathode
Reduction
RXN

anode
oxidation
RXN

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Electrode A

Electrode B

NOVA documentary:
“Search for the Super Battery”

<https://youtu.be/a4McN9OYDwg?t=770>

What is battery capacity?

- Quantity of electricity (charge) involved for the electrochemical reaction between the active materials in the battery
- For our Fe(III)-phage batteries, the theoretical (gravimetric) specific capacity is 178 mA*h/g

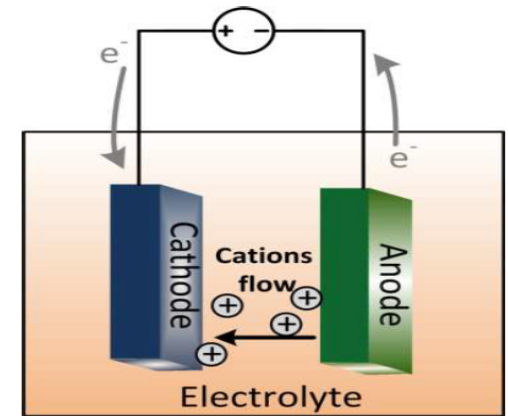
- **Units:** $\frac{\text{charge}}{\text{time}} \cdot \frac{\text{time}}{\text{mass}} = \frac{\text{charge}}{\text{mass}}$

- Capacity calculated from

- total # of electrons that can be accepted
- charge of those electrons
- and atomic mass

- Why will our batteries not achieve **theoretical** specific capacity?

additional mass from other additives (example: phage, gold, teflon)



from Dr. Maryam Moradi

How do phage scaffolds improve batteries?

- Ion diffusivity → nano structuring active material

- What is the advantage of nano structures?

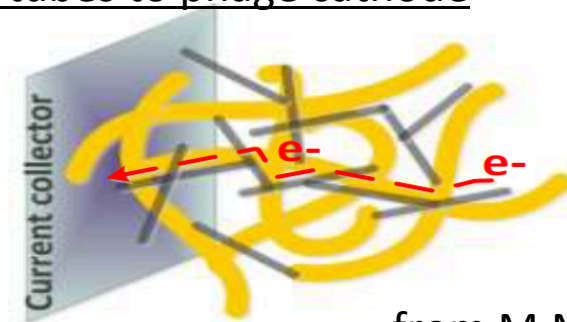
higher surface area to volume ratio

- Electronic Conductivity → integrating additives

- How do phage improve integration of additives?

Phage display: improves ability to screen + select phage for binding additives (iron, gold, carbon nanotubes)

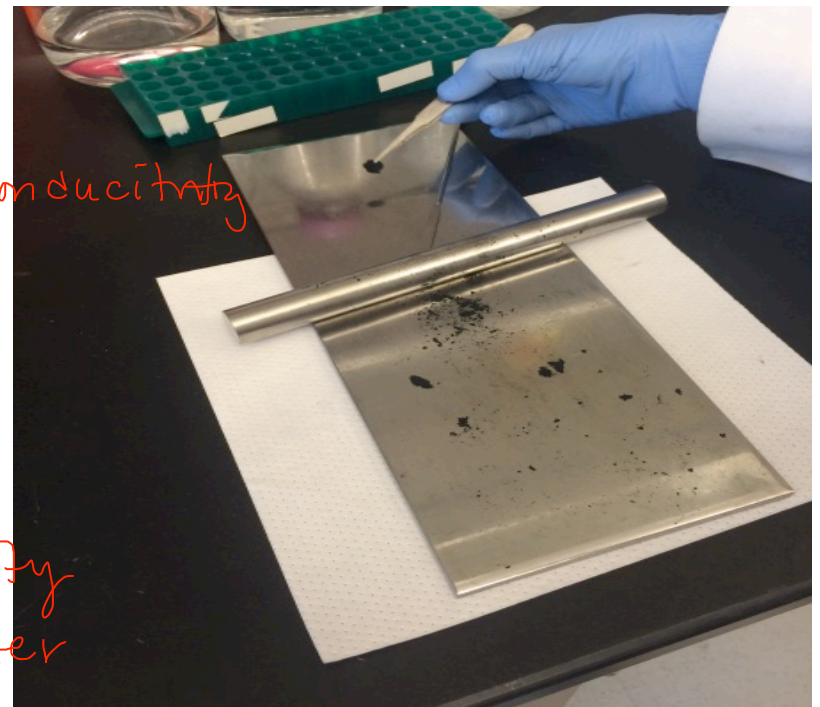
Example: Adding carbon nanotubes to phage cathode



from M.Moradi

How will you construct your cathode?

1. Weigh AuNP-Fe(III)-phage nanowires (active material)
2. Mix with Super P: *carbon, increase conductivity* and PTFE: *teflon, binder*
3. Roll cathode material into thin sheet
4. 'Punch out' cathode disc
5. Weigh cathode (why?) *calculate capacity*
6. Dry cathode (why?) *remove solvents, water*
 - *improve binding*



Today in lab...

1. Construct cathode Belcher lab
 - Bring lab coat and eye protection
 - Bring a notebook and something to write with
 2. Research proposal peer exercise
 - Everyone must be the “presenter” and “listener” at least once
 - Partner assignments will depend on timing of cathode construction
- M3D4HW: (see slide 2) You cannot make major changes to your research proposal idea after Thursday(5/3)!