M3D2:
Purify active material

11/18/2016

note: **lecture**, but no lab on 11/22 – 11/23

In lab today… and beyond

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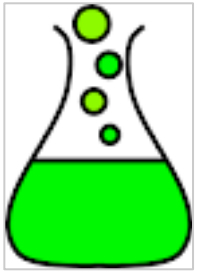
How to write your
M3 research proposal



- Demo: Fe(III)PO_4-phage-AuNP reaction
- Collect and wash active material
  - Refine your M3 proposal ideas during downtime
- Spot active material onto TEM grid
- Dry active material in 80°C vacuum oven

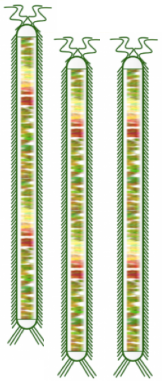
Module 3: biomaterials engineering

How does gold size affect battery capacity?

Purify
M13 phage
Add AuNP

DAY 1

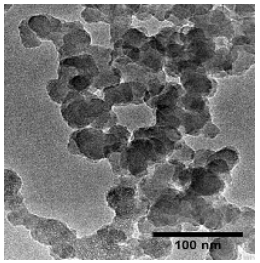
4 nm
9 nm



Biomineralize
Fe(III)-
phage-AuNP

Visualize
nanowires
on TEM

DAY 4



Purify
active material

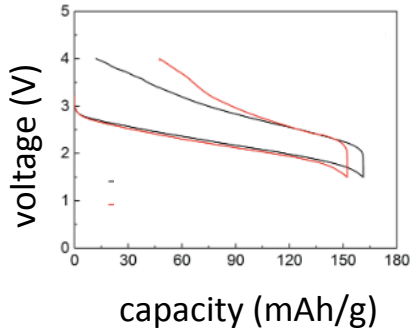
DAY 2

Construct
cathode
(and battery)

DAY 3

Measure battery
capacity

DAY 5



Biomineralization happened this week

- __p8__ coat protein modified to include DSPHTELP, __negative__ charged peptide
- Gold nanoparticles (AuNP ●) incubated with phage for 24 hours
- Electrostatic affinity between p8 and (gold and) Fe^{3+} … from $(NH_4)_2Fe(SO_4)_2$
  - 90% efficiency!
  - Fe^{3+} back into solution if wait > 12 h
- PO_4^{3-} from $NaPO_4$ precipitates Fe(III)
- nucleation / accumulation / mineralization ensues
  - amorphous a-$FePO_4$ ≠ crystal

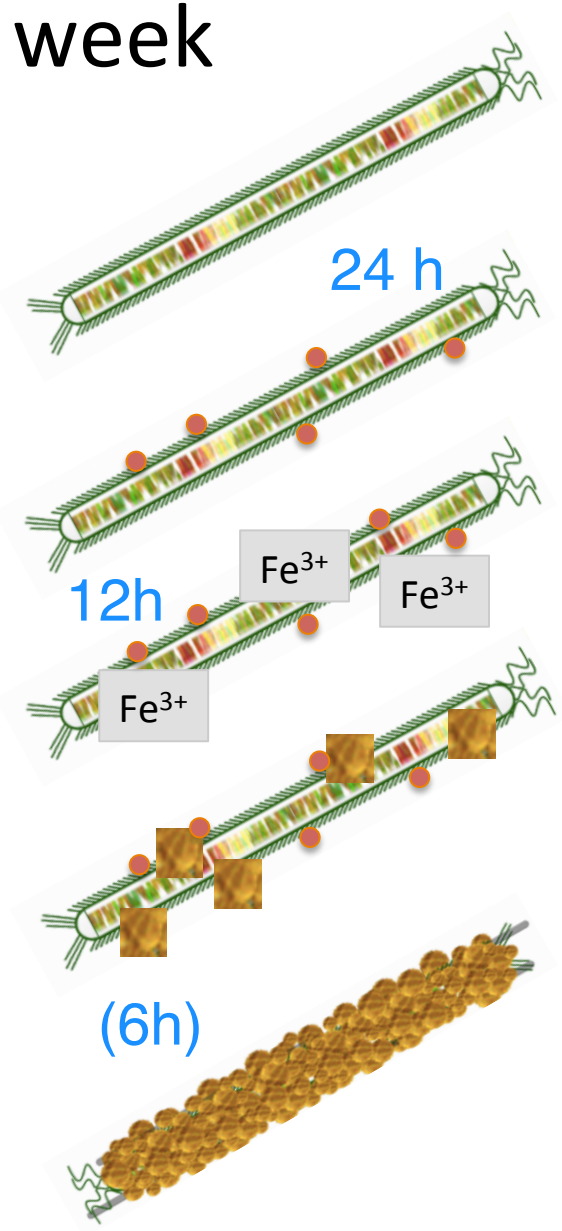
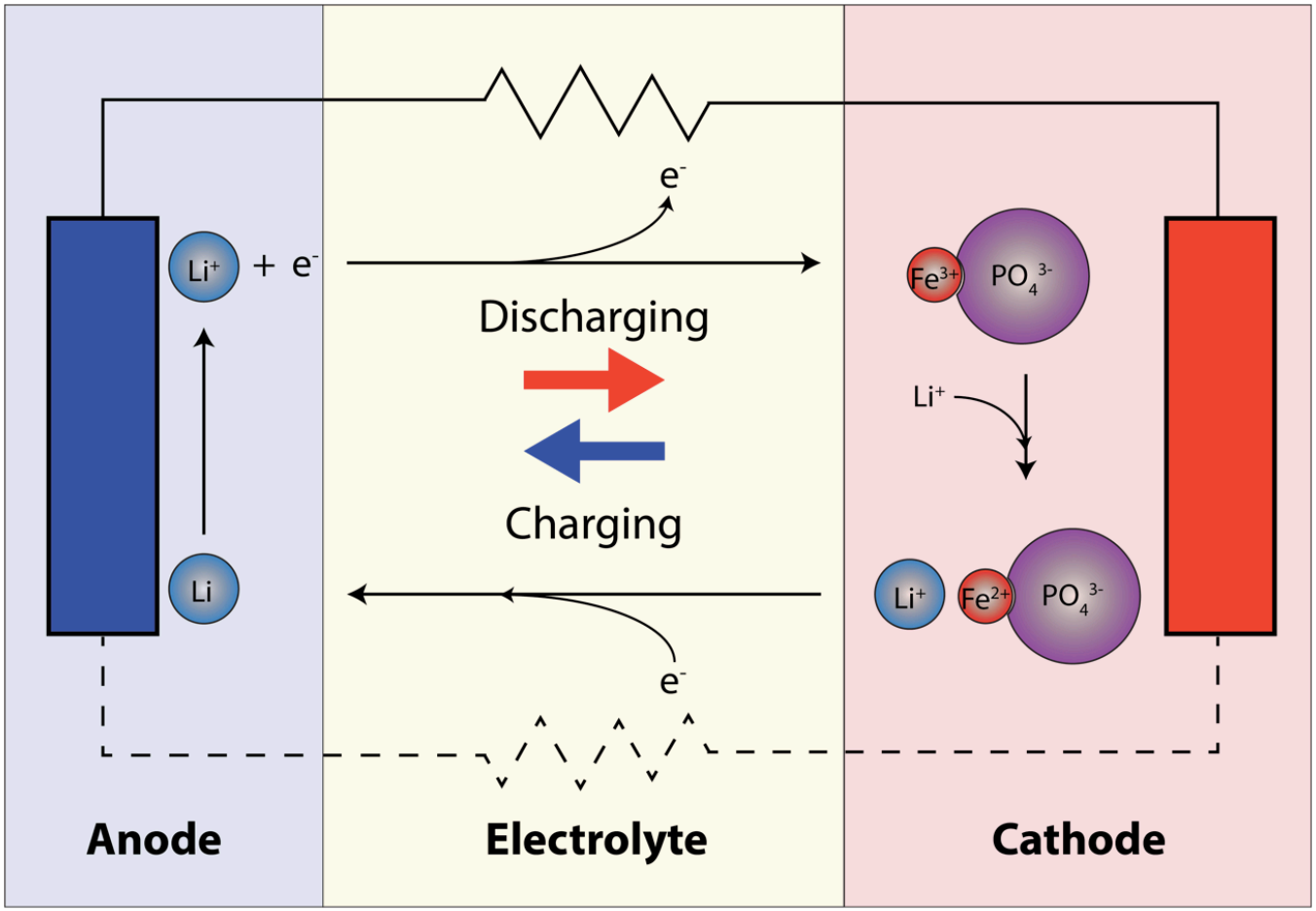


Diagram of M3 battery

M13 phage scaffold
AuNP e- conductivity
Li Fe(III) PO_4 ionic conductivity



negative

positive

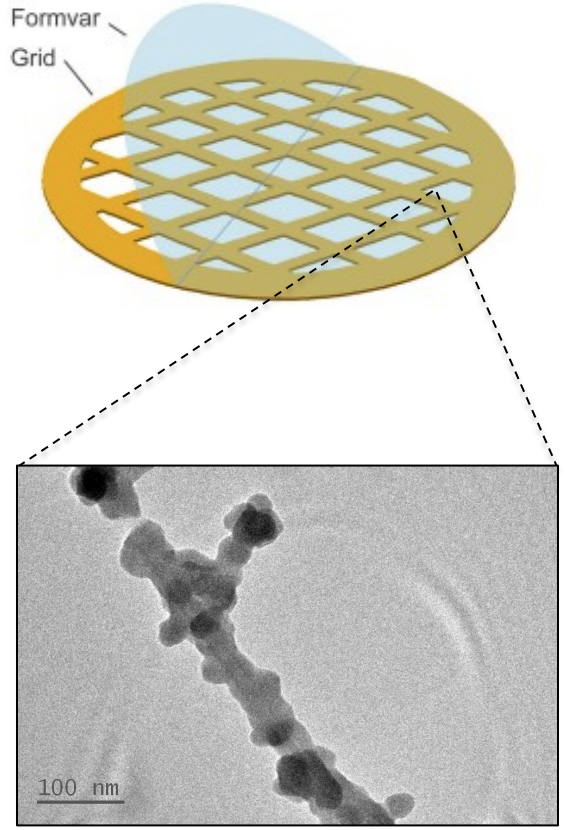
Set aside Fe(III)-phage-AuNP for TEM inspection

active material

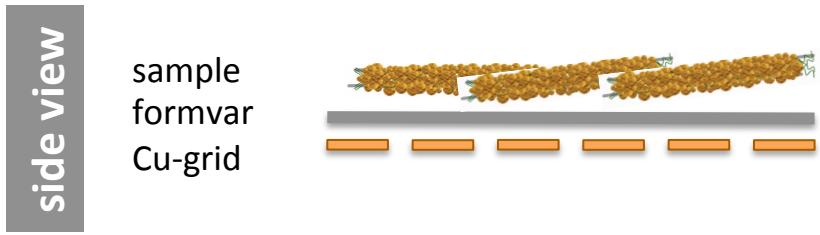
- The Fe(III)-phage-AuNP active material is in its purest form
  - no impurities, binder, etc.

- Formvar coated Cu-grid
  - copper-orange side
  - ✓ <u>silver/black side</u> where droplet deposited

  ➢ Practice handling it with tweezers



side view



2 grids: undiluted, 1:10 dilution in water

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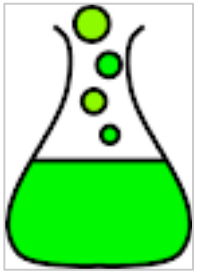

- Demo: Fe(III)PO_4-phage-AuNP reaction

- Collect and wash active material
  - Many long spins!
  - Refine your M3 proposal ideas during downtime
- Practice, then prepare TEM samples
- Prepare active material for 80°C vacuum oven

➢ 11/22: elevator pitches to Prof. Belcher
➢ 11/30: quiz