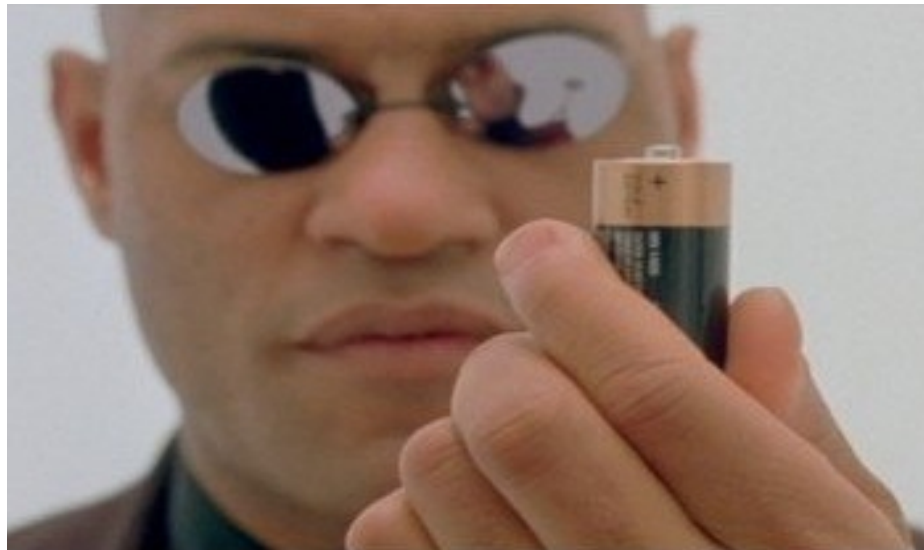


M3D3: Cathode construction

11/28/2017

1. Quiz
2. Prelab Discussion
3. Construct cathode material (Belcher Lab)
4. Research Proposal Peer Review Exercise
(20.109 lab)

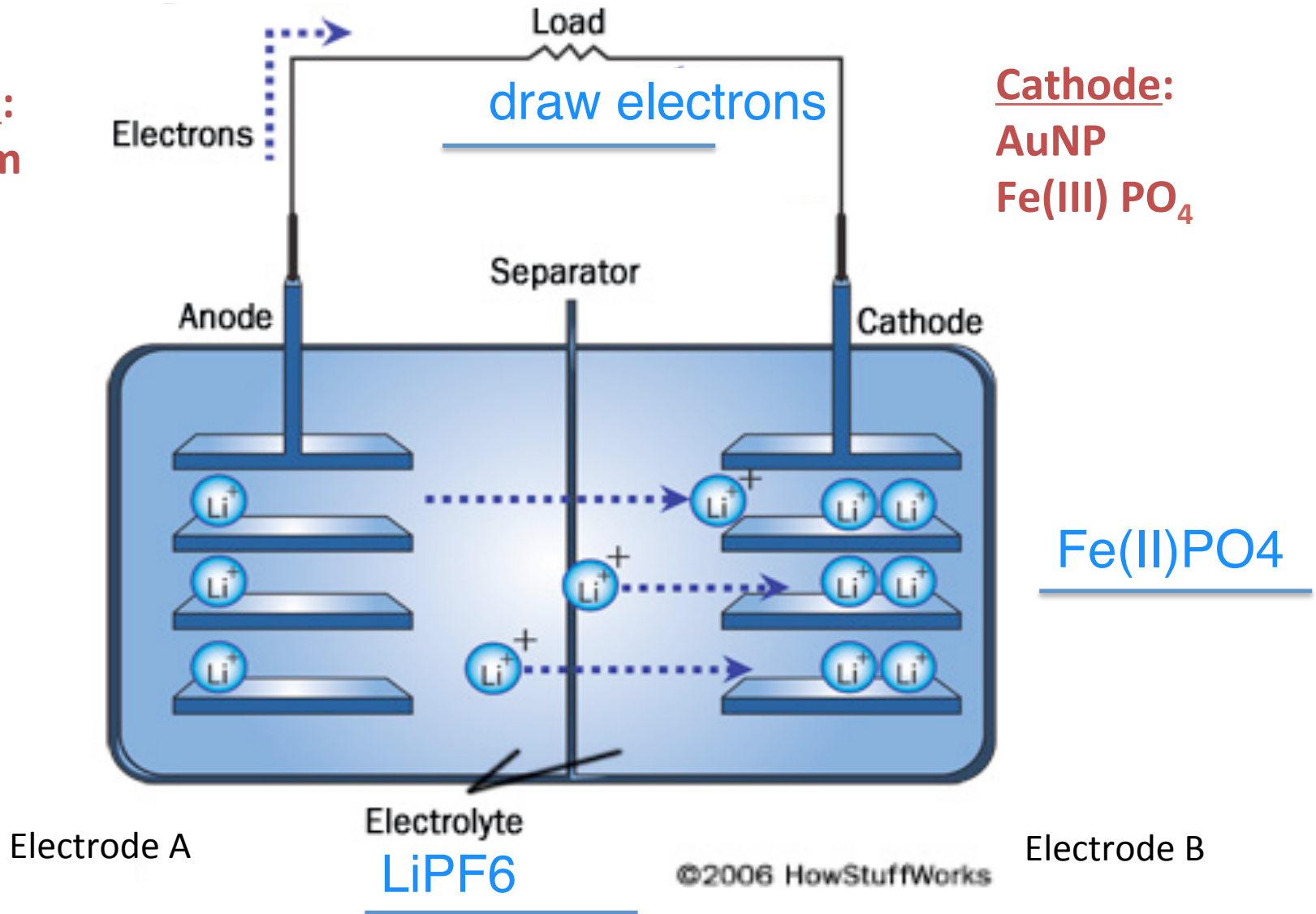


- ***M3 major assignments***
 - Research proposal (20%), slides due 12/7 at 1pm
 - Mini-report (5%), due 12/11 at 10pm
- **M3D4 Homework, Both parts submitted as a team**
 - Research Proposal Presentation outline (wiki, google doc, benchling)
 - ***address topics in HW prompt for full credit***
 - Outline Background and Approach for mini-report ***with references***
 - <http://belcherlab.mit.edu/publications/>

Is this battery discharging or charging?

Anode:
Lithium

Cathode:
AuNP
Fe(III) PO₄



Cathode is (+) During Spontaneous Discharge

Reduction

occurs at the cathode (accepts e^-)

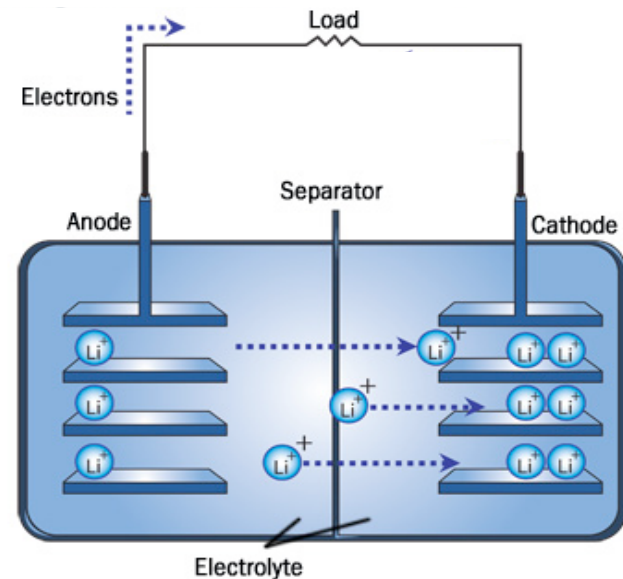
Oxidation

occurs at the anode (donates e^-)

Electrons flow from

negative to positive

So on the right, we have the cathode AND the positive electrode



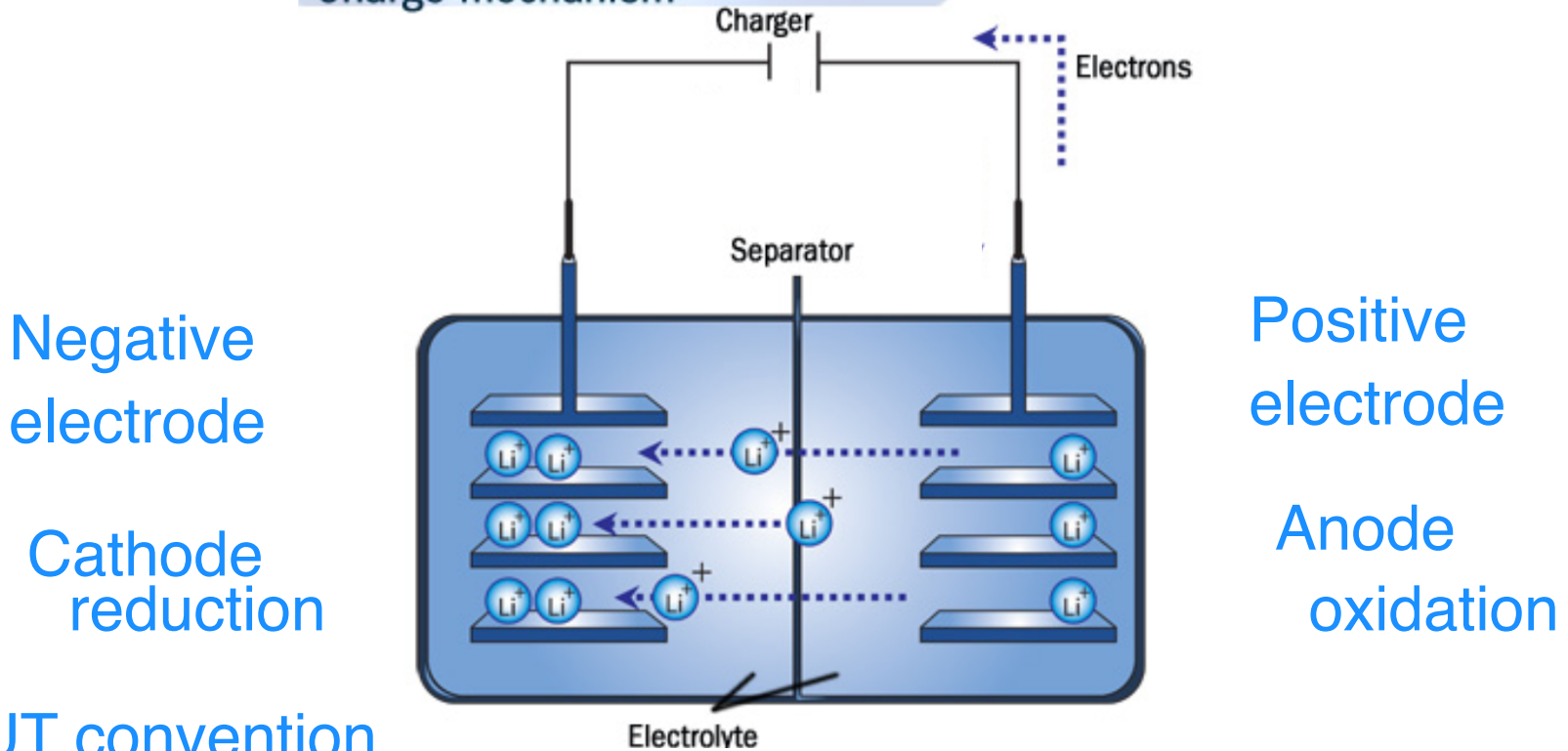
©2006 HowStuffWorks

Electrode A

Electrode B

During (re)Charge, Electron Flow is Reversed

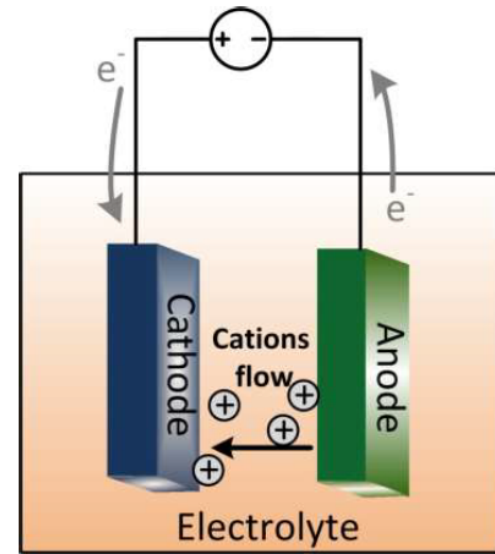
Lithium-ion rechargeable battery
Charge mechanism



BUT convention
is to describe the cathode as positive
(spontaneous discharge)

What is battery capacity?

- Quantity of electricity (charge) involved for the electrochemical reaction between the active materials in the battery
- For our Fe(III)-phage batteries, the theoretical (gravimetric) specific capacity is 178 mA*h/g
- Units: $\text{charge} / \text{time} * \text{time} / \text{mass}$
- Capacity calculated from
 - total # of electrons that can be accepted
 - charge of those electrons
 - and atomic mass
- Why will our batteries not achieve theoretical specific capacity?
 - side reactions
 - purity
 - additives contribute to mass (denominator) but not capacity



from Dr. Maryam Moradi

How do phage scaffolds improve batteries?

- Ion diffusivity → nano structuring active material
 - What is the advantage of nano structures?
increase surface area: volume
- Electronic Conductivity → integrating additives
 - How do phage improve integration of additives?

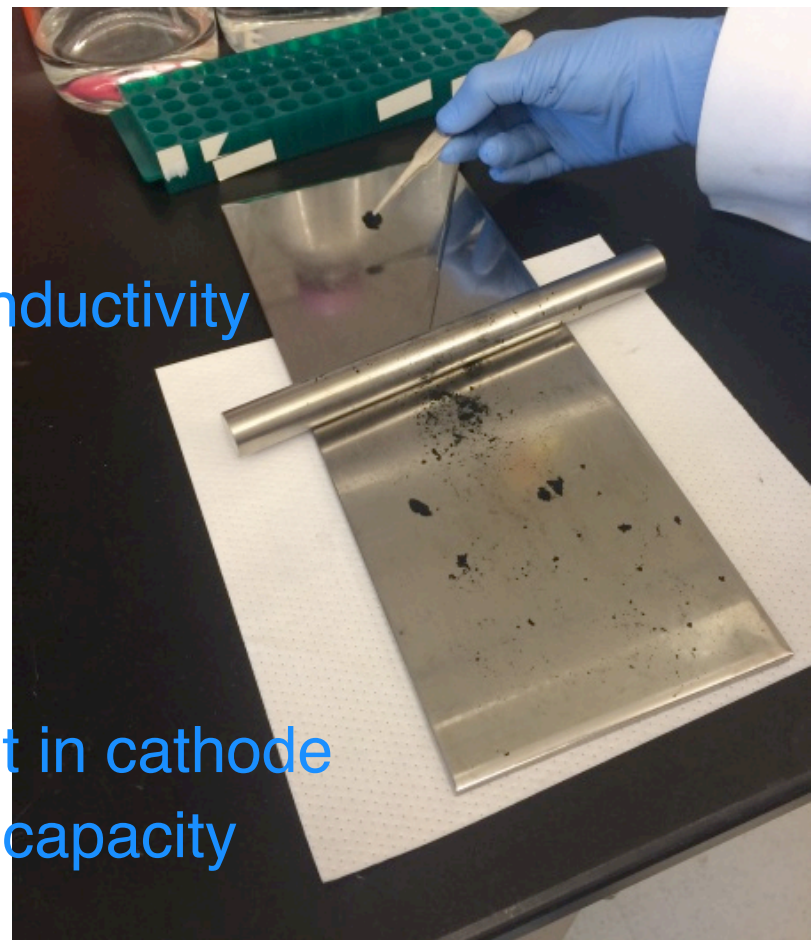
binding of phage to additives / structured material
ability to find/select useful phage for binding additives
Example: Adding carbon nanotubes to phage cathode
through phage display



from M.Moradi

How will you construct your cathode?

1. Weigh AuNP-Fe(III)-phage nanowires (active material)
2. Mix with Super P ^{carbon} and PTFE ^{binder}
 ^{increase conductivity}
3. Roll cathode material into thin sheet
4. 'Punch out' cathode disc
5. Weigh cathode _(why?) ^{- control amt in cathode}
6. Dry cathode _(why?) ^{** calculate capacity}
 ^{improve binding}



Today in lab...

1. Construct cathode Belcher lab
 - bring lab coat and eye protection
 2. Research proposal peer exercise
 - everyone must be the “presenter” and “listener” at least once
 - partner assignments will depend on timing of cathode construction
- M3D4HW: (see slide 2) You cannot make major changes to your research proposal idea after Thursday (11/30)!