M3D5: Battery assembly and testing

5/05/2016

1. Last Quiz
2. Prelab Discussion
3. Half of class goes to Belcher lab
4. Half of class works on report or research proposal

- Notebook entry M3D2 will be graded

The final countdown…

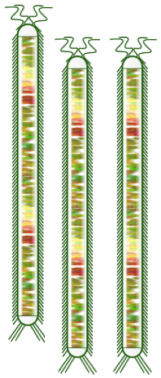
- **Reminder: visit Comm. Lab for 5pts M3 HW credit**
- **M3 mini-report (5%)**
  - **2 pages (3 at MOST) without figures**
  - **OH TODAY 6-10pm 16-220** (lecture room) with pizza
  - No abstract, no methods section, combined results and discussion
  - **Figures**: TEM, Elemental mapping, battery capacity, compare class data
- **M3 research proposal (20%)**
  - Office hours on Sunday (5/8) 11am – 5pm in 56-302
  - slides due Tuesday, May 10th at 1pm
  - bring **1** print-out of your slides to 16-336
- **M3 Blog and extras**
  - Mod3 blog due May 11th 5pm
  - all other blogs due May 14th 11am

Module 3: biomaterials engineering

How does gold size/quantity affect battery capacity?

Purify
M13 phage
Add AuNP

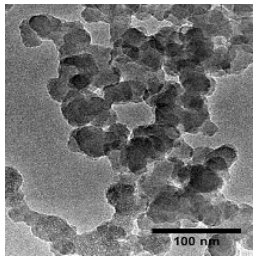
DAY 1



Biomineralize
AuNP-Fe(III)-
phage

Visualize
nanowires
on TEM

DAY 4



Purify
active material

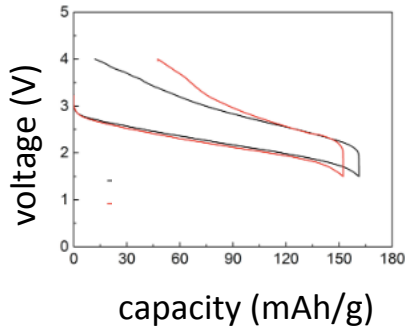
DAY 2

Construct
cathode
(and battery)

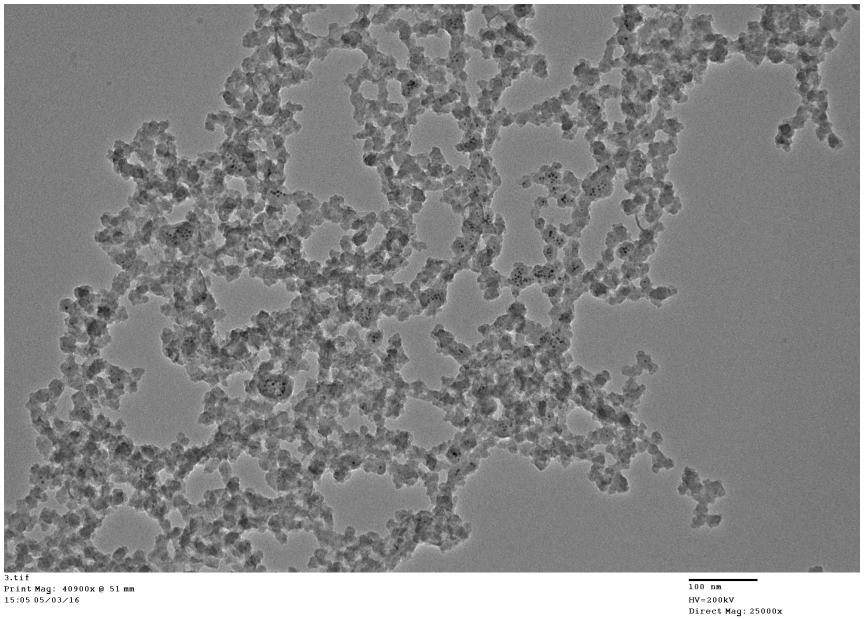
DAY 3

Measure battery
capacity

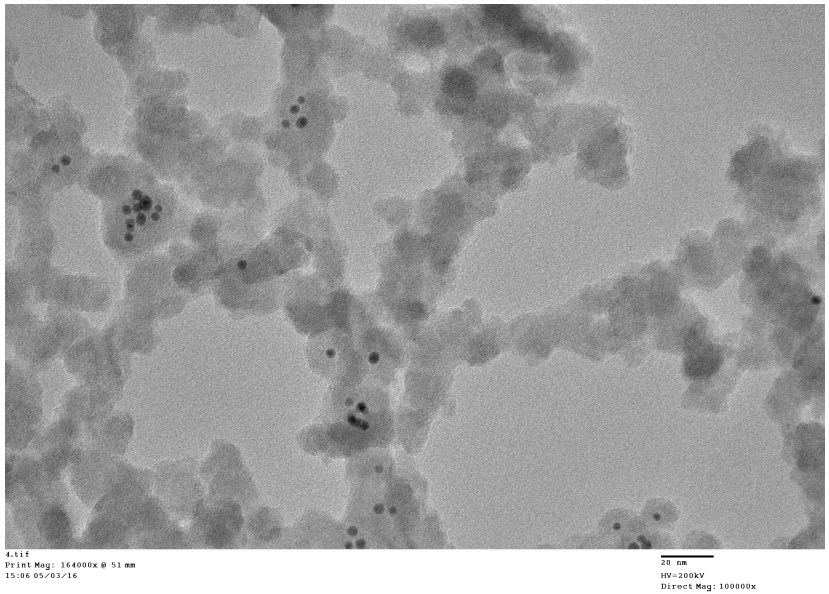
DAY 5



TEM micrographs



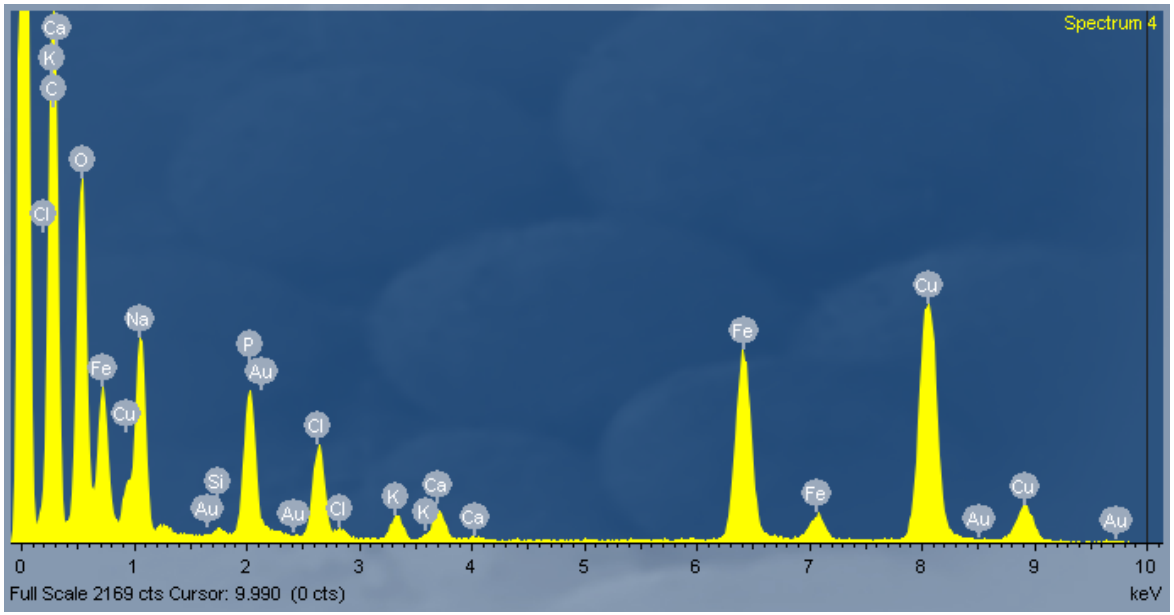
-biomineralization
-distribution of NP
-NP associated with virus



-uniformity of iron phosphate/phage, NP
-NP size
-lattice structures in gold an iron phosphate

from Fall 2015 20.109

TEM EDX

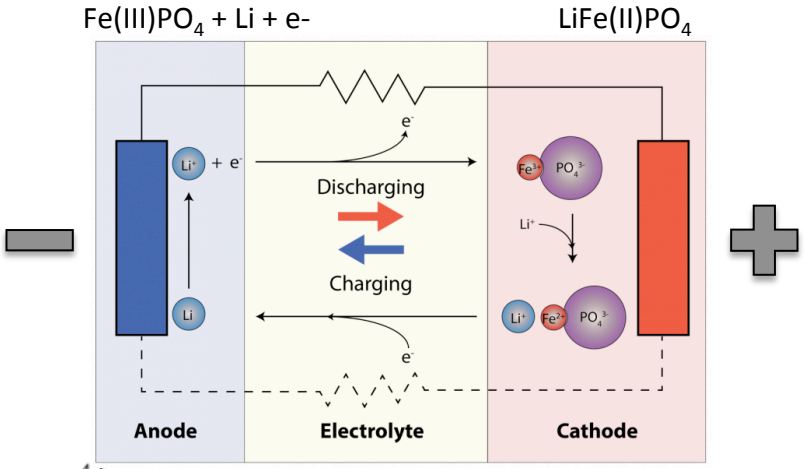


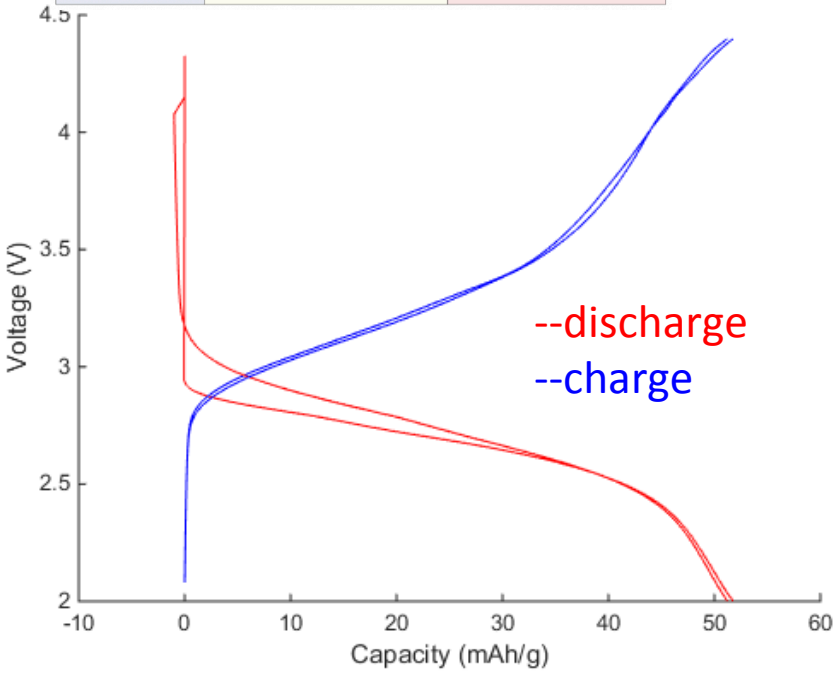
Element	Weight%	Atomic%
C K	36.75	58.91
O K	16.56	19.94
Na K	6.81	5.71
Si K	0.25	0.17
P K	5.25	3.26
Cl K	3.42	1.86
K K	0.90	0.44
Ca K	1.07	0.52
Fe K	10.73	3.70
Cu K	18.10	5.49
Au L	0.16	0.02

-X ray detector made of silicon
-Iron to phosphate ratios

Battery Capacity Measurements

Galvanostat: Instrument used to measure battery capacity; keep current constant





Theoretical capacity is 178 mA*h/g
value based on the reduced state of the cathode material - LiFe(II)PO$_4$

Practically determine capacity by calculating the difference between the maximum differences in the discharge and charge cycles.

Battery Capacity Calculations

	I	J	P	Q
1	Exported CellTest Data			
2	Data file version : 12			
3	Experiment start time : 4/29/2016 4:28:09 PM			
4				
5	Voltage (V)	Current (A)	Charge (Ah)	
6	2.95300293	-4E-09	-1E-12	
7	2.95288086	-5E-09	-3E-12	
8	2.95288086	-5E-09	-4E-12	
9	2.95288086	-5E-09	-5E-12	
10	2.95288086	-5E-09	-7E-12	
11	2.95300293	-4E-09	-8E-12	
12	2.95300293	-4E-09	-9E-12	
13	2.95300293	-4E-09	-1E-11	
14	2.95300293	-4E-09	-1.1E-11	
15	2.95300293	-4E-09	-1.2E-11	
16	2.95300293	-4E-09	-1.4E-11	
17	2.95300293	-4E-09	-1.5E-11	
18	2.95300293	-4E-09	-1.6E-11	
19	2.95300293	-4E-09	-1.7E-11	
20	2.95300293	-4E-09	-1.8E-11	
21	2.95300293	-4E-09	-1.9E-11	
22	2.95300293	-4E-09	-2E-11	

$$\frac{mA \cdot h}{g}$$

1) Calculate the capacity by dividing the Charge (Ah) by the weight of the electrode (check weight with me). *Ensure the units are in (Ah/g).*
2) Repeat the capacity calculation for the entire column for both the discharge and charge sections. You can simply drag the formula down the column.
3) Calculate capacity by **subtracting** the difference in highest and lowest capacities from the charge cycle, from the difference in the highest and lowest capacities from the discharge cycle. *In other words, what is the greatest difference between the maximum differences in the discharge and charge cycles.*

Today in lab

- Belcher lab (5th floor Koch)
  - 1:45pm: red/orange/purple/pink
  - 2:45pm: green /yellow/blue

- Use your time wisely:
  - Finish your M3 mini-report early!