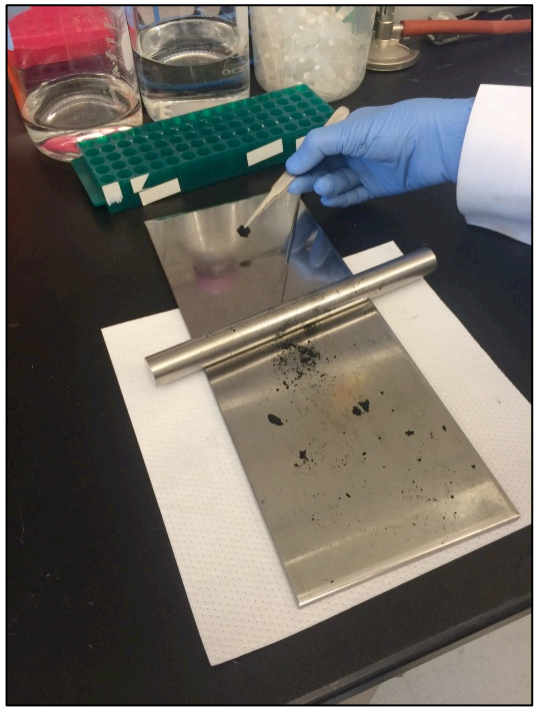
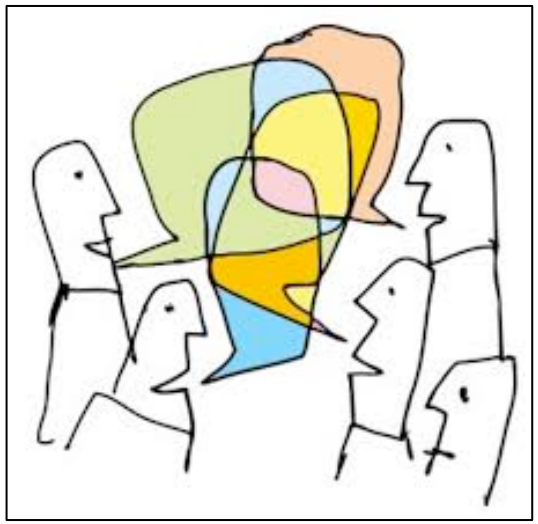
M3D3:
Cathode construction

04/27/2016





Today in lab

- ✓ Quiz
- Prelab discussion
- In 76-568: prepare material and roll & punch the cathodes
- In 56-322: research proposal peer review exercise

❖ Prepare elevator pitch for Prof. Belcher

- Thursday 11am
- 2-3 minute presentation + 2-3 minutes Q&A

On the horizon for M3

- Major assignments
  - Research proposal oral presentation (20%); Wednesday, May 11, 1pm
  - Mini-report (5%); Friday, May 6, 10pm

- Homework due M3D4 (one week from today!)
  - Submit both parts as a group
  1. Refine presentation outline, incorporate peer review feedback
  2. Background and Approach, with references

     http://belcherlab.mit.edu/publications/

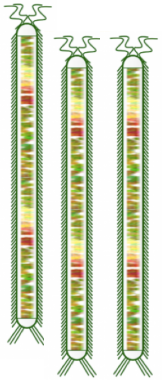
- Visit once
  (5 HW points)

MIT BE
BIOLOGICAL ENGINEERING
Communication Lab

Module 3: biomaterials engineering overview

Purify
M13 phage
Add AuNP

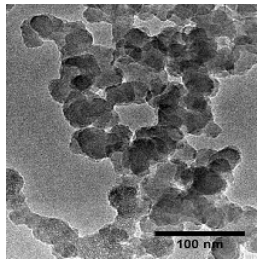
DAY 1



Biomineralize
Fe(III)-
phage-AuNP

Visualize
nanowires
on TEM

DAY 4



Purify
active material

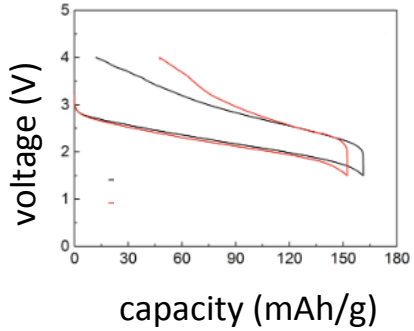
DAY 2

Construct
cathode
(and battery)

DAY 3

Measure battery
capacity

DAY 5



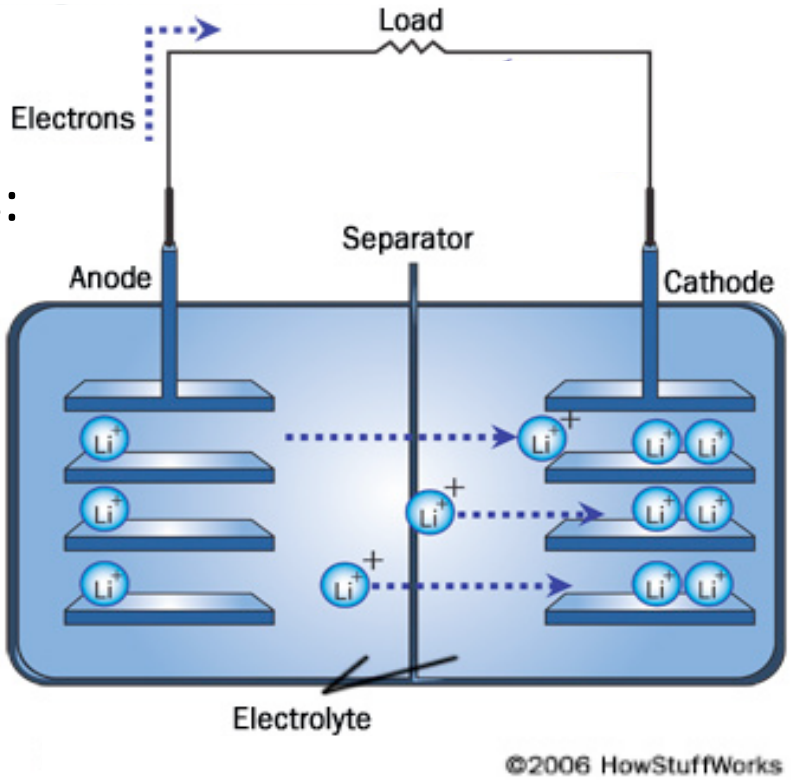
dried in 80C incubator
for 68 h, then
dried in 80C vacuum
oven during 4 h

What is a battery cath

- Battery consists of two electrodes:
  - cathode = positive electrode
  - anode = negative electrode
- During discharge,

  cathode accepts electrons e^-

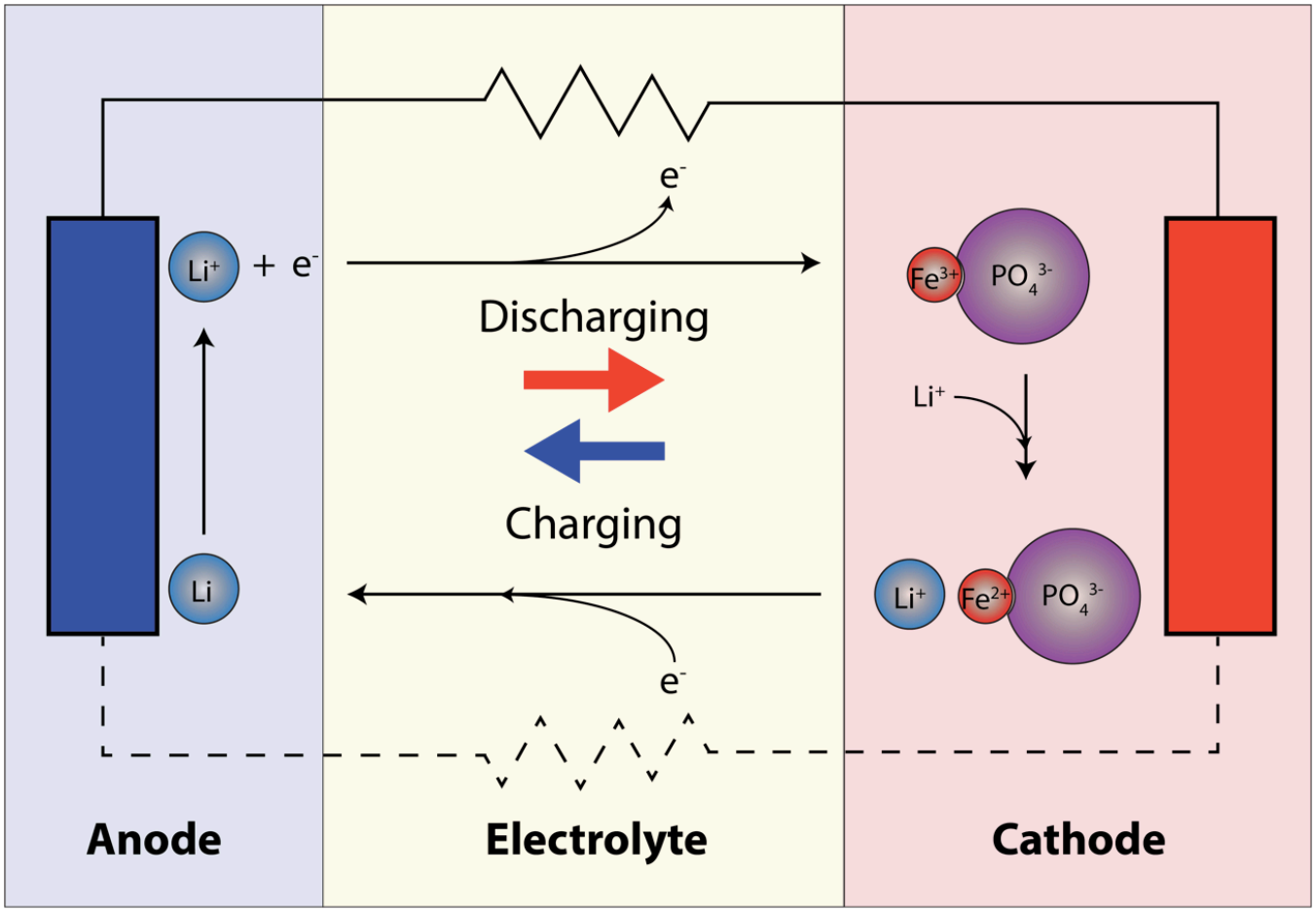
  and lithium ions Li^+



- What is capacity?
  - quantity of electricity (charge) involved for the electro-chemical reaction within the battery
  - for our Fe(III)-phage batteries, the theoretical capacity is 178 mA*h/g

Diagram of M3 battery

M13 phage
AuNP
Fe(III) PO_4 / Li Fe(II)PO_4



How can a phage scaffold improve battery?

- ion diffusivity → nano structuring active material volume to surface ratio
- electronic conductivity → integrating additives

Example: adding carbon nanotubes to phage cathode

from Dr. Moradi, Belcher Lab

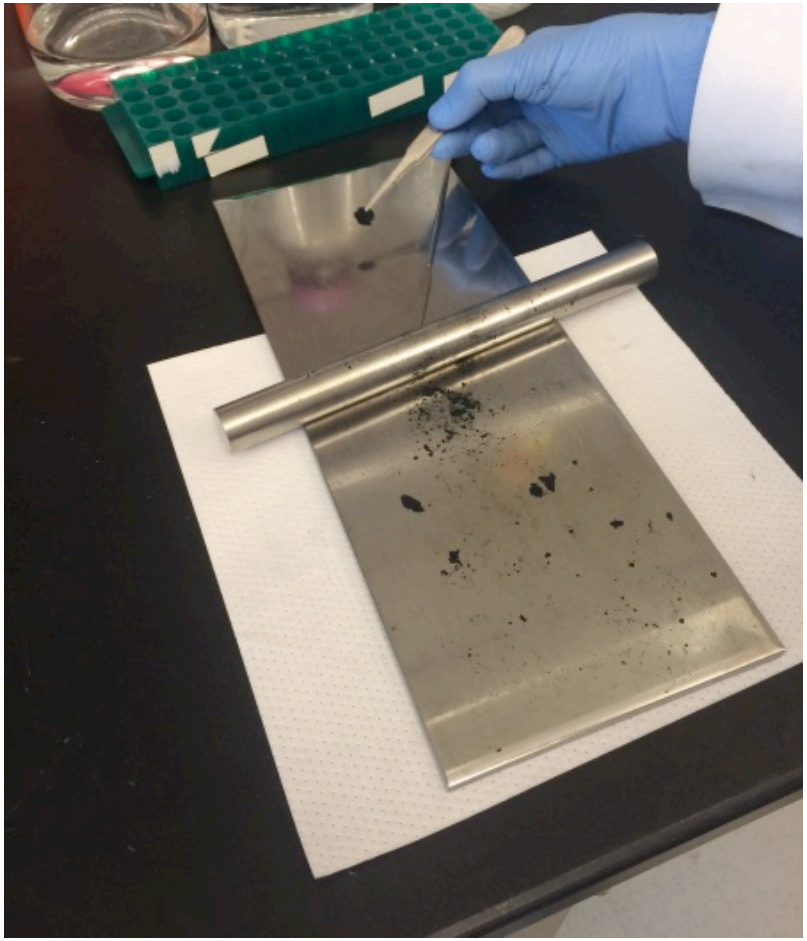
➢ How might AuNP size and quantity affect your battery capacity?

– experimental variables: diameter: 3.6 vs. 5.0 nm
AuNP : single phage 50 - 120 : 1
see M3D1 Discussion for details

How will you construct your cathode?

1. Weigh Fe(III)-phage-AuNP nanowires (active material)
2. Mix with Super P: carbon

   and PTFE: binder
3. Roll material into thin sheet
4. “Punch out” cathode disc
5. Weigh cathode
6. Dry cathode



Split intro two groups:

- Part 1: cathode construction in the Belcher Lab
  - first Blue, Pink
- Part 2: peer review in the 20.109 Lab
  - first Red, Orange, Purple