# M3D2:Purify active material 11/16/2016

- 1. BE Communication lab workshop: Research Proposals!
- 2. Prelab
- 3. Demo of FePO4-phage reaction
- 4. Collect and wash active material: AuNP-Fe(III)-phage nanowires
- 5. Prepare TEM samples
- 6. Prepare active material for 80°C vacuum oven

### Congratulations! You're almost done with Mod2



- ✓ Office hours Saturday 11/19 10am-5pm
- ✓ Research report: Due SUNDAY 11/20 at 5pm
- ✓ Blog by Monday 11/21 at 5pm

#### M3 research proposal

- HW due M3D3 in teams: refine your topic and approach, doesn't have to be your final proposal, get feedback during downtime(s)
- During lecture Tuesday 11/22 team elevator pitches
- Quiz on M3D3

#### Module 3: biomaterials engineering PEG:hydrophilic, active material: participates in electrochemical charge/discharge aggregates and need high resolution to see reaction, precipitates phage 🔀 Visualize nanostructures **Biomineralize** Purify nanowires Fe(III)-phage M13 phage on TEM +AuNP DAY 4 **DAY 1** Purify measure discharge and active material recharge cycles= removing salt and water Construct calculate capacity cathode Measure battery voltage (V) (and battery) capacity **DAY 5** DAY 3 120 150 180

capacity (mAh/g)

# **Phage Biomineralization**

- **P8** coat protein modified to include DSPHTELP, <u>**neg</u></u> charged peptide</u>**
- Gold nanoparticles (AuNP •) incubated with phage for 24 hours after M3D1.
- Next phage/AuNP incubated in  $(NH_4)_2Fe(SO_4)_2$  as a source of Fe<sup>3+</sup> >12 hours

24hrs

6 hours

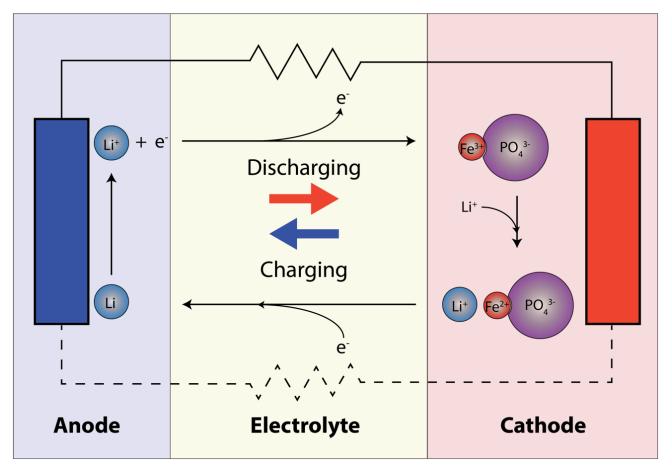
Fe<sup>3+</sup>

Fe<sup>3+</sup>

- 90% efficiency!
- $Fe^{3+}$  back into solution if wait > 12 h
- $PO_{4}^{3-}$  from NaPO<sub>4</sub> precipitates Fe(III)
- nucleation / accumulation / mineralization ensues
  - amorphous (a-FePO<sub>4</sub>), not crystal
  - promising cathode material

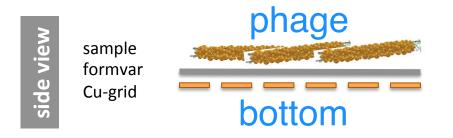
# Diagram of Mod3 battery

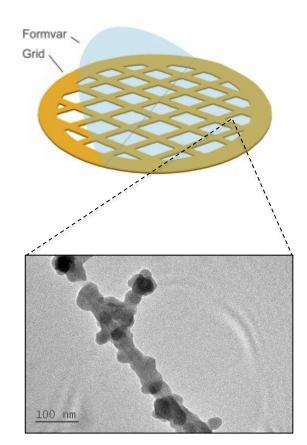
M13 phage: <u>Scaffold</u> AuNP:<u>electrical conductor</u> Fe(III) PO4: <u>ion storage</u>



## Set aside Fe(III)-phage-AuNP for TEM inspection

- The Fe(III)-phage-AuNP active material is in its purest form
  no impurities, binder, etc.
- Formvar coated Cu-grid
  - copper-orange side
  - ✓ <u>silver/black side</u> where droplet deposited
  - Practice handling it with tweezers

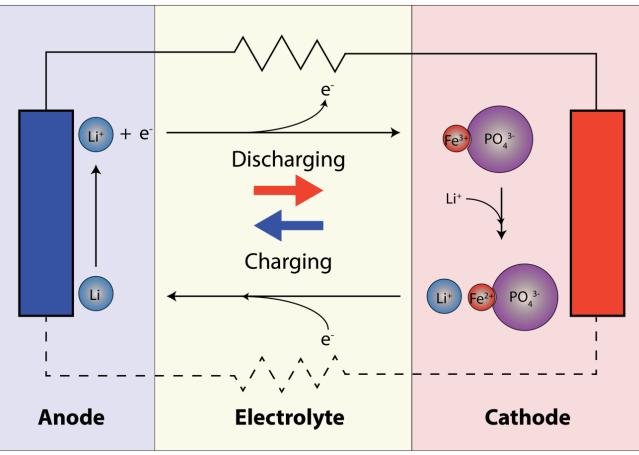




#### 2 samples: undiluted and 1:10 dilution

# What is your experimental question/ hypothesis?

Does gold nanoparticle size (4nm or 9nm incorporated into the cathode active material) affect battery capacity?



# In lab today...

- 1. Demo of FePO4-phage reaction write observations!
- 2. Collect and wash active material (lots of long spins!)
- 3. <u>Practice</u> then prepare TEM samples
- 4. Prepare active material for 80°C vacuum oven
- During the downtime you should discuss and choose a topic for M3D3 homework (and potentially beyond!) submitted as a pair/team
- Remember class time 11/22 Prof. Belcher would like to hear elevator pitches from as many of you as possible.