

# M3D5: Battery assembly and testing

5/4/2018

1. LAST Quiz
2. Prelab Discussion
3. Battery assembly demo: Belcher lab
4. Refine Research Proposal and draft figures for mini-report

# The final countdown...

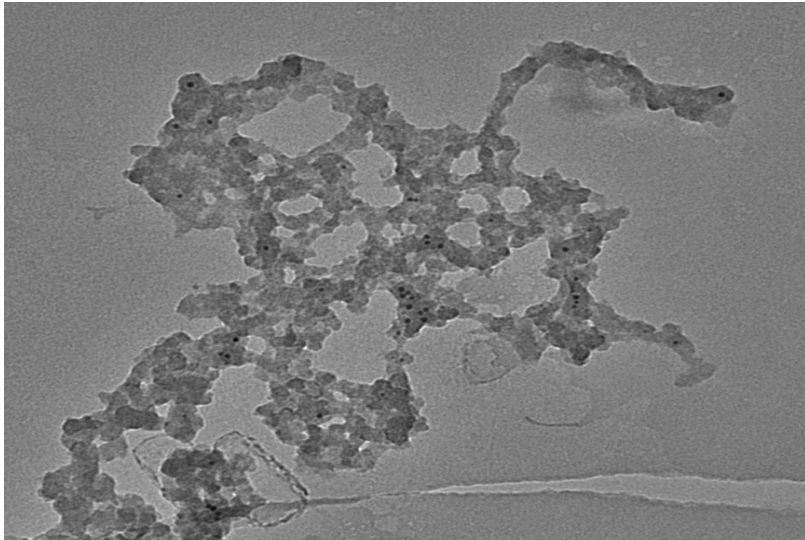
- No lecture Thursday
- M3 Lab notebook grade
  - M3D3 graded by Casper at 10pm Friday (May 11<sup>th</sup>)
- M3 research proposal
  - slides due on Stellar Thursday, May 10<sup>th</sup> at 1pm
  - bring **one print-out of your slides** to 16-336
- M3 mini-report
  - due on Stellar at 10pm Monday, May 14<sup>th</sup>
  - 3 sections: Background & Approach, Results & Interpretation of Data, and Contextualizing Results & Future Work
- Blog posts
  - Final blog post: May 12<sup>th</sup> at 10pm

## Extra office hours:

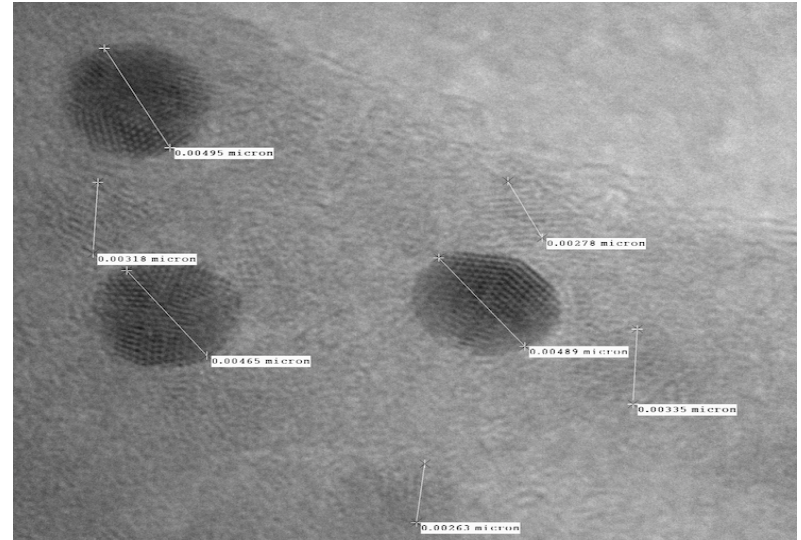
- Wednesday 10-12:30pm, Leslie & Josephine (56-322)
- Wednesday 5/9, 2-5pm, Noreen (16-317)
- Thursday 5/10, 10-11am, Josephine (56-341c)

# Figures: TEM images

- at low magnification:
  - extent of biomineralization
  - distribution of gold NPs
  - overall structure & density
  - uniformity

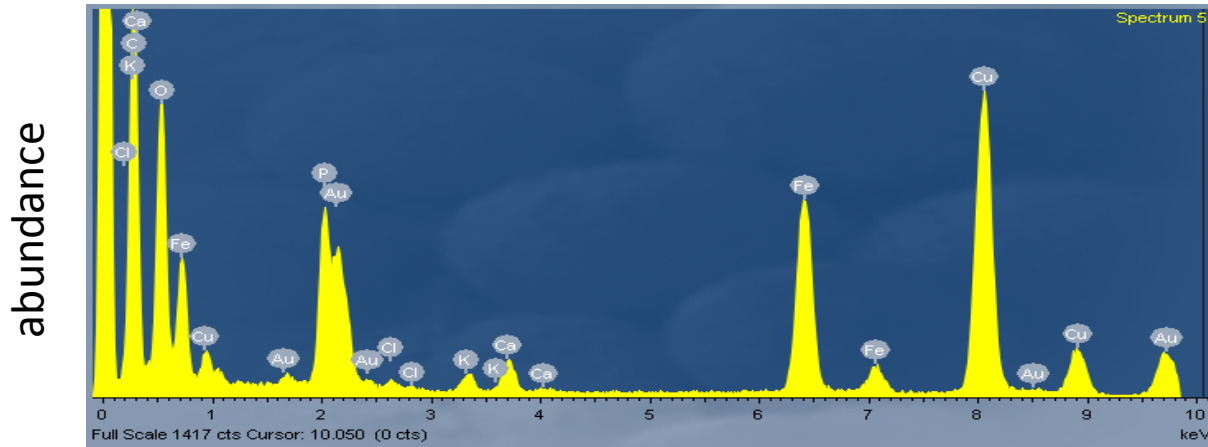


- at high magnification:
  - size of gold nanoparticles
  - lattice of gold atoms
  - amorphous vs. crystal  $\text{Fe(III)PO}_4$
  - diameter of nanowires



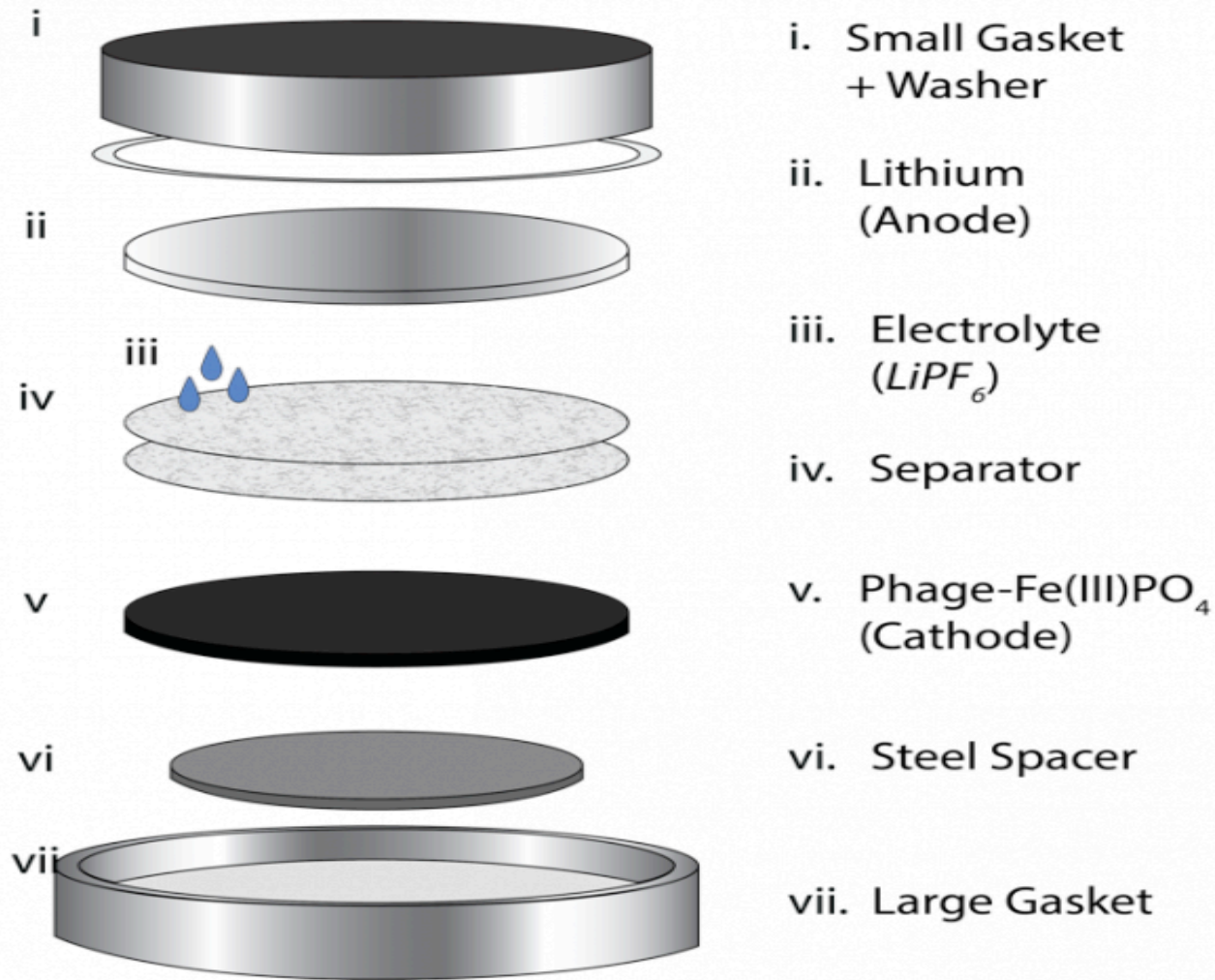
# Figures: EDX elemental mapping

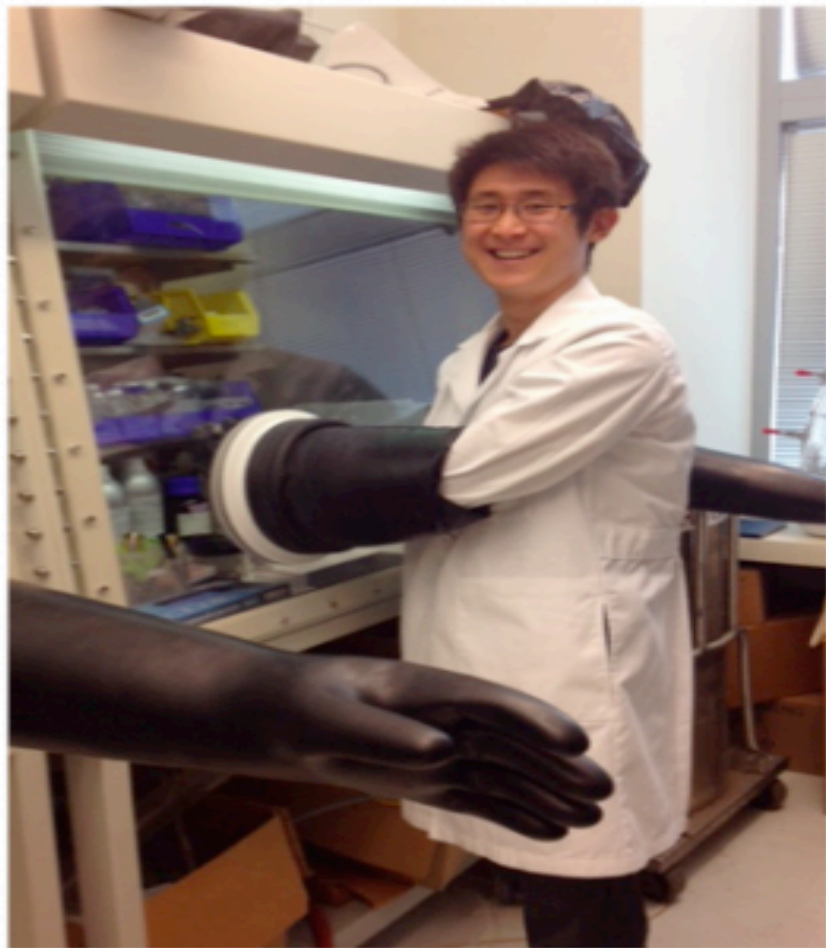
- expected: Fe, P, O, Au, (Cu)
  - contamination?
  - stoichiometric ratios?



keV (energy)

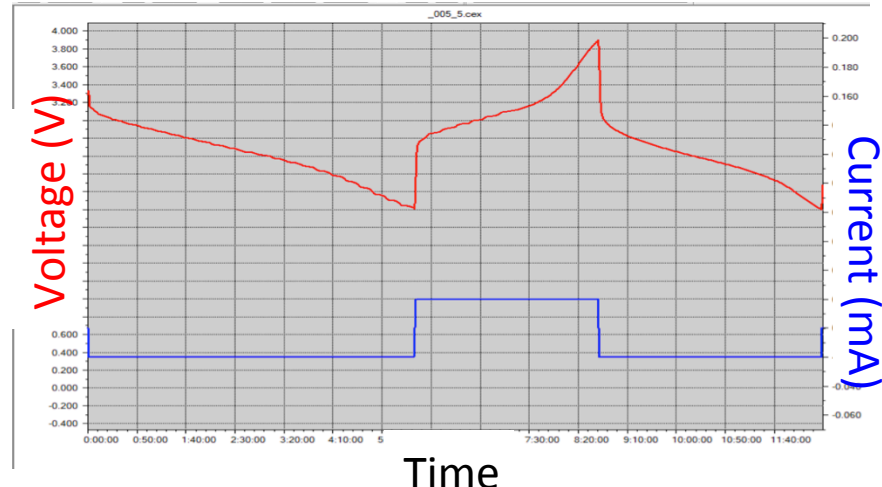
# Today: Battery assembly





# Measuring battery capacity

- **Theoretical capacity** of Fe(II)PO<sub>4</sub> (crystalline) battery ~ 178 mAh/g
- Measure the **actual capacity** of your batteries using galvanostat
  - Keep current constant (- 0.03 mA, record time to discharge)
  - Record voltage (ideally constant) as charge (capacity) stored in battery fluctuates (drops during discharge)





# Calculate actual battery capacity by dividing by mass of active material

	A	B	C	D	E	F
1						
			_005_5			
Font	Index	Mode	Period			
3	1	Rest	0:01:00			
4	Index	TestTime	Voltage/V	Current/mA	Capacity/mAh	State
5	1	0:00:00	3.2918	0	0	R
6	2	0:01:00	3.3336	0	0	R
7	Index	Mode	Period			
8	2	Discharge C	5:32:40			
9	Index	TestTime	Voltage/V	Current/mA	Capacity/mAh	State
10	3	0:01:00	3.2865	-0.0202	0	D_CC
11	4	0:02:00	3.16	-0.0202	0.0003	D_CC
12	5	0:03:00	3.1436	-0.0202	0.0007	D_CC
13	6	0:04:00	3.1343	-0.0202	0.001	D_CC
14	7	0:05:00	3.1256	-0.0202	0.0013	D_CC
15	8	0:06:00	3.1191	-0.0202	0.0017	D_CC
16	9	0:07:00	3.1095	-0.0202	0.002	D_CC
17	10	0:08:00	3.1008	-0.0202	0.0024	D_CC
18	11	0:09:00	3.0921	-0.0202	0.0027	D_CC
19	12	0:10:00	3.0822	-0.0202	0.003	D_CC
20	13	0:11:00	3.0735	-0.0202	0.0034	D_CC
21	14	0:12:00	3.0683	-0.0202	0.0037	D_CC
22	15	0:13:00	3.0627	-0.0202	0.004	D_CC
23	16	0:14:00	3.0608	-0.0202	0.0044	D_CC

## Discharge capacity example:

- look for highest value in discharge cycle (usually last time point)
- divide by cathode mass (0.54)
- multiply by 1000

$$\text{example } \left[ \frac{0.1117 \text{ mAh}}{(1.97 \times 0.54)} \right] \times 1000 = 105 \frac{\text{mAh}}{\text{g}}$$

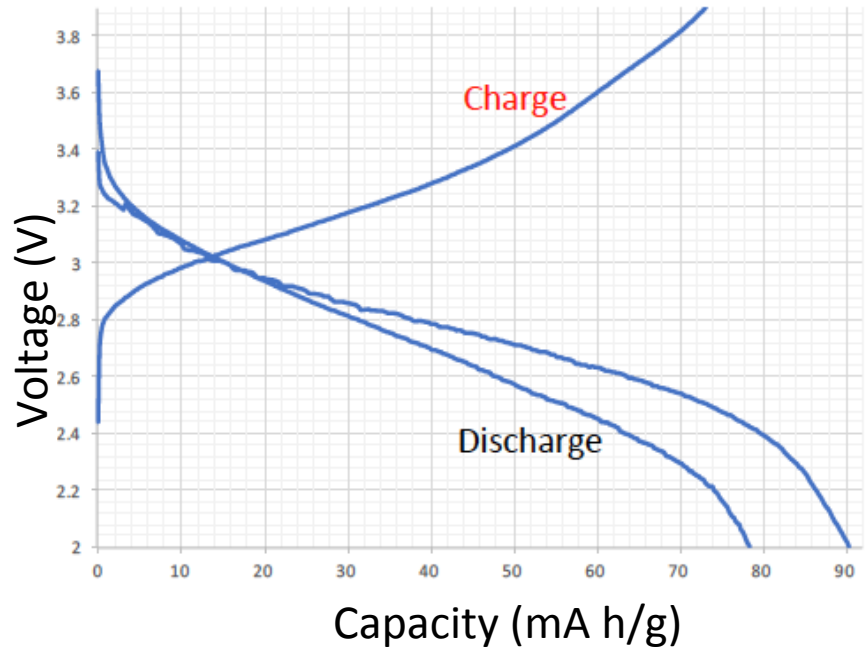
- **In report:** Report all charge and discharge capacities
- **On wiki:** Post best (highest) discharge capacity only



# Figure: Voltage profile (charge and discharge)

	A	B	C	D	E	F
1						
Font	index	Mode	Period			
3	1	Rest	0:01:00			
4	Index	TestTime	Voltage/V	Current/mA	Capacity/mAh	State
5	1	0:00:00	3.2918	0	0	R
6	2	0:01:00	3.3336	0	0	R
7	Index	Mode	Period			
8	2	Discharge C	5:32:40			
9	Index	TestTime	Voltage/V	Current/mA	Capacity/mAh	State
10	3	0:01:00	3.2865	-0.0202	0	D_CC
11	4	0:02:00	3.16	-0.0202	0.0003	D_CC
12	5	0:03:00	3.1436	-0.0202	0.0007	D_CC
13	6	0:04:00	3.1343	-0.0202	0.001	D_CC
14	7	0:05:00	3.1256	-0.0202	0.0013	D_CC
15	8	0:06:00	3.1191	-0.0202	0.0017	D_CC
16	9	0:07:00	3.1095	-0.0202	0.002	D_CC
17	10	0:08:00	3.1008	-0.0202	0.0024	D_CC
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20	13	0:11:00	3.0735	-0.0202	0.0034	D_CC
21	14	0:12:00	3.0683	-0.0202	0.0037	D_CC
22	15	0:13:00	3.0627	-0.0202	0.004	D_CC
23	16	0:14:00	3.0608	-0.0202	0.0044	D_CC
24	17	0:15:00	3.0577	-0.0202	0.0047	D_CC
25	18	0:16:00	3.0531	-0.0202	0.005	D_CC
26	19	0:17:00	3.0509	-0.0202	0.0054	D_CC
27	20	0:18:00	3.0475	-0.0202	0.0057	D_CC
28	21	0:19:00	3.0428	-0.0202	0.006	D_CC
29	22	0:20:00	3.0394	-0.0202	0.0064	D_CC
30	23	0:21:00	3.0363	-0.0202	0.0067	D_CC
31	24	0:22:00	3.0317	-0.0202	0.0071	D_CC
32	25	0:23:00	3.0242	-0.0202	0.0074	D_CC
33	26	0:24:00	3.018	-0.0202	0.0077	D_CC
34	27	0:25:00	3.0128	-0.0202	0.0081	D_CC
35	28	0:26:00	3.0084	-0.0202	0.0084	D_CC
36	29	0:27:00	3.005	-0.0202	0.0087	D_CC
37	30	0:28:00	3.0035	-0.0202	0.0091	D_CC
38	31	0:29:00	3.0013	-0.0202	0.0094	D_CC
39	32	0:30:00	2.9991	-0.0202	0.0097	D_CC

From Excel data, plot voltage vs capacity



# Today in lab...

- Battery Assembly in Belcher lab-Thank you Jifa!
  - 1<sup>st</sup> group: orange, yellow, white, grey
  - 2<sup>nd</sup> group: green, blue, red, pink, purple
- Capacity calculations in lab: How does the type of NP-phage affect battery capacity?
  - Add experimental battery details to the wiki today!
- *Use your time wisely:*
  - Improve your research proposal slides
  - Practice your presentation
  - Ask for feedback!