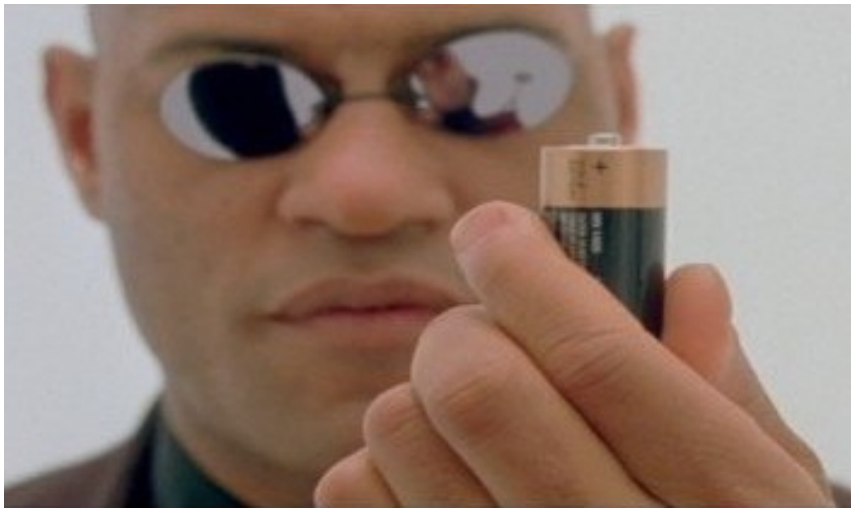
M3D3: Cathode construction

11/29/2016

1. Quiz
2. Prelab Discussion
3. Construct cathode material (Belcher Lab)
4. Research Proposal Peer Review Exercise (20.109 lab)

- ***M3 major assignments***
  - Research proposal (20%)
  - Mini-report (5%)



- **M3D4 Homework,** Both parts submitted as a team
  - Presentation outline (wiki, google doc, evernote)
    - address topics in HW prompt
  - Outline Background and Approach ***with references***
    - http://belcherlab.mit.edu/publications/

**Make comm lab apps for feedback

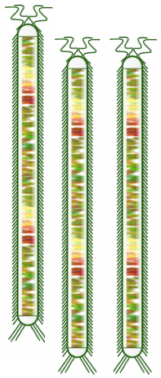
**Deadline for completely changing your proposal is Wed. 5pm

Module 3: biomaterials engineering

How does AuNP size affect battery capacity?

Purify
M13 phage
Add AuNP

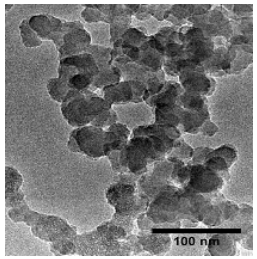
DAY 1



Biomineralize
AuNP-Fe(III)-
phage

Visualize
nanowires
on TEM

DAY 4



Purify
active material

DAY 2

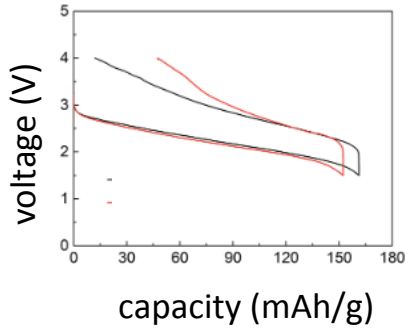
Construct
cathode
(and battery)

DAY 3

Measure battery
capacity

DAY 5

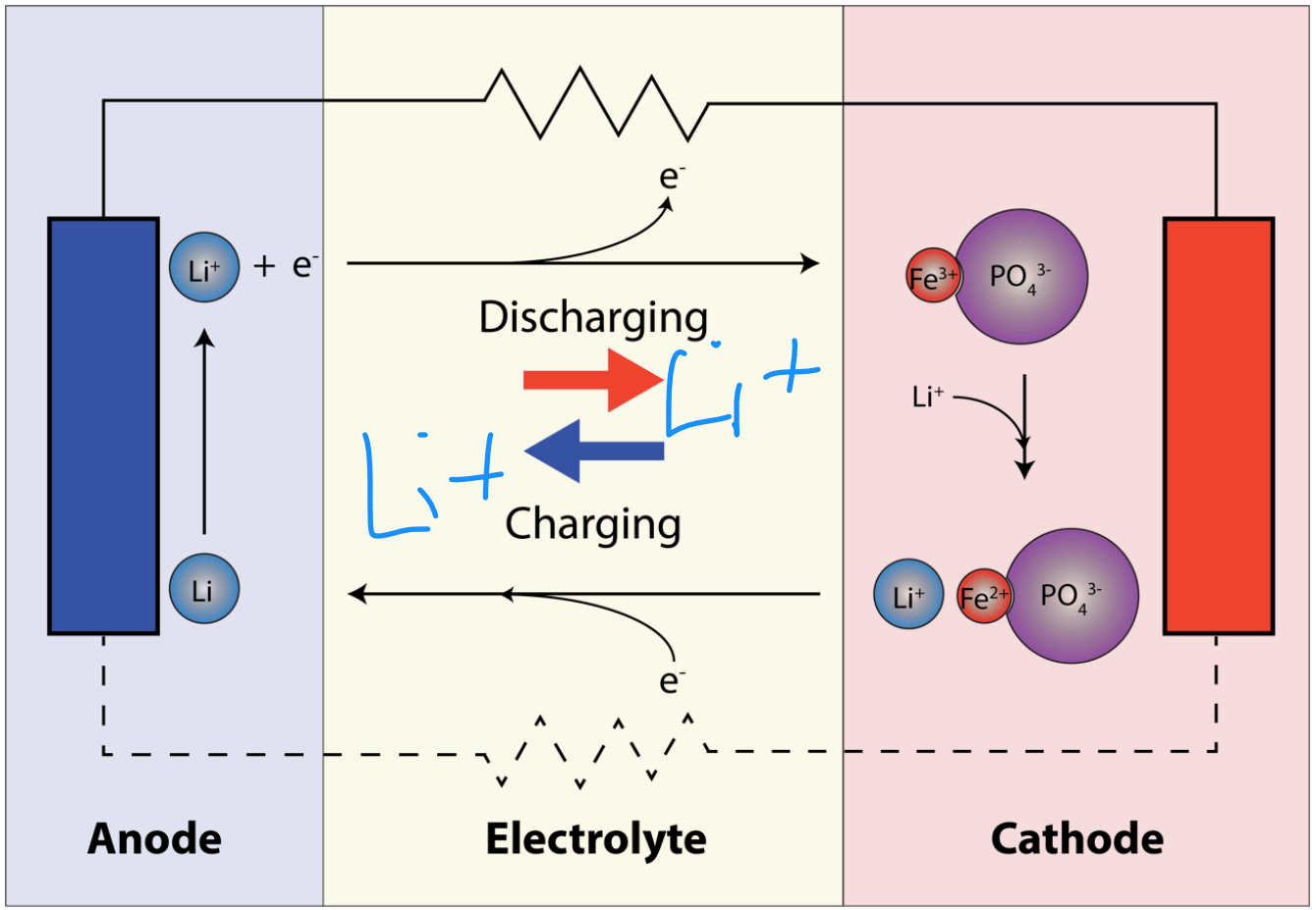
capacity: mA*h/g



Main components of the M3 battery

external device measures e-

pure lithium



Iron phosphate: ion storage

AuNP: electrical conductor

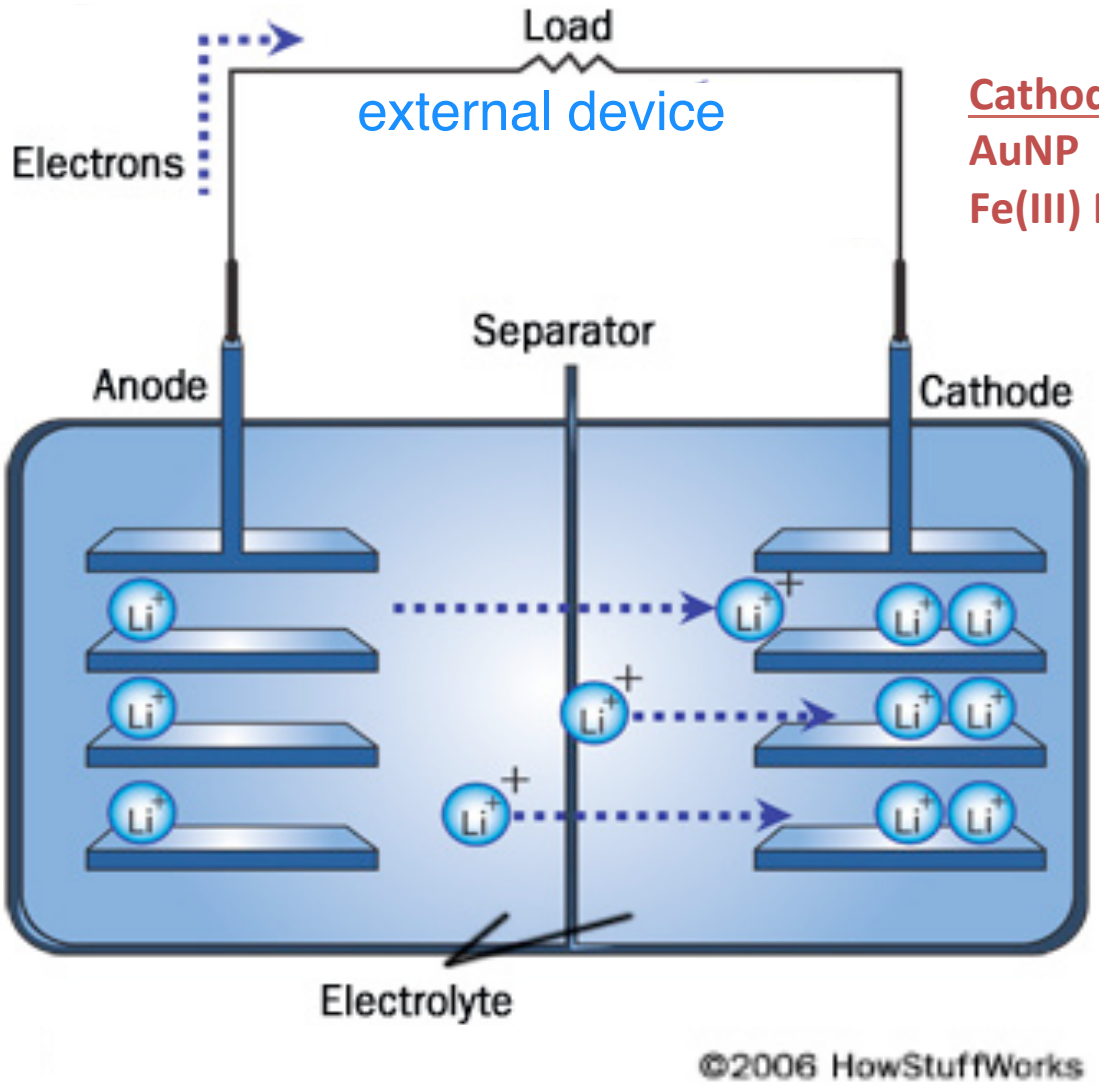
M13 phage: scaffold

allows ions to move between anode and cathode

diagram by George Sun, Belcher lab

Is this battery discharging or charging?

Anode:
Lithium



Cathode:
AuNP
Fe(III) PO_4 / Li Fe(II)PO_4

discharge: electrons flow from anode to an external load through the external circuitry to the cathode, "use of the battery"

Main components of a battery

- Battery consists of two electrodes:
  - When are electrodes defined? discharge
  - Cathode = positive electrode= accepts electrons
  - Anode = negative electrode= donates electrons
  - electrolyte allows for flow of ions

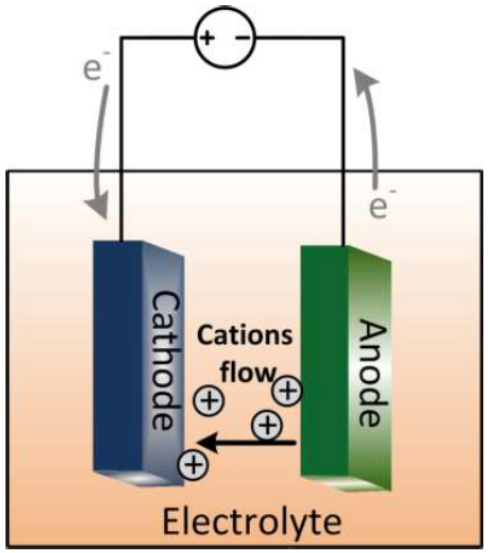
- What is discharge?

battery connected to eternal load, e- flow from anode to cathode, electric circuit completed in the electrolyte by the flow of ions

- What is capacity?

amount of charge (quantity of electricity) stored in battery

theoretical capacity for Iron (III) phosphate battery is 178mA*h/g



from M.Moradi

How can a phage scaffold improve current batteries?

- Ion diffusivity → nano structuring active material
  - What is the advantage of nano structures?

    increase surface to volume ratio
- Electronic Conductivity → integrating additives
  - How to phage improve integration of additives?

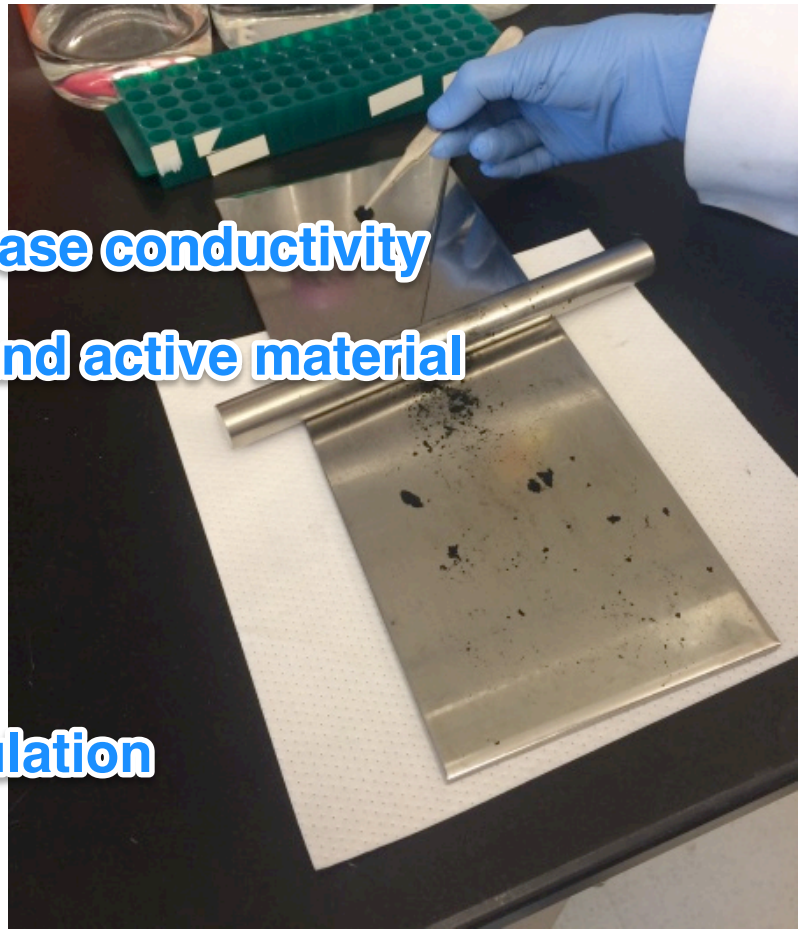
    screen for binding additives via phage display

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, carbon and active material
3. Roll cathode material into thin sheet
4. 'Punch out' cathode disc
5. Weigh cathode: capacity calculation
6. Dry cathode: helps binding



Today in lab…

- Construct cathode (Part 1)
- Research proposal peer exercise (Part 2)
- Class divided between protocols
  - Part 1 completed in Belcher Laboratory

Part 1	Part 2
Pink	Green
Purple	Yellow
Blue	