Thursday, May 18th, 4pm in 32-141:
Prof. Leona Samson presents to the BE department

M3D5:
Battery assembly and testing

05/09/2017

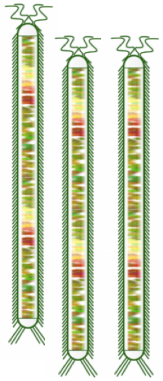
The final countdown…

- Lab notebook entry
  - M3D3 graded by Rob at 10pm tonight
- No lecture Thursday
- M3 research proposal
  - slides due on Gradebook Module Thursday, May 11th at 1pm
  - bring one print-out of your slides to 16-336
- Blog post
  - due Thursday, May 11th
- M3 mini-report
  - due at 10pm Tuesday, May 16th
  - (background + overall approach), TEM images, elemental map (spectrum), charge/discharge plot, capacity value, class-wide data analysis

Module 3 overview: biomaterials engineering

Purify
M13 phage
Add AuNP

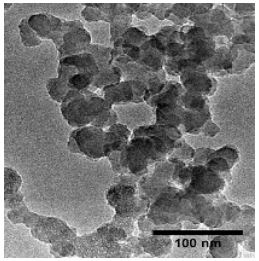
DAY 1



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

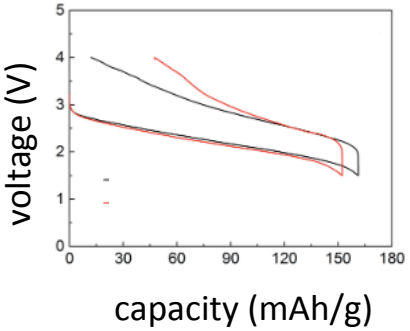
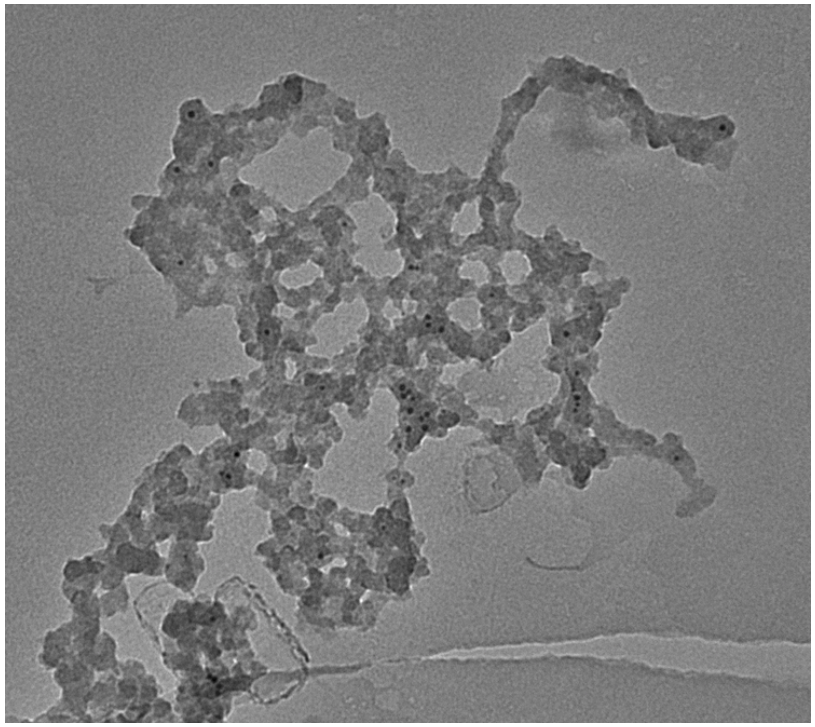


Figure: TEM images

- at low magnification:
  - extent of biomineralization
  - distribution of gold
  - overall structure & density
  - uniformity
  - length of nanowires
- at high magnification:
  - size of gold nanoparticles
  - lattice of gold atoms (*i.e.* 111)
  - amorphous *vs*. crystal Fe(III)PO_4
  - diameter of nanowires



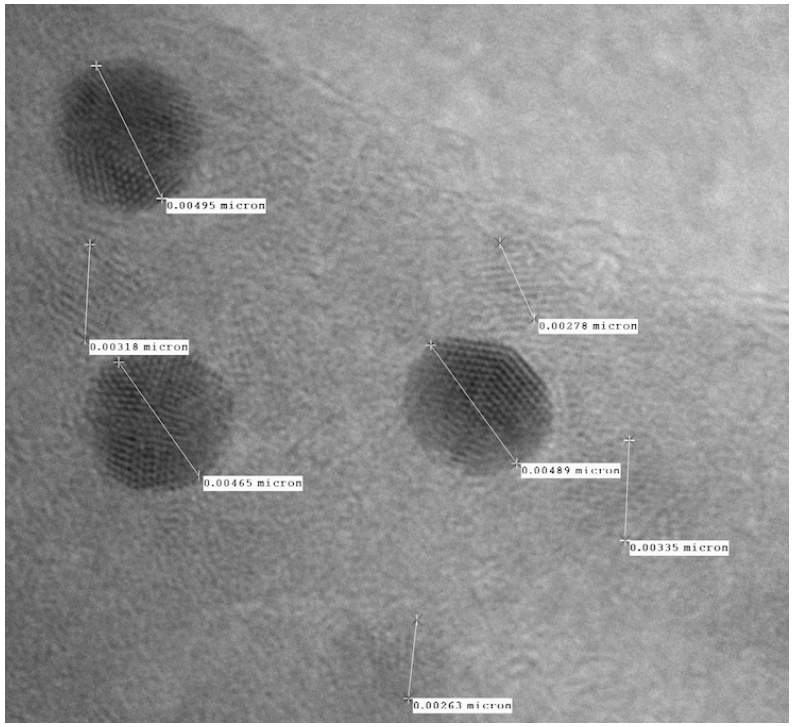
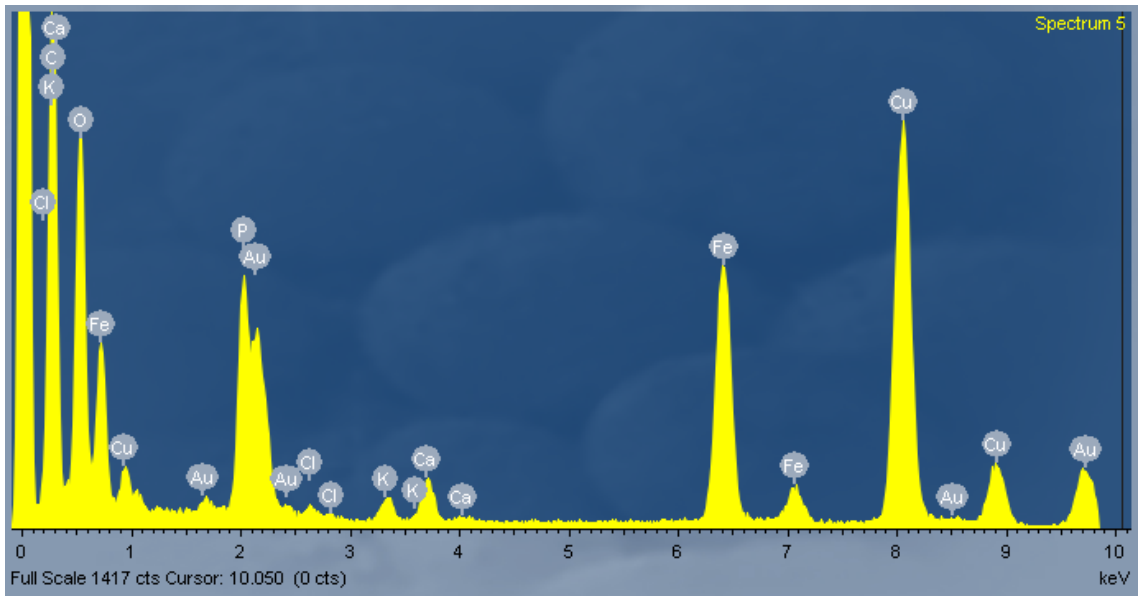


Figure: EDX elemental mapping

- expected: Fe, P, O, Au, (Cu)
  - contamination? Na, Cl, K, Ca (from diH_2O)
  - Si
  - ~~stoechiometric ratios?~~

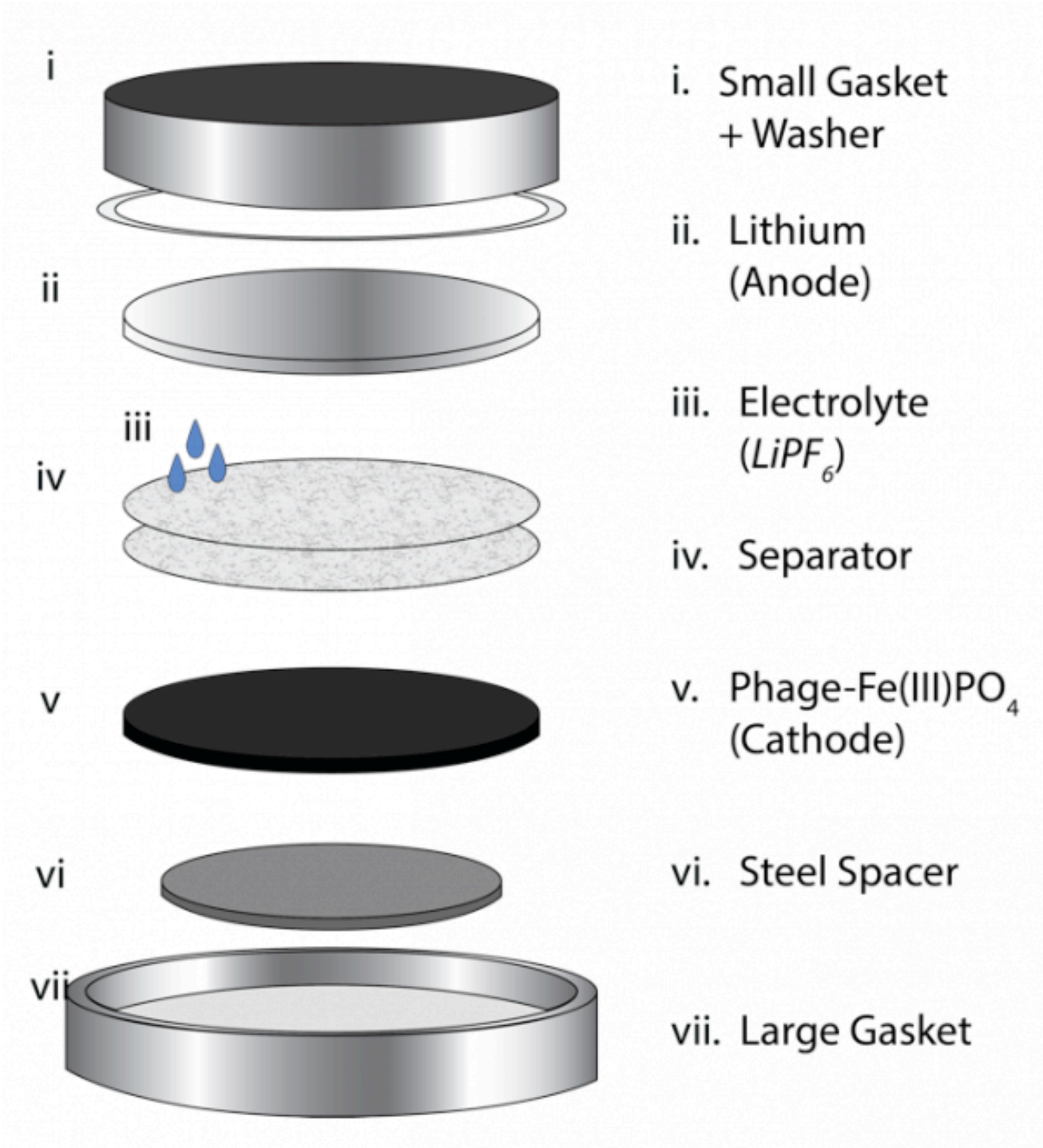


abundance

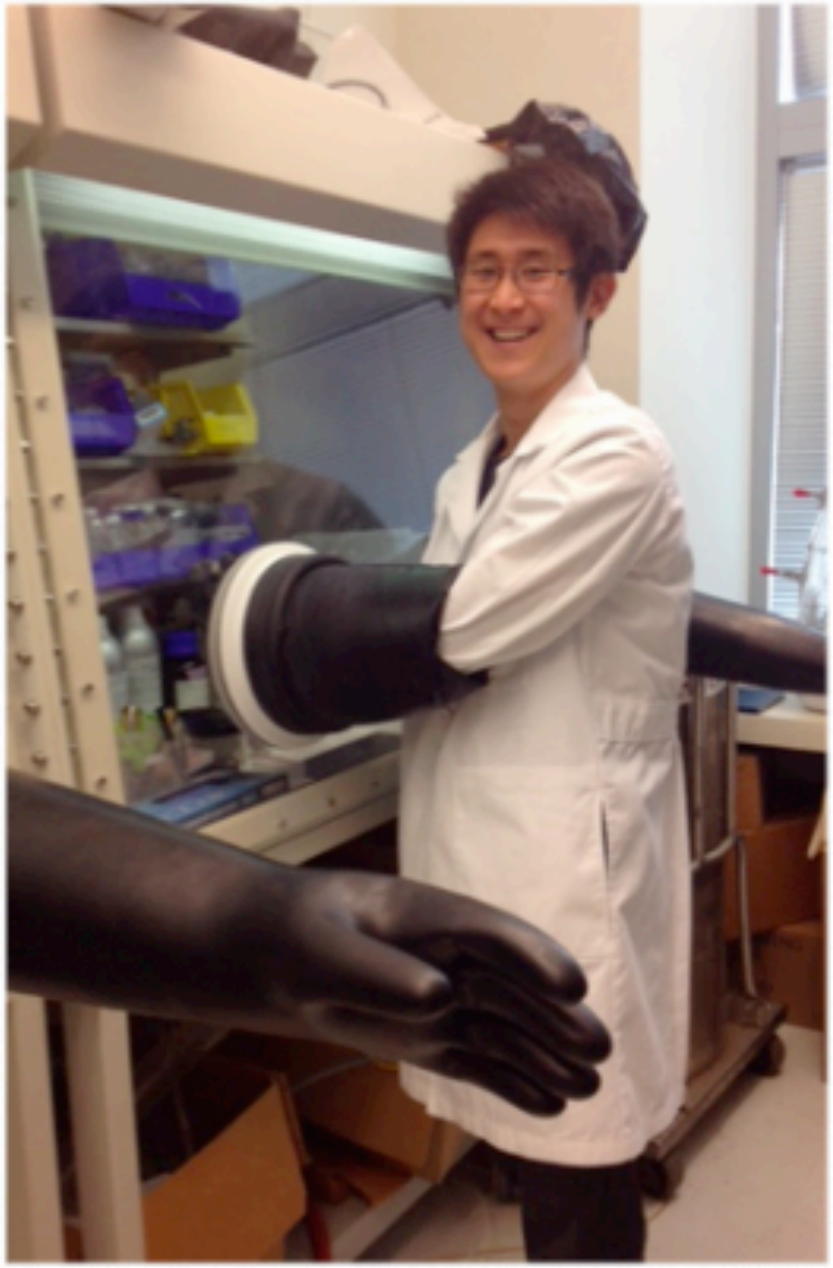
keV (energy)

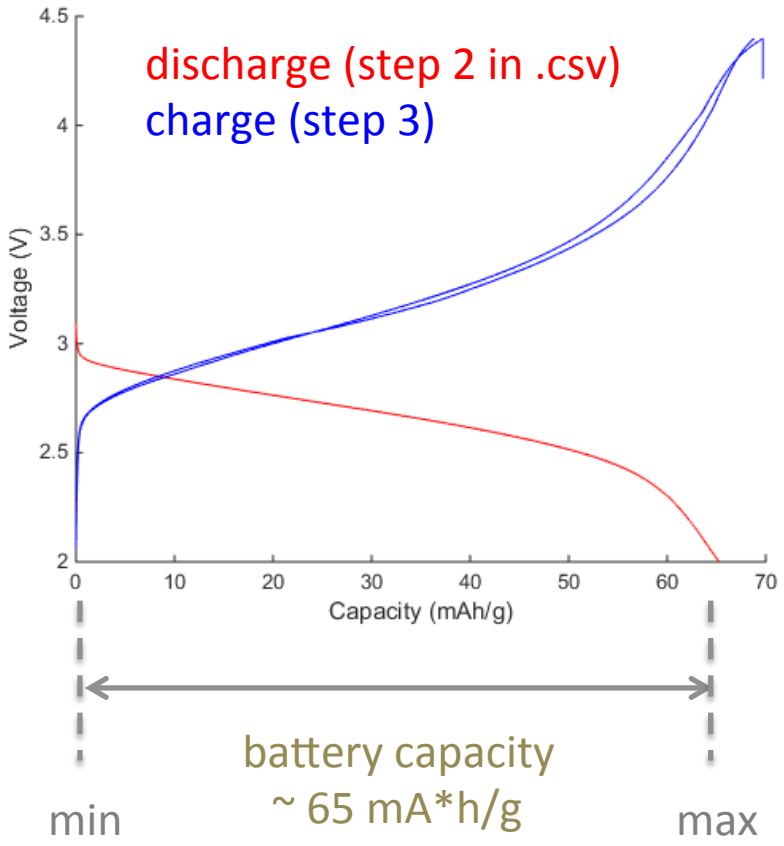
Element	Atomic%
C K	55.01
O K	27.88
P K	5.04
Cl K	0.24
K K	0.46
Ca K	0.77
Fe K	5.46
Cu K	9.34
Au L	0.79
Totals	

Today: Battery assembly



from bottom up





Result / figure: Battery capacity

- Theoretical capacity of Li – LiFe(II)PO4 battery: 178 mA*h/g
- Practically
  - analyze cycling data
  - summary by Jifa in *.csv*

- Galvanostat:
  - keep current constant (- 17.8 mA/g for 10h discharge)
  - record voltage (ideally constant)
  - as charge (capacity) stored in battery fluctuates (drops during discharge)

column F "step" = 2
look for 2nd or 3rd cycle

Battery capacity calculation

	A	B	C	D	E
1	Time	Voltage (V)	Current (A)	Charge (Ah)	Capacity (Ah/g)
2	00:01.0	3.086303711	-0.000000005	-2E-12	
3	00:02.0	3.086791992	-0.000000006	-3E-12	
4	00:03.0	3.087158203	-0.000000005	-5E-12	
5	00:04.0	3.087524414	-0.000000004	-6E-12	
6	00:05.0	3.087890625	-0.000000005	-7E-12	
7	00:06.0	3.088256836	-0.000000005	-8E-12	

during discharge (step 2)

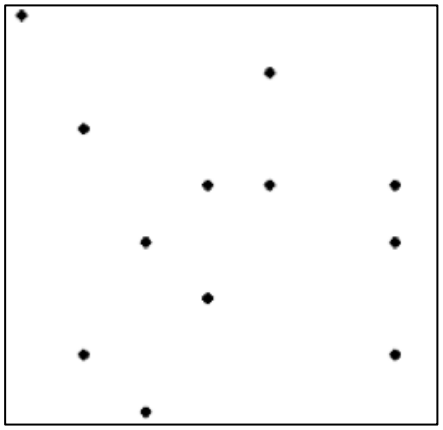
M = max capacity

m = min capacity

battery capacity = M - m

- Ensure capacity units are A*h/g or mA*h/g
- Remember cathode is (in weight)
  - 70% active material: 63% Fe(III)PO_4 + 7% phage
  - 25% Super P carbon
  - 5% PTFE binder

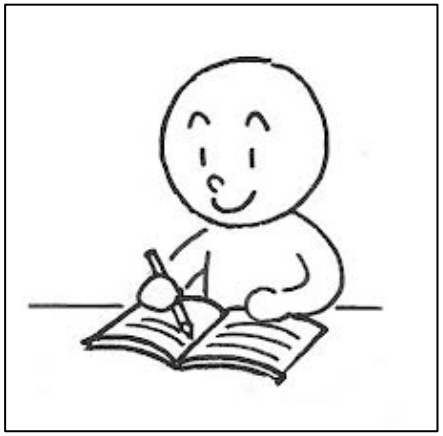
Does gold quantity affect battery capacity?



- Use class-wide data
  - *.csv* from Jifa for all capacities
  - M3 main Discussion page for AuNP quantity

post your team's capacity values on the wiki: M3 main Discussion page

Today in lab:



- Demo in Belcher Lab
- Refine your M3 research proposal