



Solar Cell Manufacturing and Code Compliance

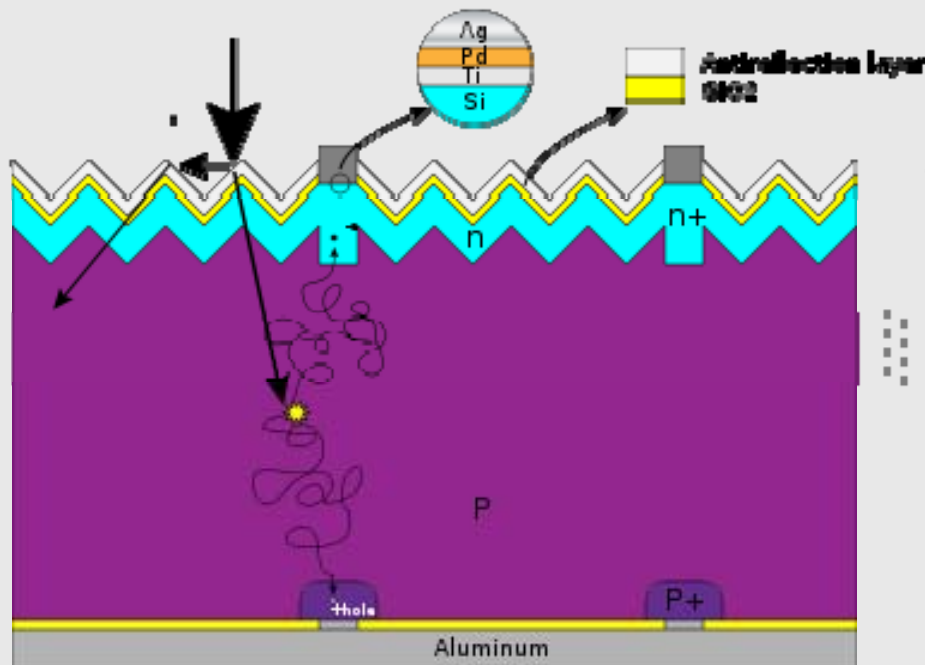
Ben Hertzler, Facilities Manager
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Solar Cell Process



- Amorphous
- Monocrystalline- **Czochralski**
- Cadmium Telluride
- CIGS(Copper Indium Gallium (di)Selenide)
- Multi/poly-crystalline
- UMG
- other

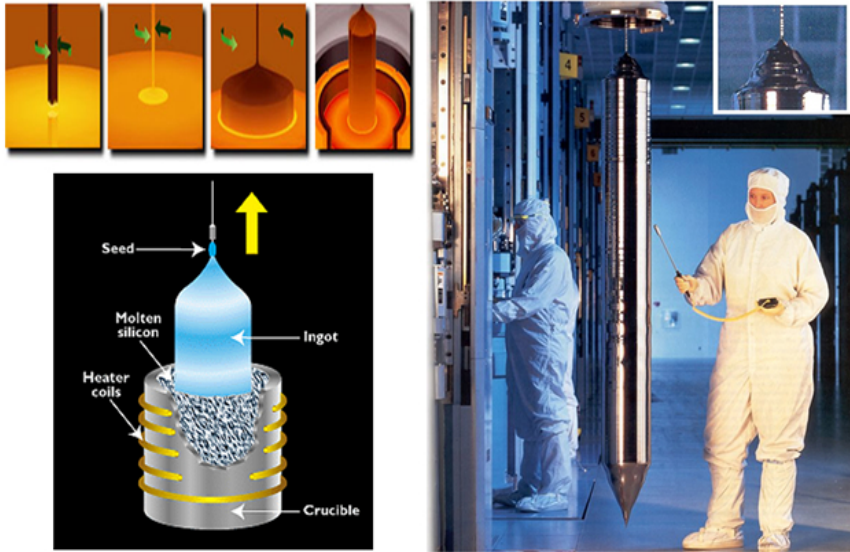
How they work...



Courtesy: http://en.wikipedia.org/wiki/Solar_cell

- Large Diode
- P-N Junction
 - N = Negative (P, Ar, Sb)
 - P = Positive (B, Ga, In)
- Electrons transferred through conductors

Crystal Growing vs. Casting



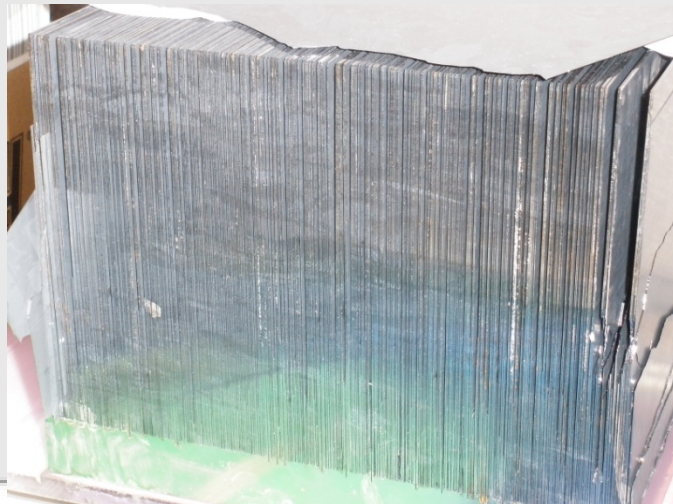
Courtesy: University of Portsmouth



Wafers and Cells



Courtesy: http://akreatika.com/pryroda_engineering/images_restricted/titan-p/Titan-P-06.jpg



Module integration



Chemicals Used



- Gases
 - Inerts (Argon, Nitrogen, Helium)
 - Silane
 - Ammonia
 - Oxygen
 - Dopant Gases (Phosphine, Arsine)
 - Nitrogen Trifluoride
- Liquids
 - Phosphorous Oxychloride (POCl_3)
 - Acids (HF, Nitric, Sulfuric, HCl)
 - Bases (KOH)
- Solids
 - Metals (Cu, In, Se, Ga, Si, Al, Ag, etc.)

Why Large Quantities?



- Surface area
 - Deposition and Etch
- High throughput(30x Semi)
 - High deposition rates
- Large tools/chambers
- Fewer chemicals, but higher volumes
- Large wet bath surface area

Facility Design



- The Process
- Large Equipment
- Manufactured outside the U.S.
- Most sold and installed outside the U.S.
- Emission/Effluent Data Collection Methods

Facility Design Issues



- Code Compliance Issues:
 - H Occupancy
 - WW Treatment/Tiered Permitting
 - Fluorides and Metals
 - Toxic Gas Ordinance
 - Cal-Arp Program

Before Plan Check



- Educate your economic development staff
- Propose a face to face meeting to review concept and proposed layout
- You should make sure that they understand setback requirements and quantity issues up front.
 - Silane Tube Trailers
 - Ammonia Y Cylinders
 - Liquids Quantities of xxx in buildings
 - Exterior Chemical Storage
 - Control areas
 - Proximity to sensitive receptors

Plan Check and Inspection



- Set expectation for inspections early
- Consistency
- Flexibility
 - Evolving process
- Be open to alternatives means and methods

Solar Power...does it really
make sense?

