M3D5: Battery assembly and testing

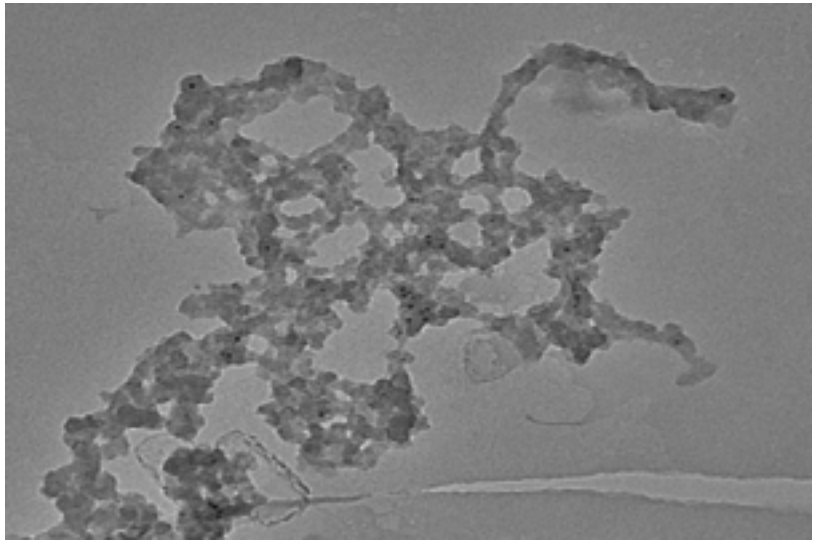
1. LAST Quiz
2. Prelab Discussion
3. Battery assembly demo: Belcher lab
4. Refine Research Proposal and draft figures for mini-report

The final countdown…

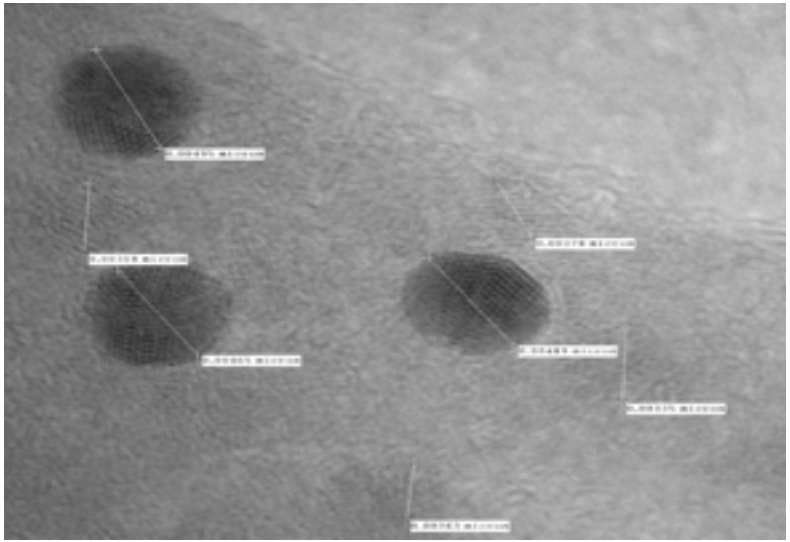
- No lecture Thursday
- M3 Lab notebook grade
  - M3D3 graded specifically, due 10pm tomorrow (Friday is okay)
- M3 research proposal
  - slides due on Stellar Thursday, December 6th at 1pm
  - bring one print-out of your slides to 16-336
- M3 mini-report
  - due on Stellar at 10pm Monday, December 10th
  - 3 sections: Background & Approach, Results & Interpretation of Data, and Contextualizing Results & Future Work
- Blog posts
  - Final blog post: Friday, December 7th at 10pm (Only 3 on-time posts are needed for full credit)

Figures: TEM images

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

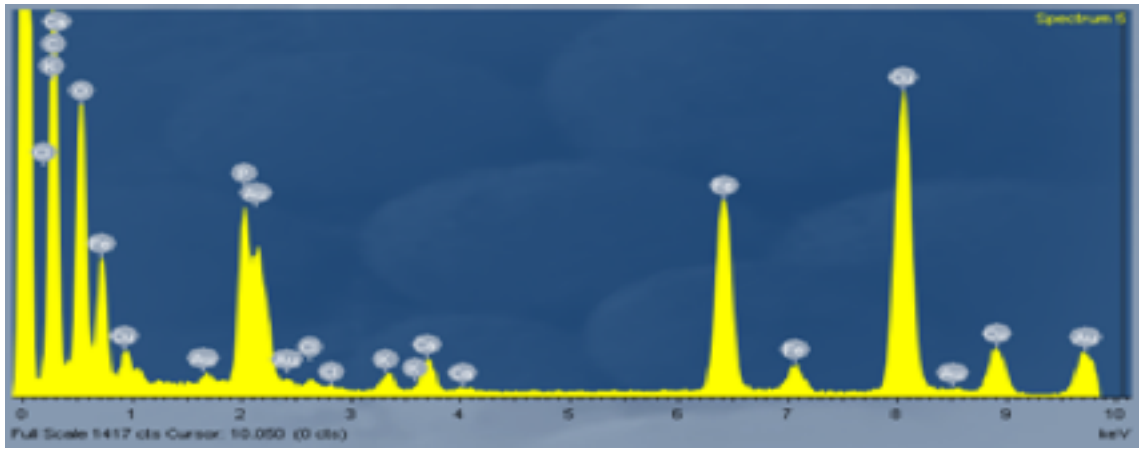


- At high magnification:
  - size of gold nanoparticles
  - lattice of gold atoms
  - amorphous *vs*. crystalline Fe(III)PO_4
  - diameter of nanowires



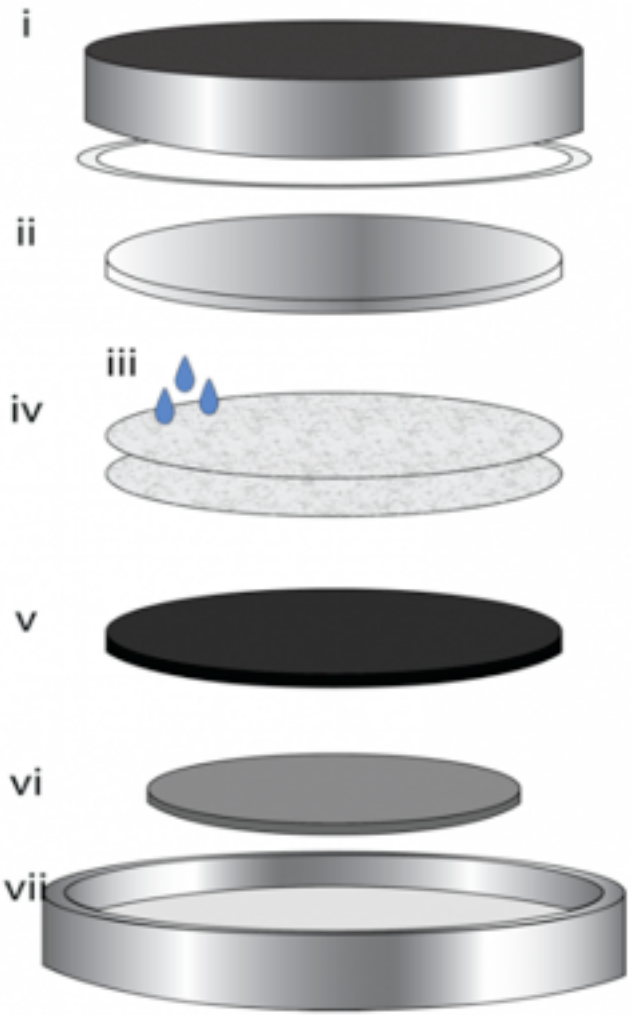
Figures: EDX elemental mapping

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



keV (energy)

Today: Battery assembly



i. Small Gasket + Washer

ii. Lithium (Anode)

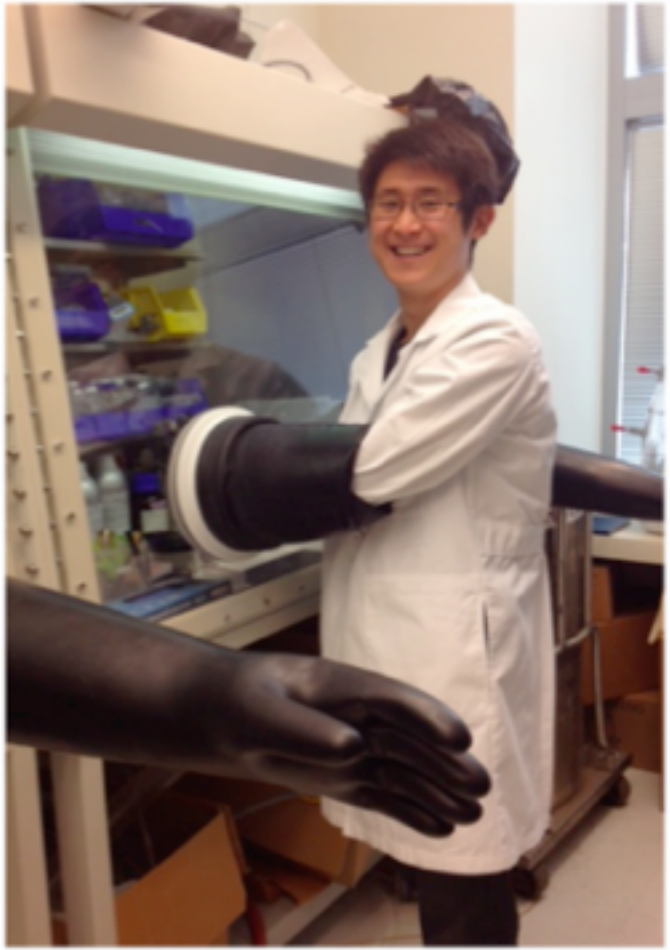
iii. Electrolyte ($LiPF_6$)

iv. Separator

v. Phage-Fe(III)PO_4 (Cathode)

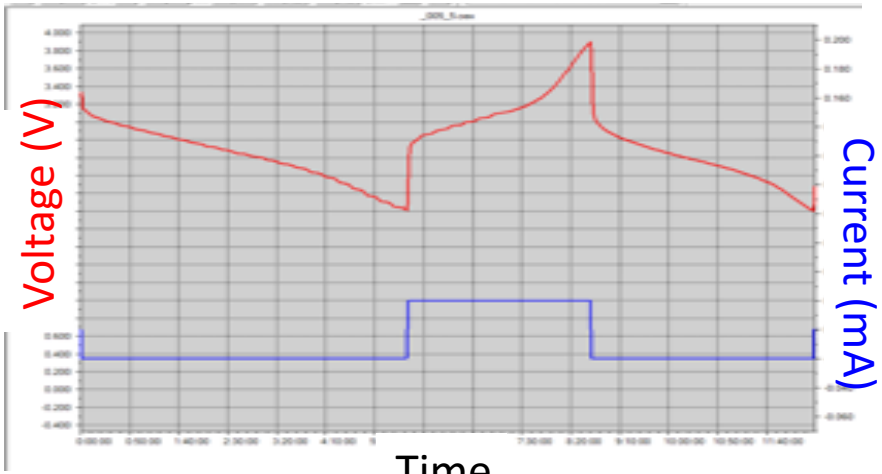
vi. Steel Spacer

vii. Large Gasket



Measuring battery capacity

- **Theoretical capacity** of Fe(II)PO4 (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

5/5 ← discharge in 5 hrs

	A	B	C	D	E	F
610	Index	Mode	Period			
611	6	Discharge C	5:59:31			
612	Index	TestTime	Voltage/V	Current/mA	Capacity/m	State
613	595	9:43:26	3.7714	-0.0319	0	D_CC
614	596	9:43:41	3.7212	-0.0319	0.0001	D_CC
615	597	9:43:58	3.6654	-0.0319	0.0003	D_CC
616	598	9:44:16	3.6111	-0.0319	0.0004	D_CC
617	599	9:44:37	3.5596	-0.0319	0.0006	D_CC
618	600	9:45:02	3.5073	-0.0319	0.0009	D_CC
619	601	9:45:33	3.4552	-0.0319	0.0011	D_CC
620	602	9:46:15	3.4049	-0.0319	0.0015	D_CC
621	603	9:47:15	3.3581	-0.0319	0.002	D_CC
622	604	9:48:15	3.3287	-0.0319	0.0026	D_CC
623	605	9:49:15	3.3057	-0.0319	0.0031	D_CC
624	606	9:50:15	3.2878	-0.0319	0.0036	D_CC
625	607	9:51:15	3.2735	-0.0319	0.0042	D_CC
626	608	9:52:15	3.2583	-0.0319	0.0047	D_CC
627	609	9:53:15	3.2468	-0.0319	0.0052	D_CC
628	610	9:54:15	3.2354	-0.0319	0.0058	D_CC
629	611	9:55:15	3.2239	-0.0319	0.0063	D_CC
630	612	9:56:15	3.2152	-0.0319	0.0068	D_CC
631	613	9:57:15	3.2065	-0.0319	0.0074	D_CC

Discharge capacity example:

$$\frac{0.1117\ mAh}{(1.97\ mg * 0.54)} \times \frac{1000\ mg}{g} = 105\ \frac{mAh}{g}$$

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

Figure: Voltage profile (discharge)

From Excel data, plot voltage vs capacity

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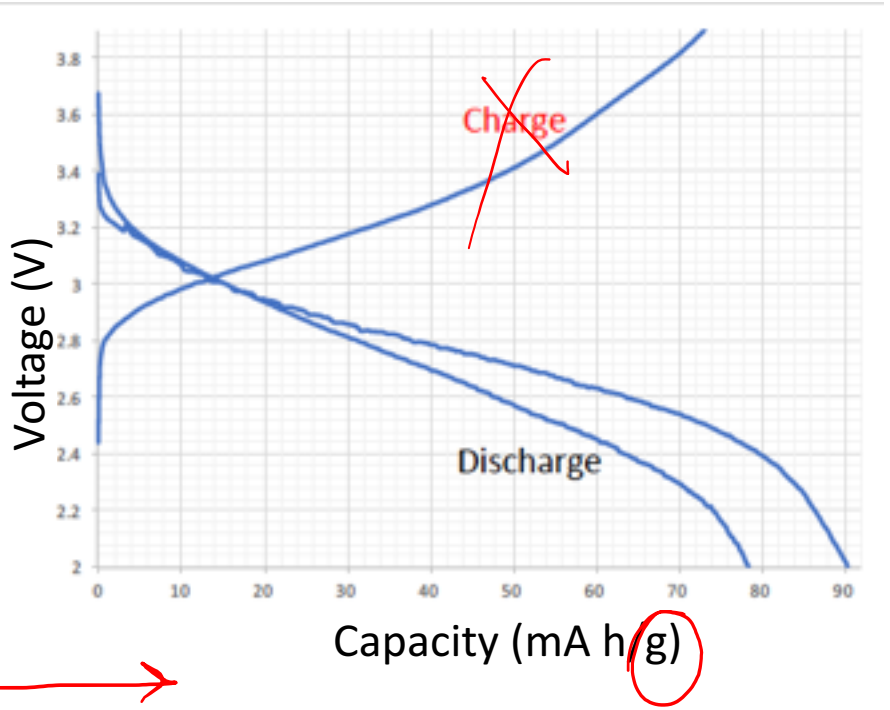

Convert

Today in lab…

- Battery Assembly in Belcher lab—Thank you to Jifa and Shuya!
  - 1st group: Red, Orange, Purple
  - 2nd group: Pink, Green
- Capacity calculations in lab: How does the type of NP-phage affect battery capacity?
  - Add battery details to the wiki today!
- Get TEM & EDX images before you leave
- *Use your time wisely:*
  - Improve your research proposal slides
  - Practice your presentation
  - Ask for feedback