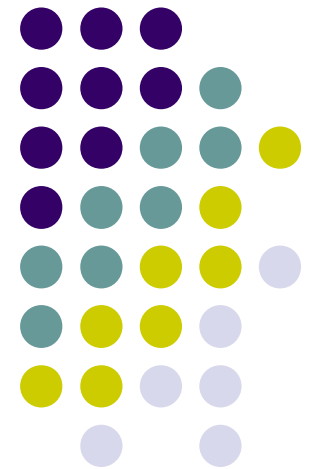
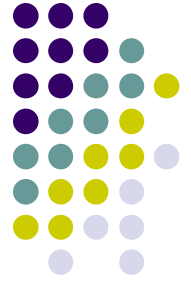


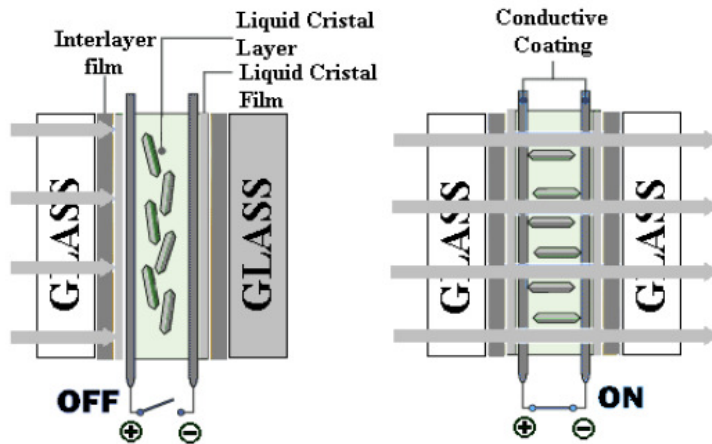
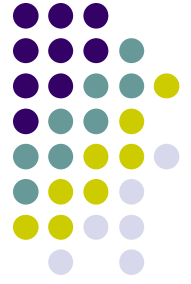
# Electrochromic Glass



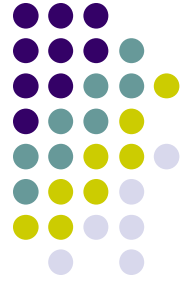


- 3% of the United States' energy use is spent on heating and cooling indoor space
- Costs \$26 billion/year
  
- Electrochromic glass prevents solar heat, reducing the need for air conditioning
- Maximizes sunlight reducing need for electric lighting.

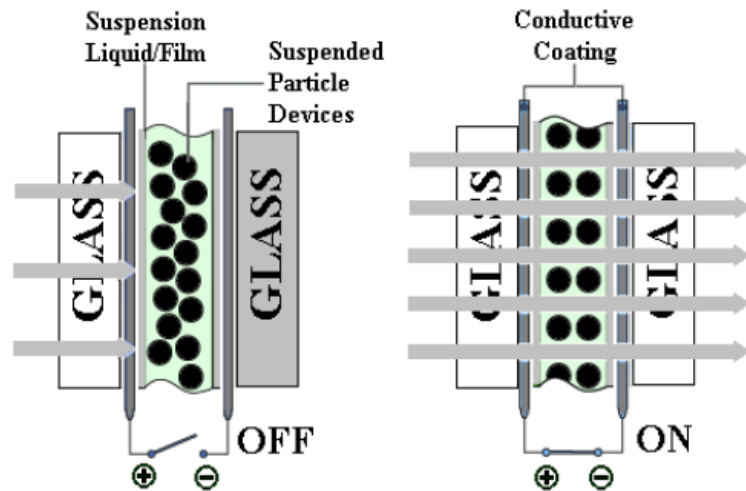
# Polymer dispersed Liquid Crystals



- Off-liquid crystals are randomly oriented, scatter light. Milky white opaque.
- On-liquid crystals align and let light pass through. Transparent.
- No variation
- Needs constant voltage in On state

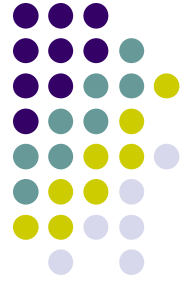


# Suspended Particle Devices

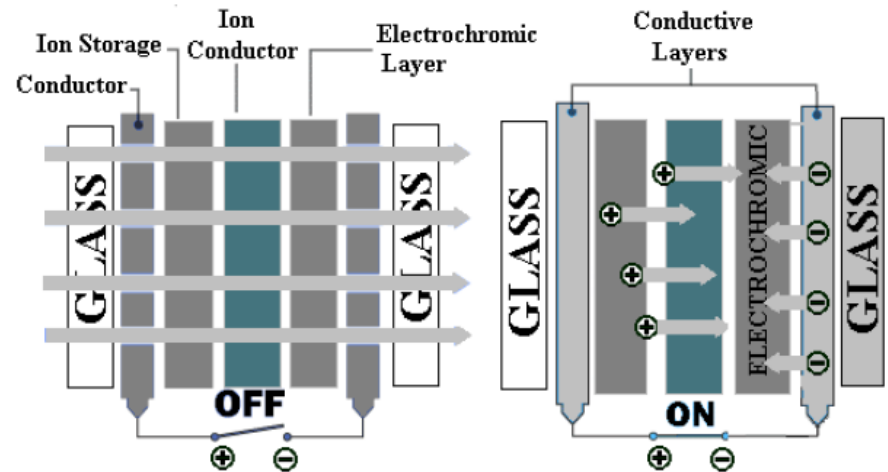


- Off-particles absorb light. Dark blue opacity
- On-particles align and let light through. Transparent.
- Variation in transparency
- Constant voltage to remain On.

# Electrochromic devices

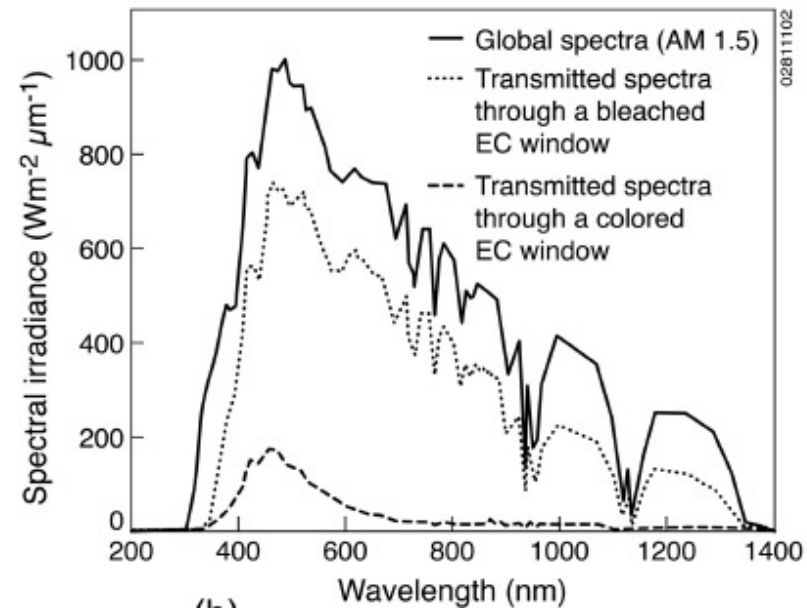


- On-oxidation reaction causes electrons to be stored in ion storage region. Transparent.
- Off-ions forced from storage area into electrochromic area. Opaque.
- Variable transparency
- No voltage needed to remain on

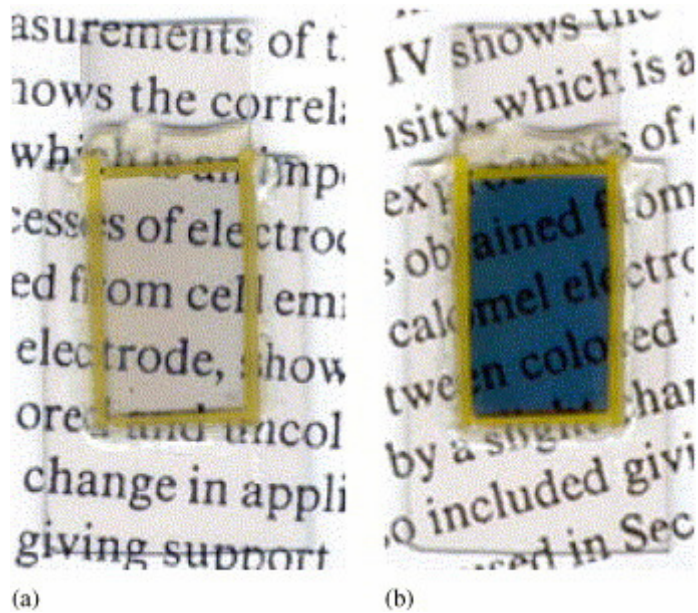
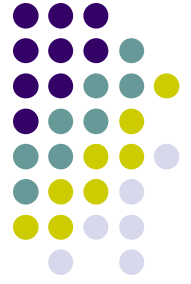




- Requires 100 milliseconds to 60 seconds to change state
- 0.5 to 3 Volts to operate one window.
- Same cost as running a 75 Watt light bulb



# Electrochromic materials

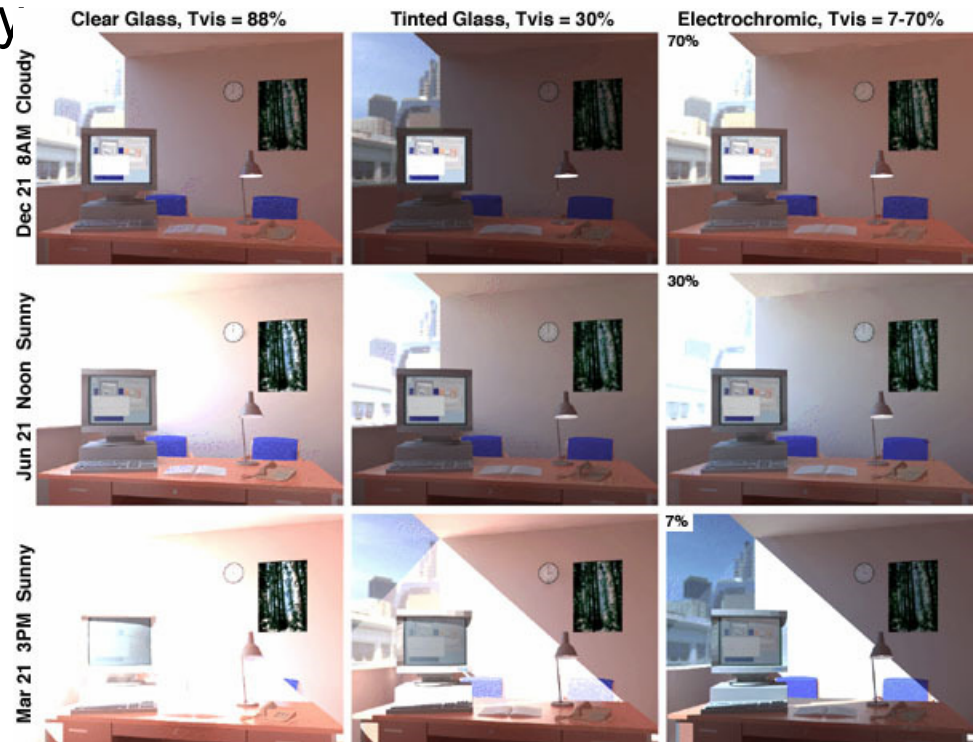


- Absorbed organic polymers
- PEDOT nanotubes
- WO<sub>3</sub>
  - better lifetime, UV stability, transition time
  - Grown into nanowires via VS method on a indium, tin oxide coated glass

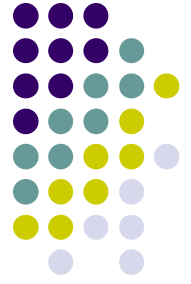


# Advanced Windows Testbed

- Located in Lawrence Berkeley National Laboratory
  - Divided into 3 thermally separate rooms with sensors
  - 18x35" and 6-7 min transition time
  - 48 to 67 percent annual lighting energy savings compared to the control
  - 19 to 26 percent annual cooling energy
  - Increased savings in warm areas
  - Volunteers



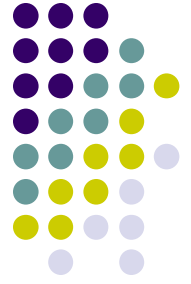




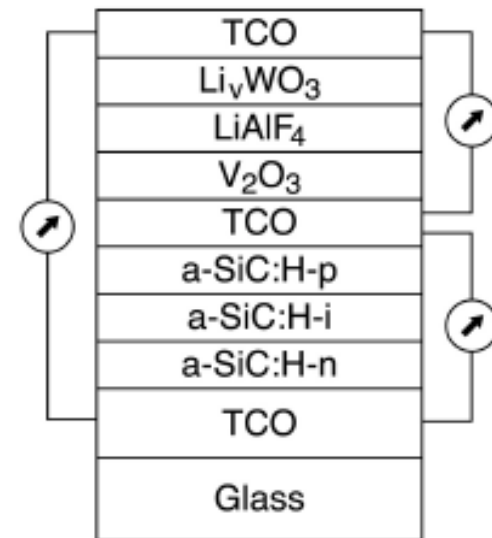
# Reflective Electrochromics

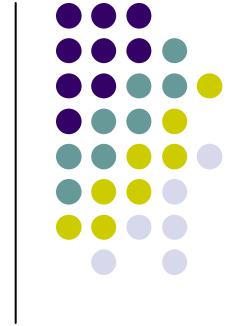
- Made from transition metal hydrides.
  - Created by exposing metal to hydrogen gas
  - Most common are thin Ni-Mg films
    - Exposed to H<sub>2</sub> gas -> become transparent due to formation of Mg<sub>2</sub>NiH<sub>4</sub>
    - Single target cosputtering
- Created by Discovered by Tom Richardson and Jonathon Slack of Berkeley Lab's Environmental Energy Technologies Division
- Have low emittance coatings to reject unwanted thermal heat due to solar infrared
- WO<sub>3</sub> and NiO-used in cars such as as Audi, Bentley, BMW

# Renewable Energy



- Side by Side Solar panel
- Monolithic tandem
  - Transparent PV coating
  - SiC:H due to semitransparency
  - Need to reduce thickness
- Sye-sensitized solar cell electrode with electrochromic film
  - Deposit the electrochromic film on the counterelectrode of a dye-sensitized solar cell
  - Voltage produced by electrode drives electrons and  $\text{Li}^+$  from  $\text{WO}_3$  causing opacity





**Questions?**