

M3D5: Battery assembly and testing

12/07/2016

Bonus: “20.380 BE Senior Design” pitch presentations
at 9am in Simmons Hall tomorrow Thursday, December 8th



The final countdown...

- Lab notebook entry
 - M3D3 graded by Emily at 10pm tonight
- No lecture Thursday
- M3 research proposal
 - slides due on Stellar Friday, December 9th at 1pm
 - bring **one print-out of your slides** to 16-336
- M3 mini-report
 - due on Stellar at 10pm Monday, December 12th
 - (background + overall approach), TEM images, elemental map (spectrum), charge/discharge plot, capacity value, class-wide data analysis
- Blog posts
 - due Wednesday, December 14th

Module 3 overview: biomaterials engineering

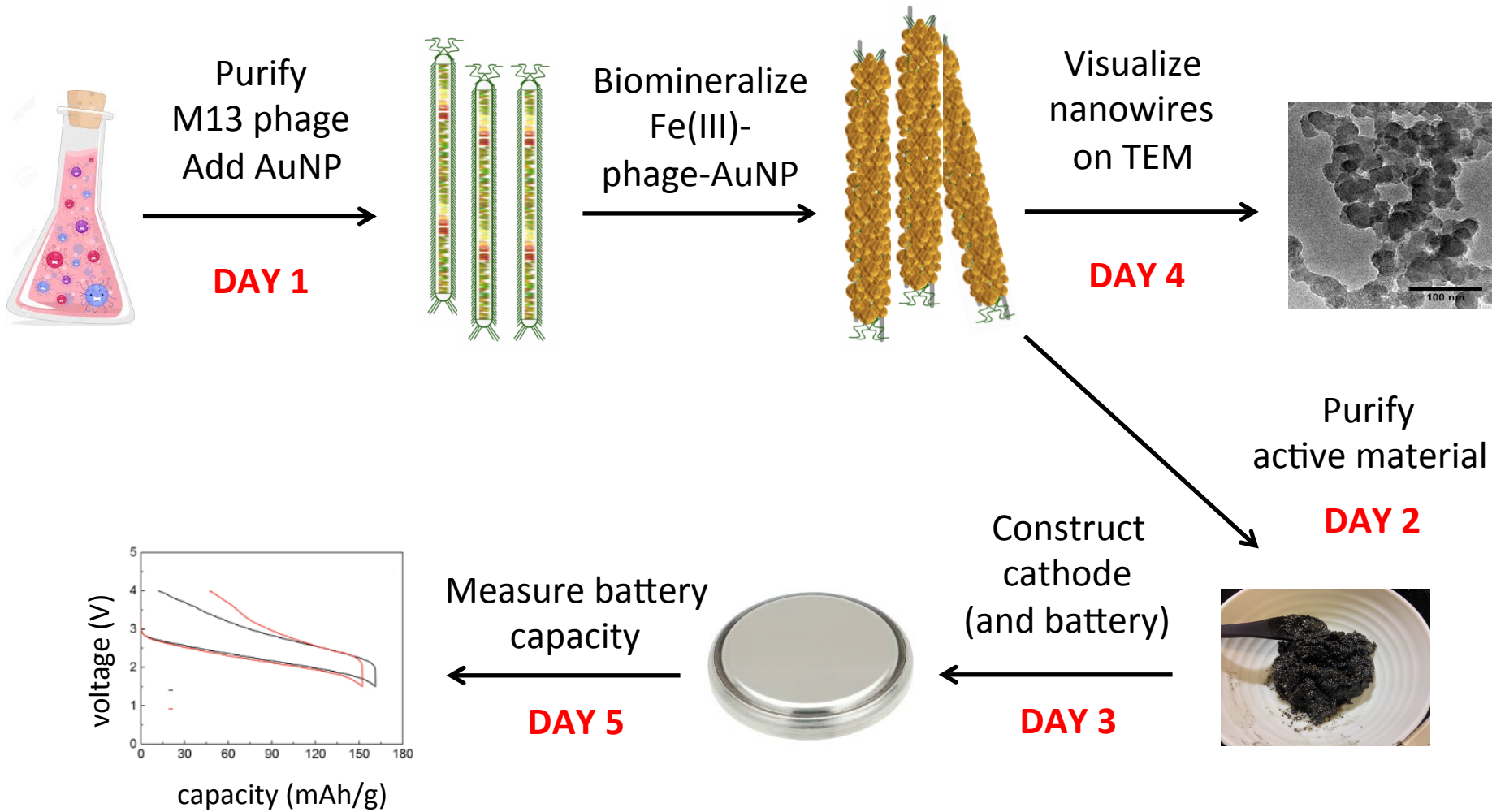
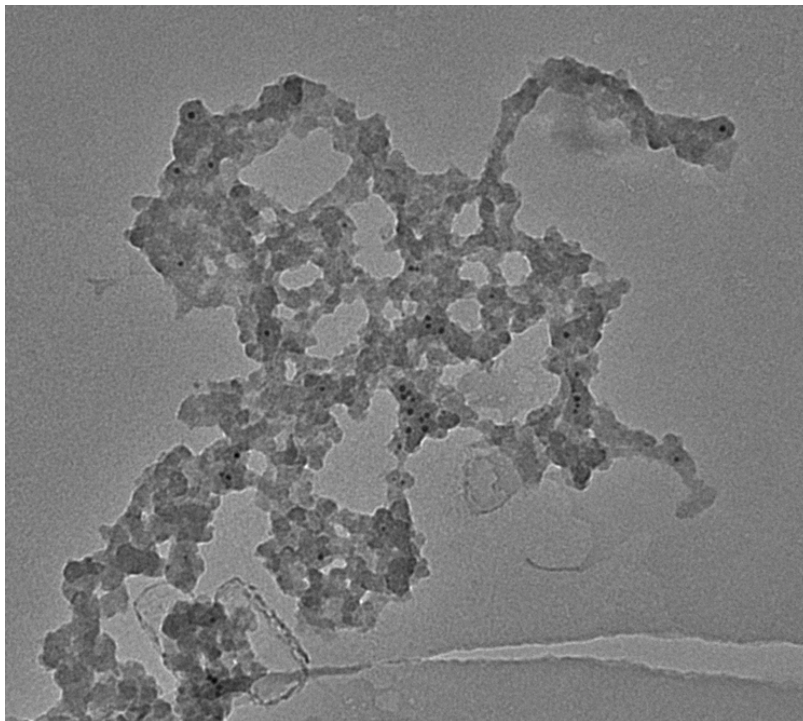


Figure: TEM images

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



also use control 'no gold' images

- at high magnification:
 - size of gold nanoparticles
 - lattice of gold atoms (*i.e.* 111)
 - amorphous vs. crystal Fe(III)PO_4
 - diameter of nanowires

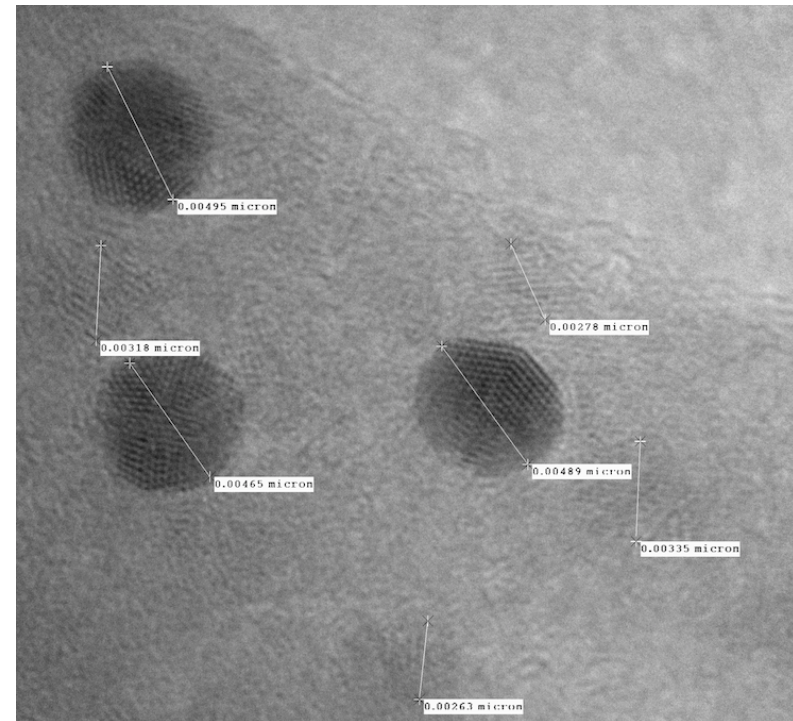
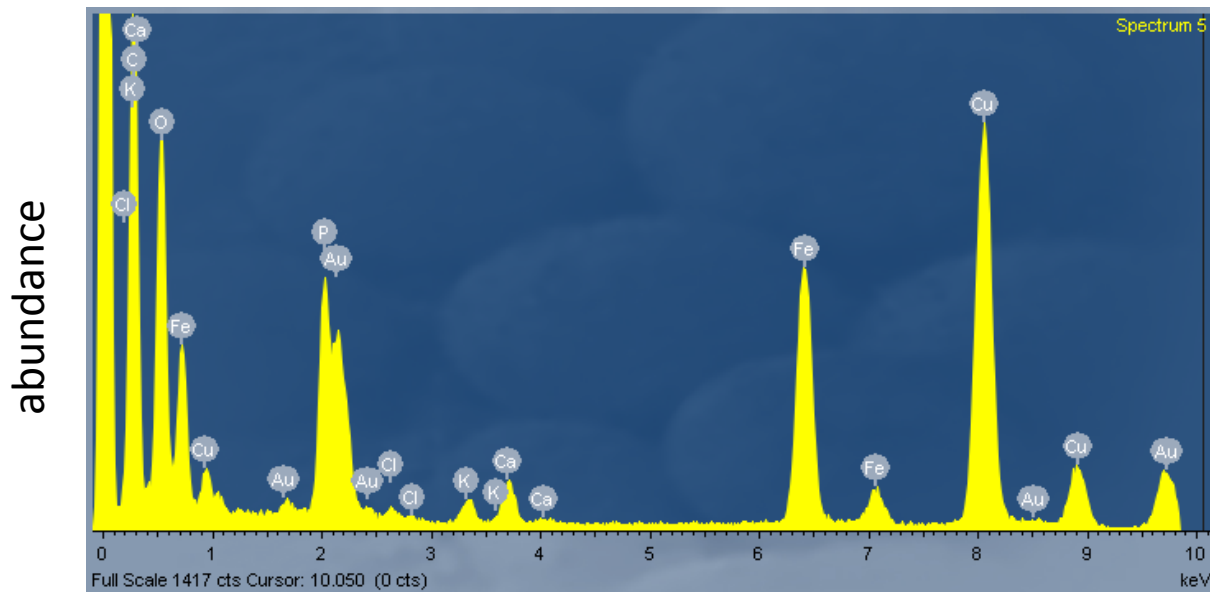


Figure: EDX elemental mapping

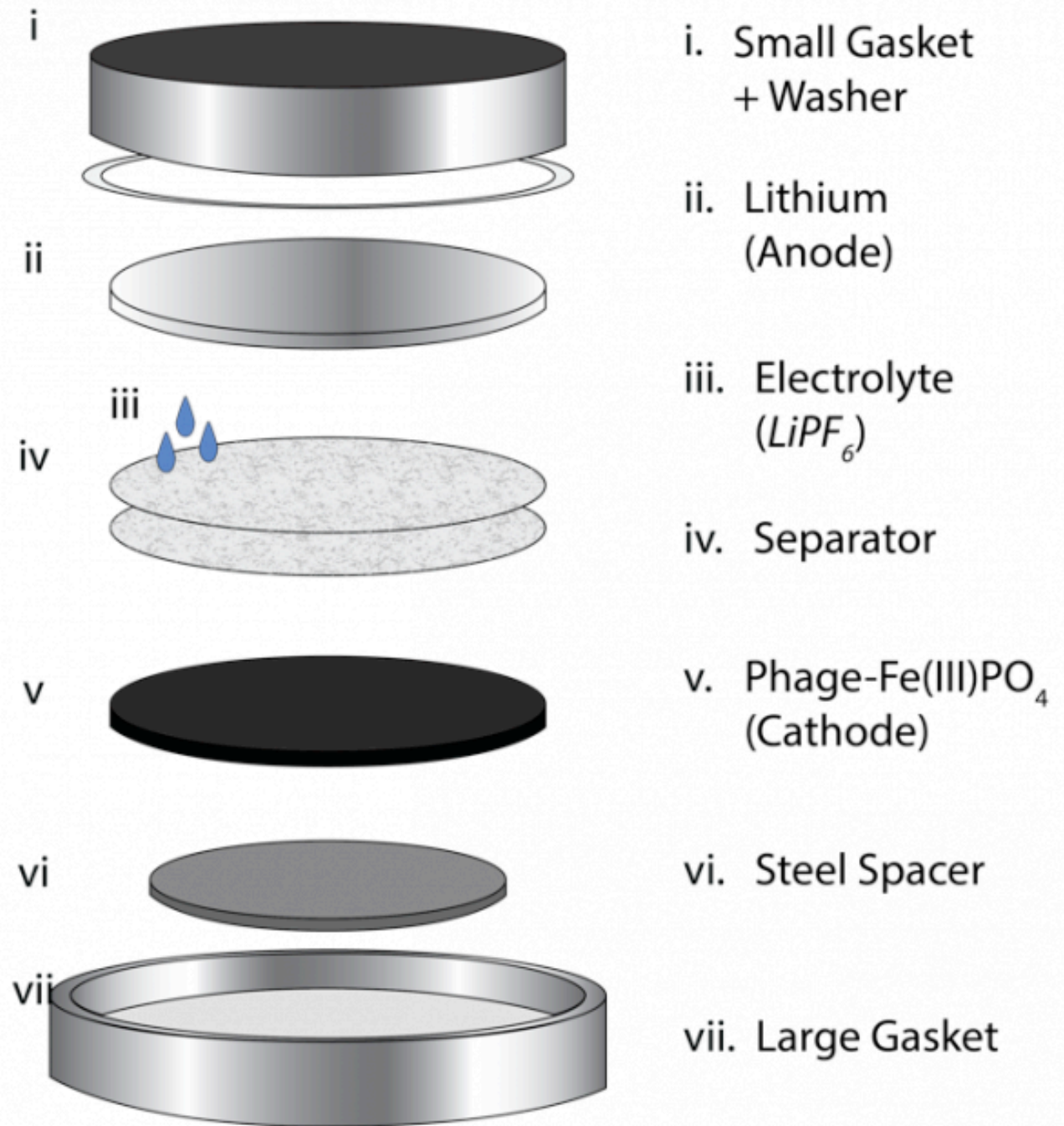
- expected: Fe, P, O, Au, (Cu)
 - contamination? Na, Cl, K, Ca (from diH₂O)
 - Si
 - stoichiometric ratios?

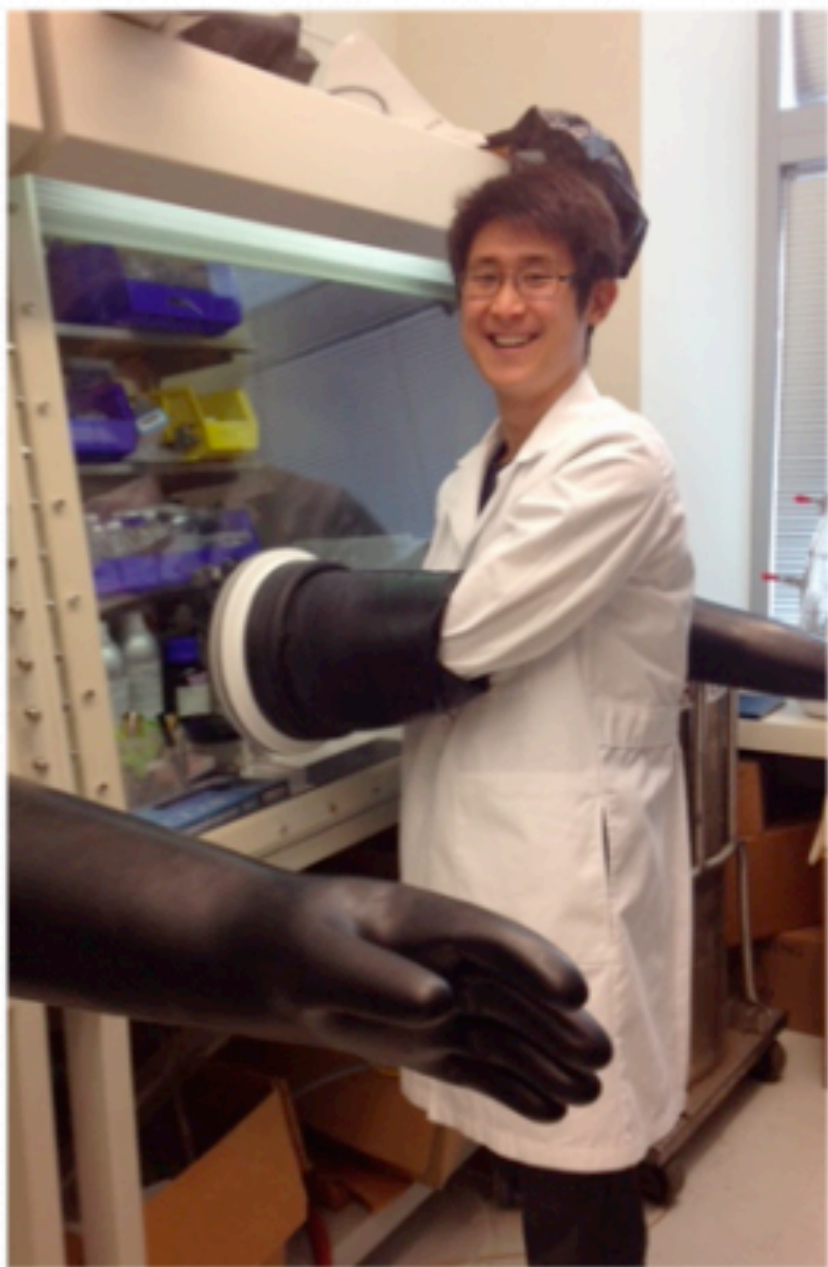


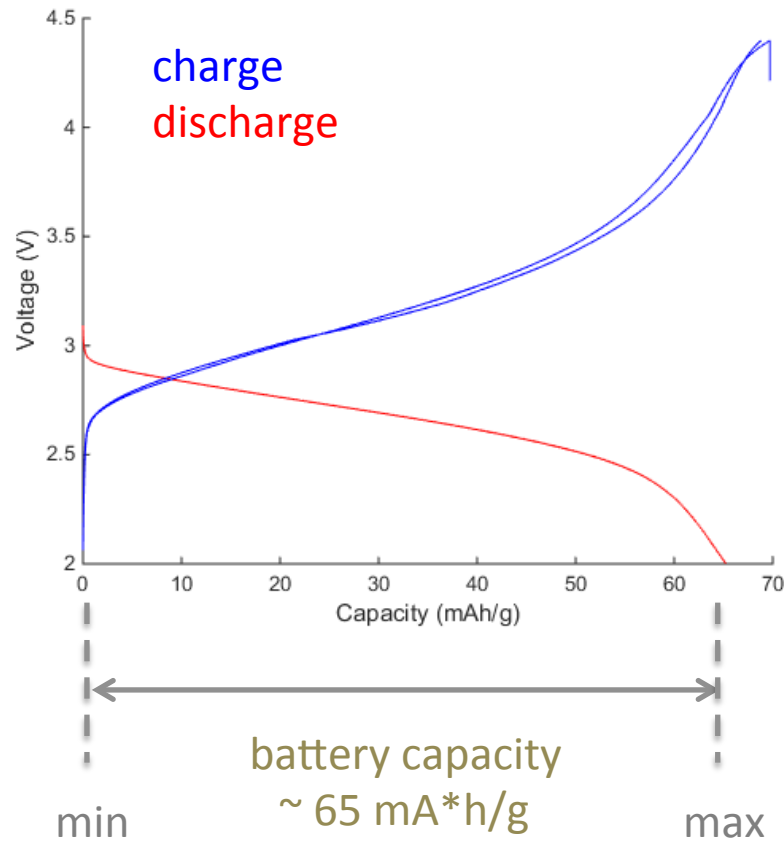
keV (energy)

Element	Atomic%
C K	55.01
O K	22.88
P K	5.04
<u>Cl</u> K	0.24
<u>K</u> K	0.46
Ca K	0.77
Fe K	5.46
Cu K	9.34
Au L	0.79
Totals	

Today: Battery assembly







Result / figure: Battery capacity

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

- Galvanostat:

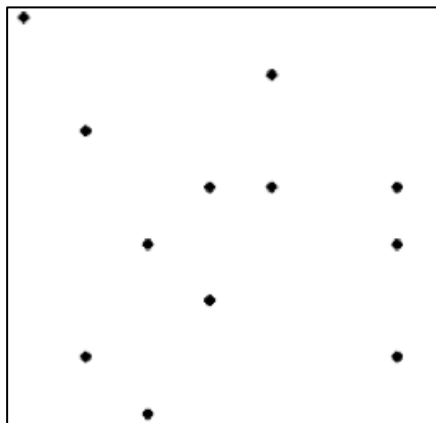
- keep current constant (- 89 mA/g for 2h discharge)
- record voltage (ideally constant)
- as charge (capacity) stored in battery fluctuates (drops during discharge)

Battery capacity calculation

	A	B	C	D	E	F	G	H	I
1	Time	Voltage (V)	Current (A)	Charge (Ah)	Capacity (Ah/g)	during discharge:			
2	00:01.0	3.086303711	-0.000000005	-2E-12		M = max capacity			
3	00:02.0	3.086791992	-0.000000006	-3E-12		m = min capacity			
4	00:03.0	3.087158203	-0.000000005	-5E-12					
5	00:04.0	3.087524414	-0.000000004	-6E-12		battery capacity = M - m			
6	00:05.0	3.087890625	-0.000000005	-7E-12					
7	00:06.0	3.088256836	-0.000000005	-8E-12					

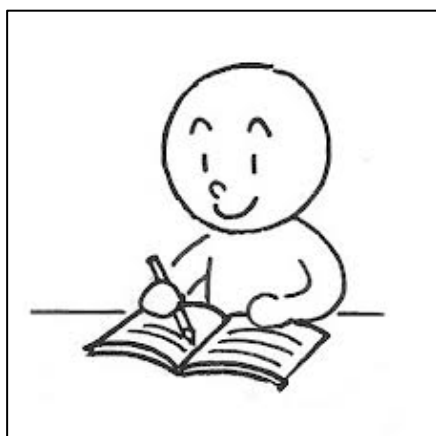
- Ensure capacity units are A*h/g
- Remember cathode is (in weight)
 - 70% active material: 63% Fe(III)PO₄ + 7% phage
 - 25% Super P carbon
 - 5% PTFE binder

Does gold size affect battery capacity?



- Use class-wide data
 - `.xlsx` from Jifa for all capacities
 - M3 main Discussion page for AuNP size

Today in lab:



- Demo in Belcher Lab
- Refine your M3 research proposal
- or finish your M3 mini-report early?! 😊