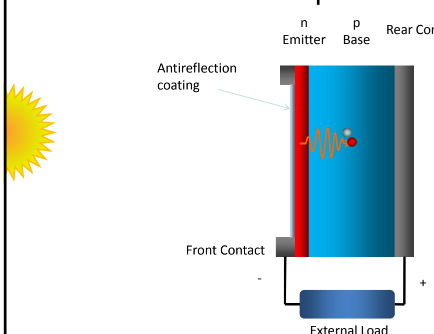
EE580 – Solar Cells
Todd J. Kaiser

- Lecture 10
- Summary

Summer 2010 Class

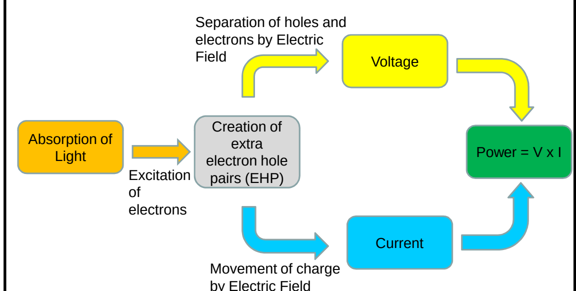
Solar Cell Operation



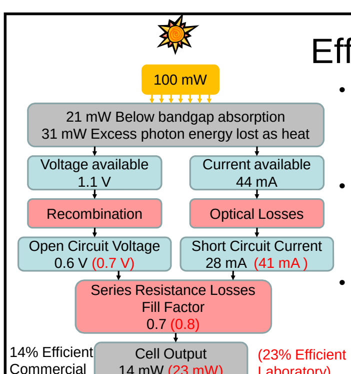
Absorption of photon creates an electron hole pair. If they are within a diffusion length of the depletion region the electric field separates them.

The electron after passing through the load recombines with the hole completing the circuit delivering power to the load

Photovoltaic Effect



Efficiency



- Over half of energy lost initially due to mismatch in photon energy and gap energy
- Trade off between EHP recombination and optical absorption (thickness of cell)
- Almost half of potential lost to recombination

Photovoltaic Myth #1

- Solar modules consume more energy for their production than they ever generate.
  - Most frequent argument and just as incorrect
  - Monocrystalline silicon energy payback is 7.3 years (1998)
    - Lifetime of 25-30 years will generate over 3 times the energy of production
  - Thin-film modules energy payback is 1.5 years (1998)

Photovoltaic Myth #2

- PV produces more greenhouse gases than it saves
  - Same argument as energy production
  - Greenhouse gas recovery time range between 2.4 – 3.6 years

Photovoltaic Myth #3

- Grid-connected PV requires lots of back-up fossil power plants
  - PV energy production coincides largely with peak demand
  - Wind can meet some needs. It has a different and partly opposite time dependence
  - Smart Grid will become widespread in the future. Demand control can be adapted.

Photovoltaic Myth #4

- Photovoltaics is too expensive
  - Indeed it is expensive but this is a transitory situation
  - Prices continue to fall
  - PV is long lived, reliable & unlimited potential
  - Long term benefits undeniable

Photovoltaic Myth #5

- PV is not ready for marketing, more research is required
  - Improvements of technology is stimulated by interactions with markets
  - Market driven improvements continues
    - Example: cell phones, digital cameras, laptops
  - Lower costs will materialize with feedback from markets and technology improvements

Photovoltaic Myth #6

- PV only makes sense in high insolation areas
  - Certainly true that PV modules can produce twice as much energy in high desert areas
  - But larger transmission costs and transmission losses
  - Distributed systems remove costs of transmission and metering, transmission losses, administration and taxes

Photovoltaic Myth #7

- PV involves toxic materials
  - Minimal toxic materials in silicon solar cells, but used in the purification and processing
  - The silicon purification technology is well controlled based on decades of experience from the integrated chip industry
  - Future recycling of modules will further reduce environmental impact

Photovoltaic Myth #8

- PV consumes valuable land area
  - Large projects use land that is not suitable for other applications
  - There is still a huge supply of unused roof, building, facade, and sound barrier space

Photovoltaic Myth #9

- PV competes for roof space with thermal collectors
  - Without question PV modules and solar thermal use the same southern roof space
  - Thermal collectors need only limited space due to higher efficiency (~70%)
    - For hot water 1 m^2 / person
  - Space heating only needed in winter
  - Thermal insensitive to partial shading → use in shadowing areas

Final Report

- Introduction
- Fabrication Processes and Theory
- Fabrication Sequence
- Solar Cell Theory of Operation
- Experimental Results
  - IV curve
  - Fill factor
  - Maximum Power
- Recommendations
  - Lecture Modifications
  - Laboratory Modifications
- Summary & implementation into your curriculum