6.772 Compound Semiconductor Materials and Devices

Conducting Polymeric Materials as They Pertain to Supercapacitors

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Presentation Outline

- Uses of Conducting Polymers
- Overview of Supercapacitors Technology
- Activated Carbon (AC) Supercapacitors
- Electrically Conducting Polymer (ECP) Supercapacitors
- Hybrid Supercapacitors
- Reference List

Uses of Conducting Polymers

- Light emitting diodes (LEDs)
- Laser materials
- Photoconducting devices
- Electrochromic cells and displays
- Solar cells
  - Photovoltaic and photoelectrochemical
- Energy storage applications
  - Solid-state rechargeable batteries
  - Supercapacitors

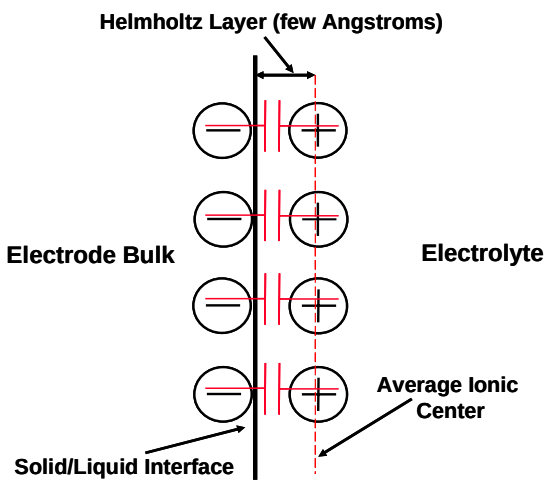
Overview of Supercapacitors Technology

- Very high capacitance per unit volume and weight
- Low voltage devices (~3V)
- Superior charging/ discharging efficiency
- Cycleability of device exceeds the lifetime of most applications

AC Supercapacitors

$$C \propto A/d$$

- Small charge separation
- High surface area (1500-2400 m^2/g)



ECP Supercapacitors

Many ECPs to choose from:

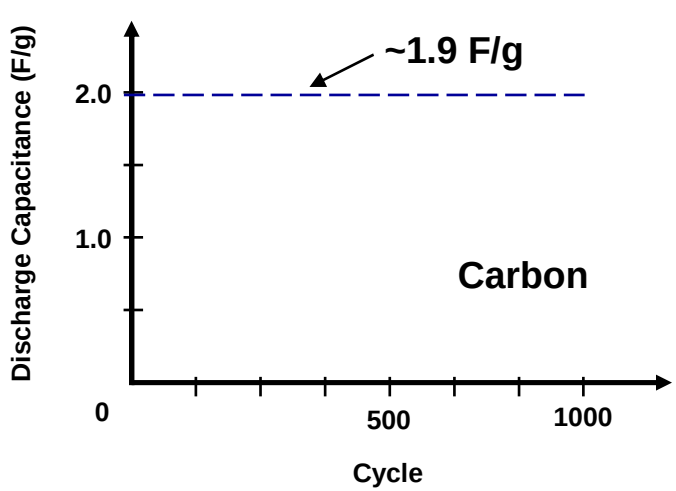
- Polyaniline (Pani)
- poly(3-methylthiophene) (pMeT)
- poly(dithieno[3,4-b:3',4'-d]thiophene) (pDTT1)
- poly(3-p-fluorophenylthiophene) (pFPT)
- etc.

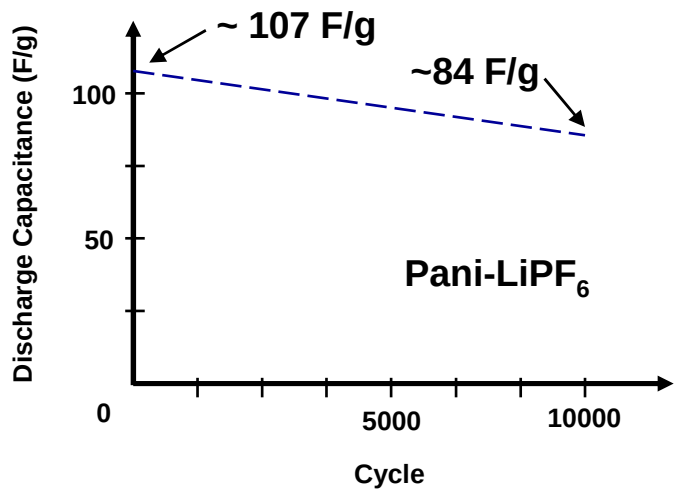
ECP Supercapacitors: Pani

- Electrode
  - Polyaniline
    - » High enviormental stability
    - » Controllable electrical conductivity
    - » Easy to process
  - Pani-$LiPF_6$
    - » Pani doped with Li ion salt
- Electrolyte
  - Et_4NBF_4 in acetonitrile (AN)

ECP Supercapacitors: Pani

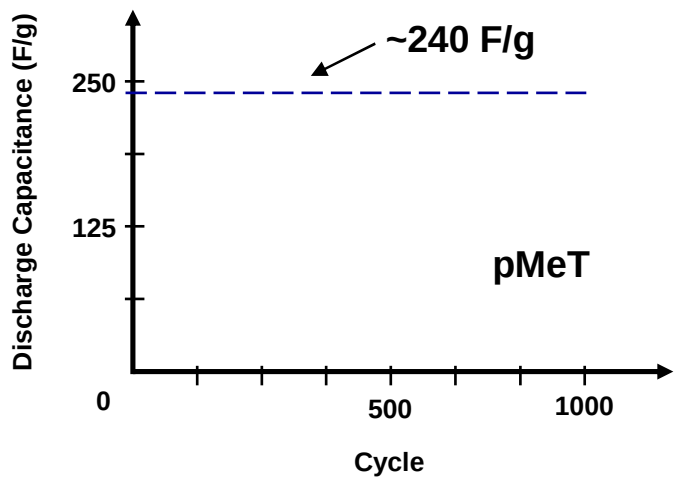
- Cycle-life Comparison:
  - Conductive carbon electrode
  - Pani-$LiPF_6$ electrode





ECP Supercapacitors: pMeT

- pMeT on Pt electrode by monomer oxidation
- Composite Electrode
  - Mixture of pMeT, conducting additive (carbon), binder (carboxy methyl cellulose)



Hybrid Supercapacitors

pMeT (p-electrode)

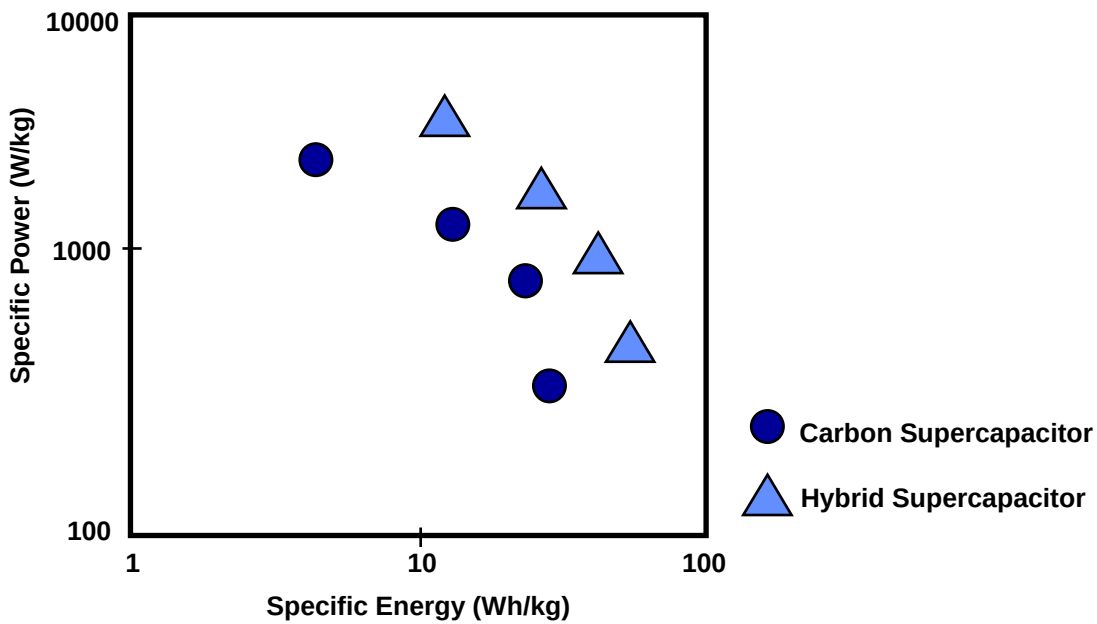
n/p pMeT	p-electrode	n-electrode
Capacitance (F/g)	240	180
Capacity (mAh/g)	70	30
Resistance	low ($2\Omega cm^2$)	very high

Activated Carbon (n-electrode)

Material Capacitance	p-electrode	n-electrode
AC1	74 F/g	84 F/g
AC3	125 F/g	158F/g

Hybrid Supercapacitors

Hybrid device performance is superior to carbon based devices



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Thank You

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