M3D3: Cathode construction

4/26/2016

Lecture Thurs. 4/28, no lab

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

- ***M3 major assignments***
  - Research proposal oral presentation
  - Mini-report

- **M3D4 Homework**(1 week from now!)
  - Both parts submitted as a pair
  - Presentation outline (wiki, google doc, evernote)
    - address topics in HW prompt
  - Outline Background and Approach ***with references***
    - http://belcherlab.mit.edu/publications/

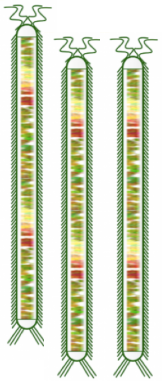
- Reminder: visit Comm. Lab for 5pts M3 HW credit

Module 3: biomaterials engineering

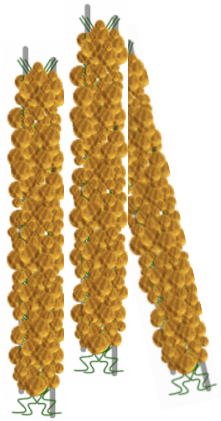
How does gold size/quantity affect battery capacity?

Purify
M13 phage
Add AuNP

DAY 1

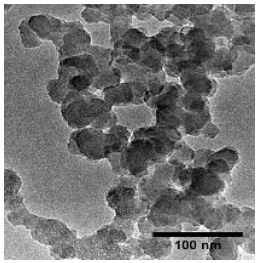


Biomineralize
AuNP-Fe(III)-
phage



Visualize
nanowires
on TEM

DAY 4



Purify
active material

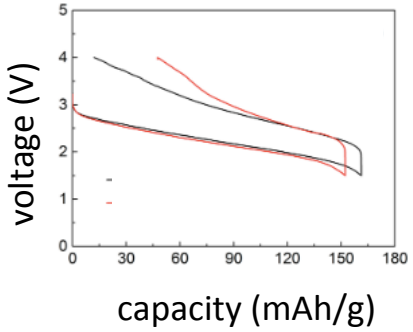
DAY 2

Construct
cathode
(and battery)

DAY 3

Measure battery
capacity

DAY 5



charge and discharge 5 times
each cycle 10 hours

battery: converts chemical energy to electrical energy

What is a battery cathode?

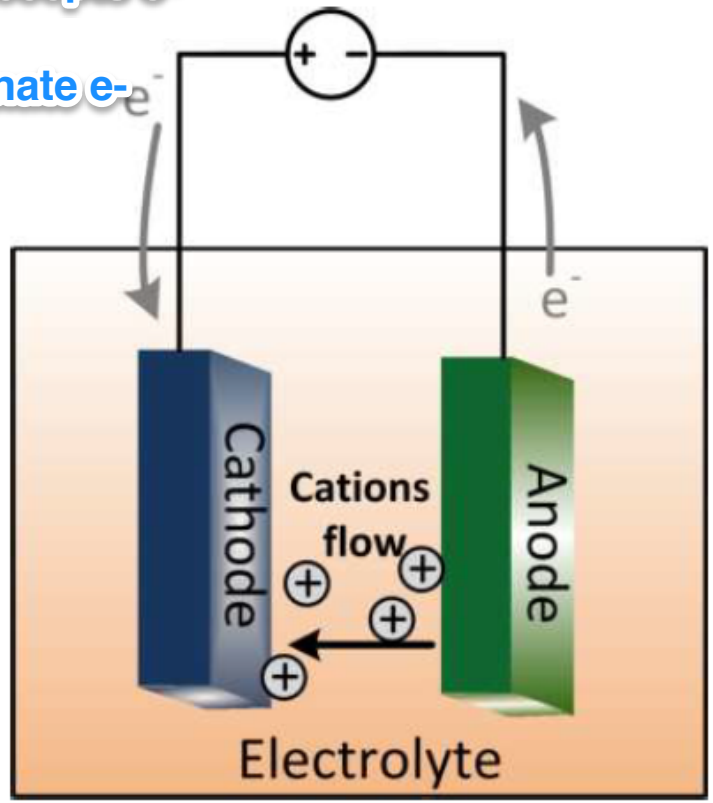
- Battery consists of two electrodes:
  - Cathode = positive electrode accepts e-
  - Anode = negative electrode donate e-

electrolyte: allows the flow of ions

- During discharge, cathode accepts electrons

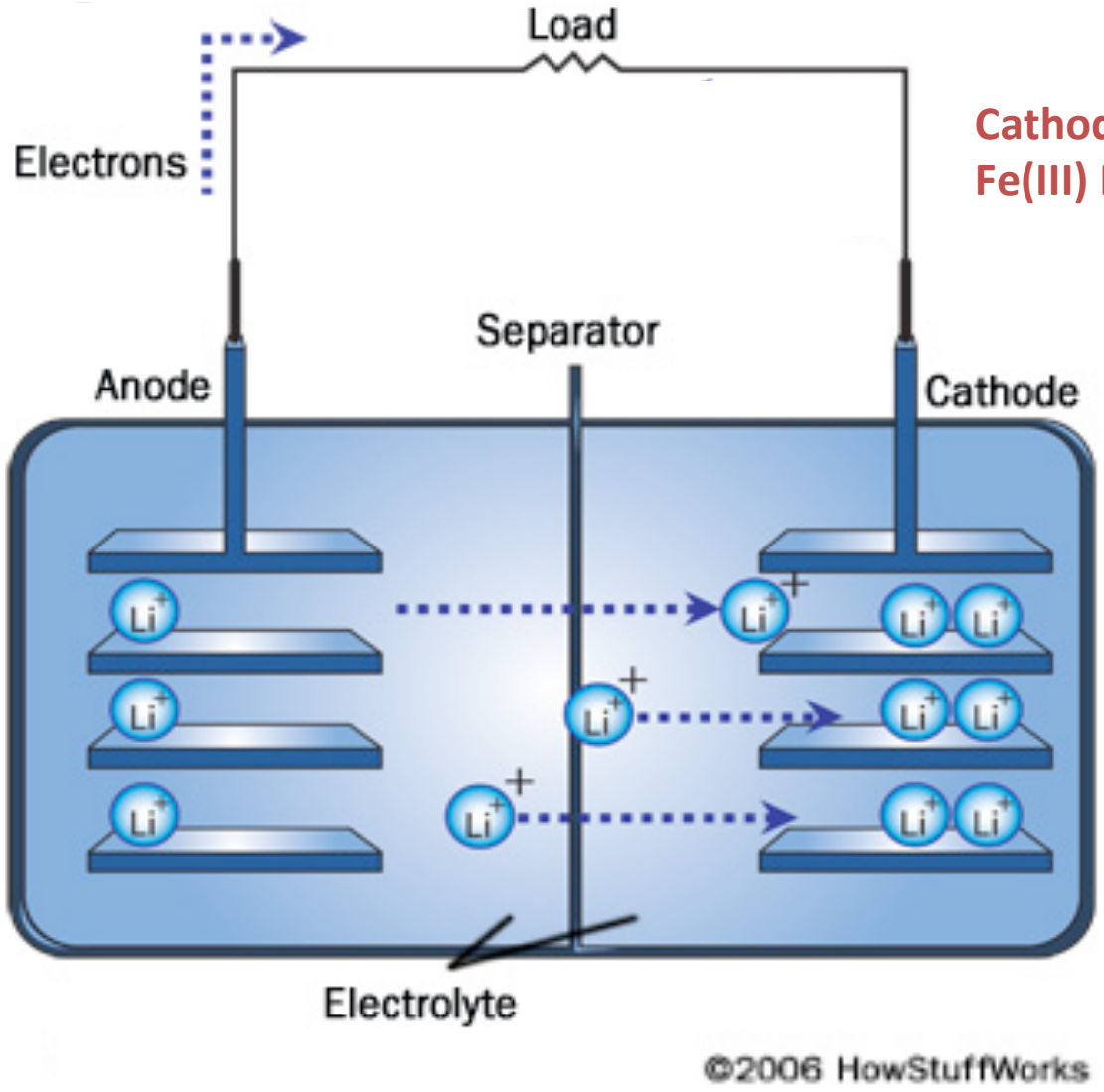
- What is capacity?

(mA*h/g) amount of charge stored



from M.Moradi

Anode:
Lithium



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

How can a phage scaffold improve current batteries?

- Ion diffusivity → nano structuring active material
  surface to volume ratio
- Electronic Conductivity → integrating additives
  phage display to screen for binding to additives of interest

Example: Adding carbon nanotubes to phage cathode

from M.Moradi

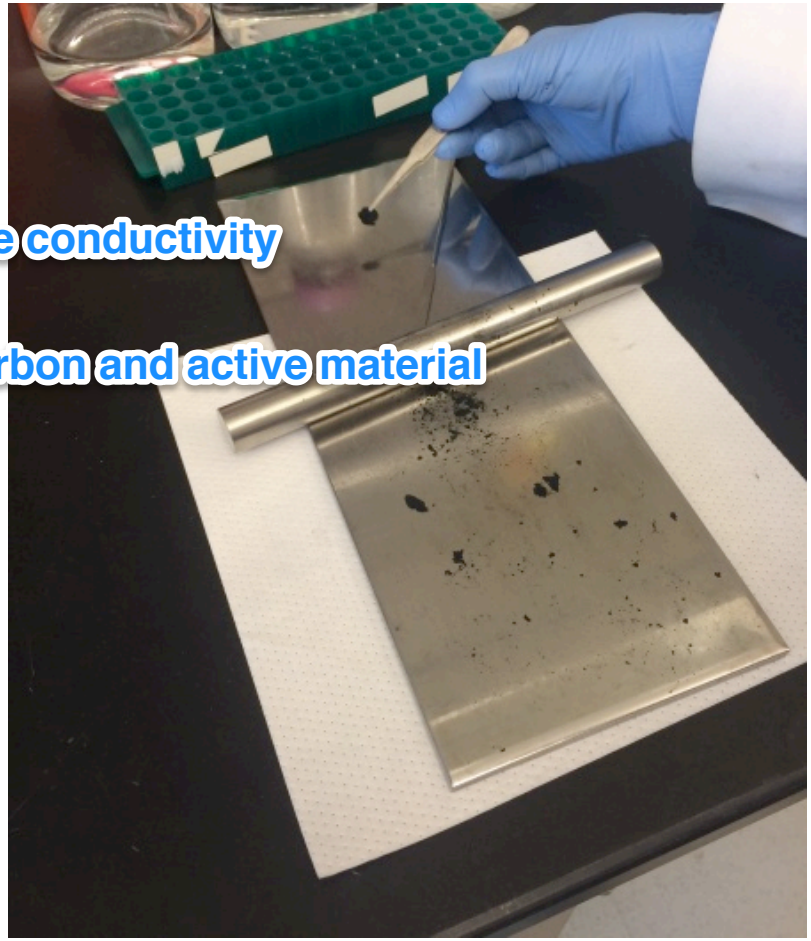
How might AuNP size and quantity impact your phage battery capacity?

- Experimental variables:
  - TR 3.6 nm gold NP
  - WF 5.0 nm gold NP
  - 3 AuNP/phage ratios

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 to complex carbon and active material
3. Roll cathode material into thin sheet
4. ‘Punch out’ cathode disc
5. Weigh cathode needed for capacity
6. Dry cathode



Today in lab…

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

Part 1	Part 2
Red Team	Yellow
Orange Team	Green
Pink	Blue
Purple	