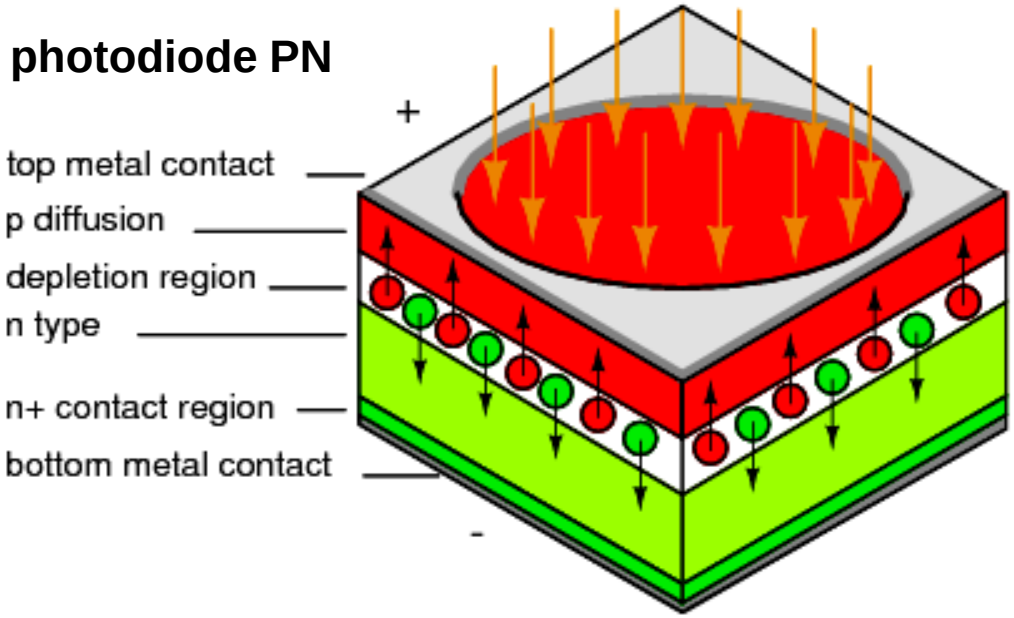
photovoltaics

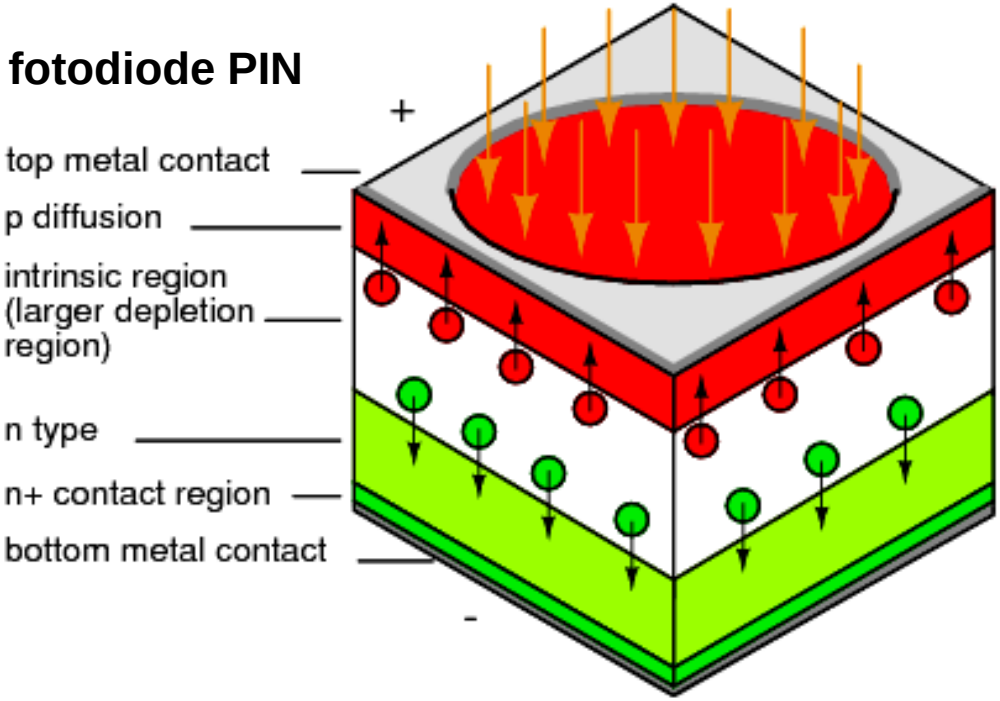
- **no electric polarization**
  diode = current source

light produces electromotive force

photodiode PN

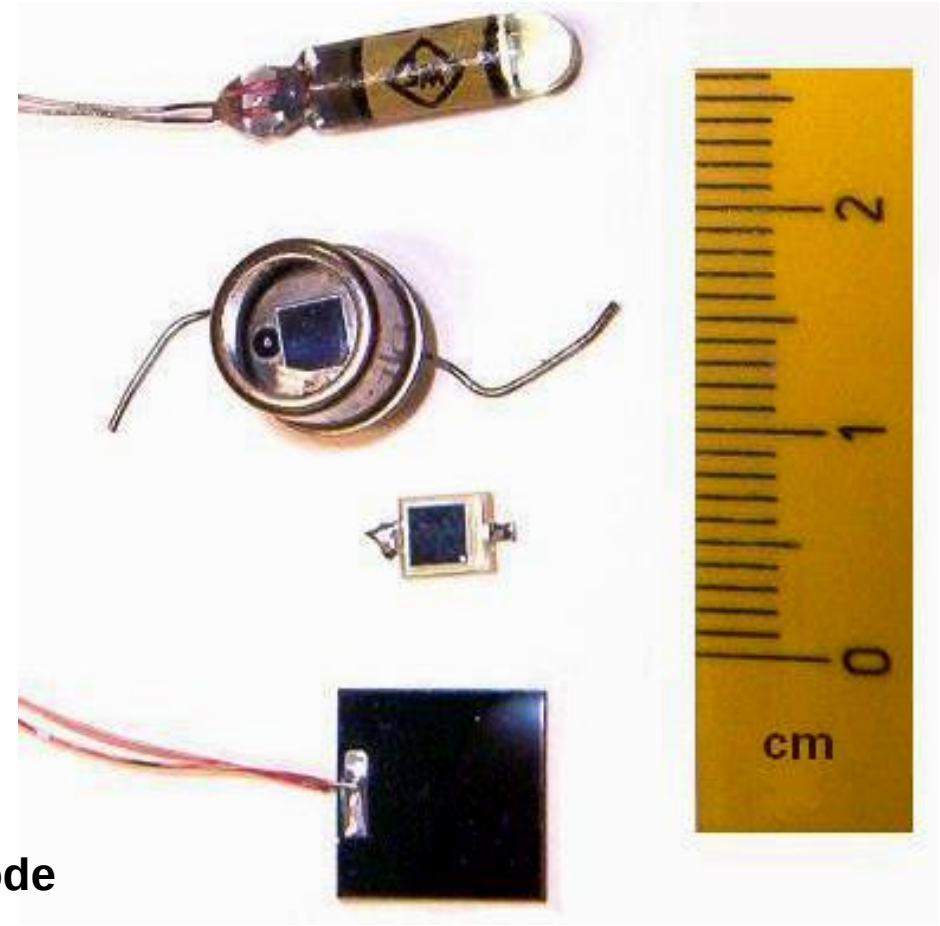


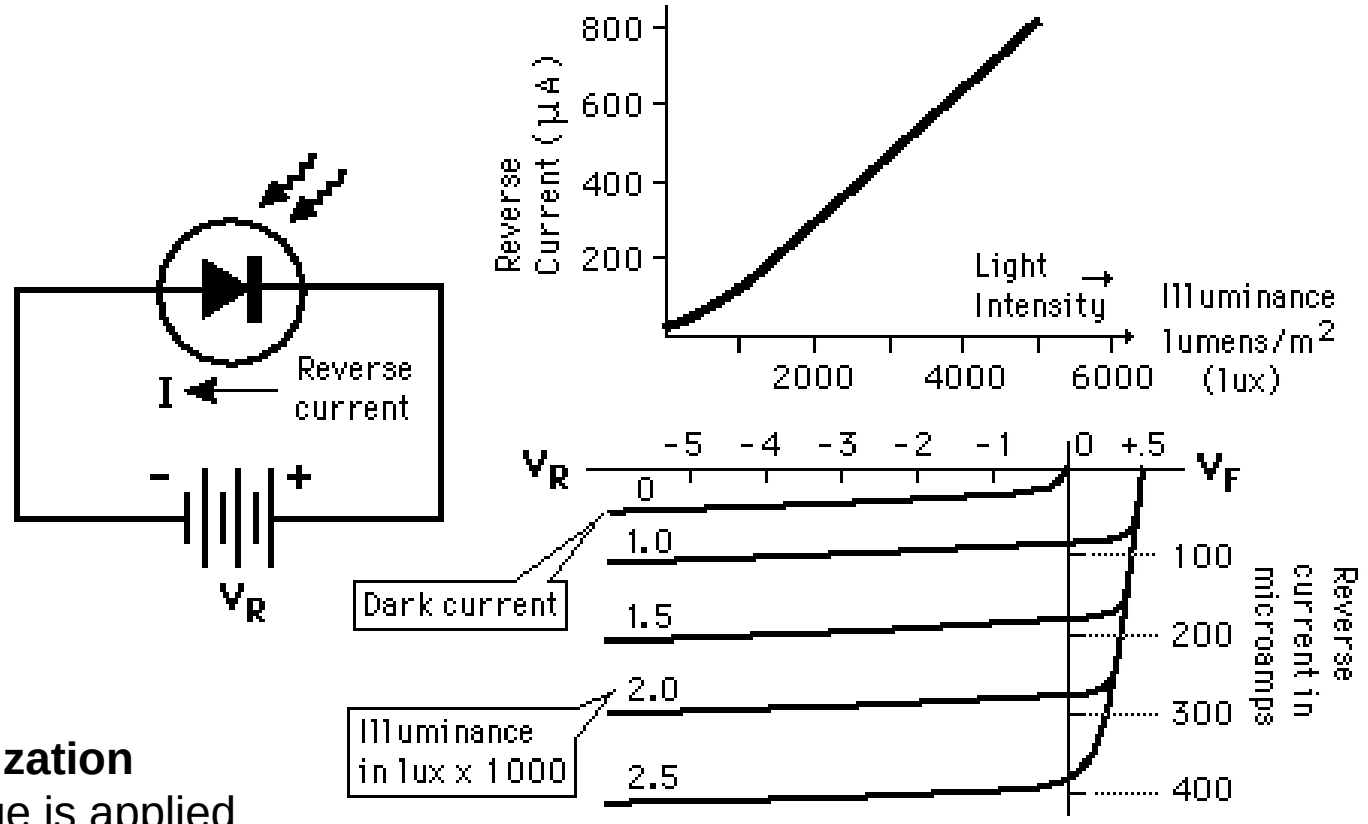
fotodiode PIN



GaP photodiode

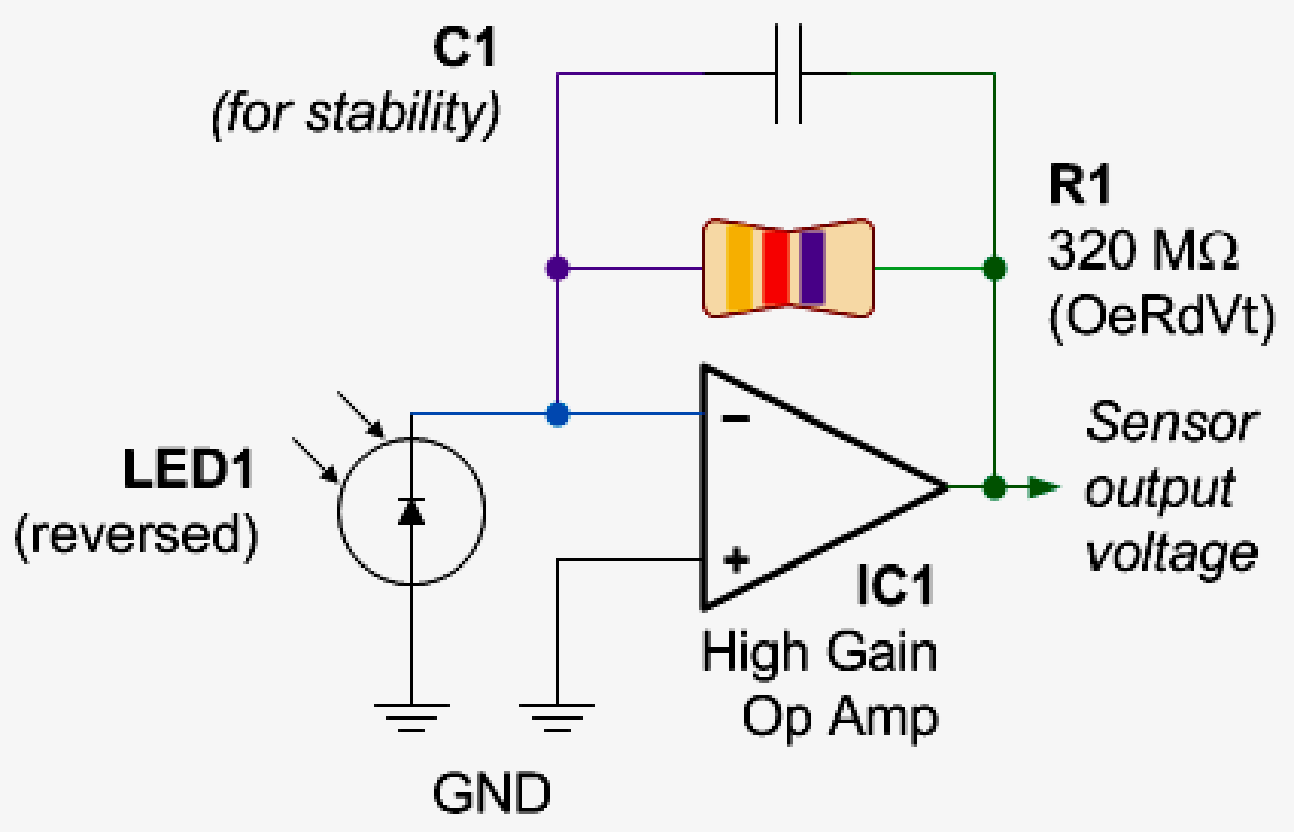
Si photodiode





reverse polarization

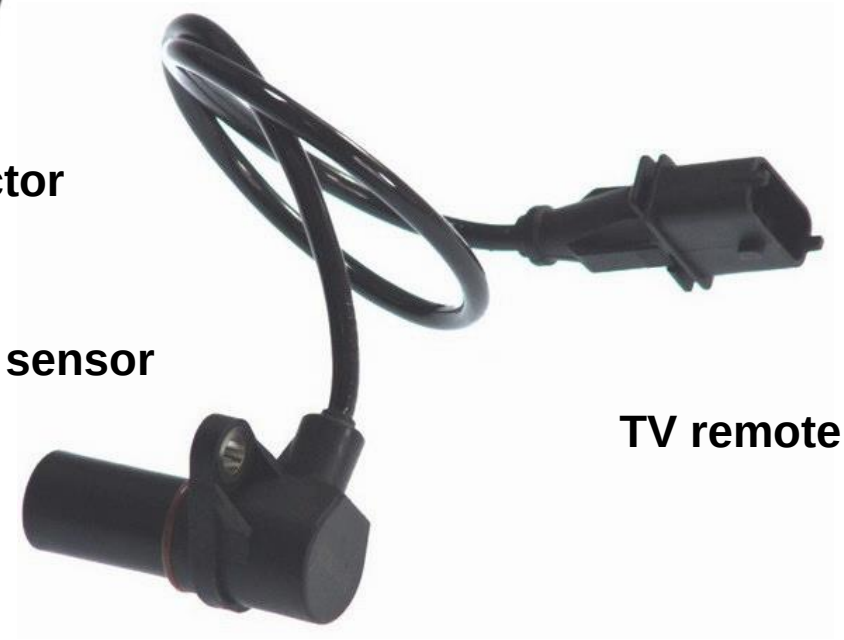
- reverse voltage is applied
- diode = a resistor
- resistance depends on light intensity
- „dark current” at zero ligth
- light denerates minor carriers → rverce current rises



- **reverse polarization** – operational amplifier circuit

motion detector

GaP infrared photodiode

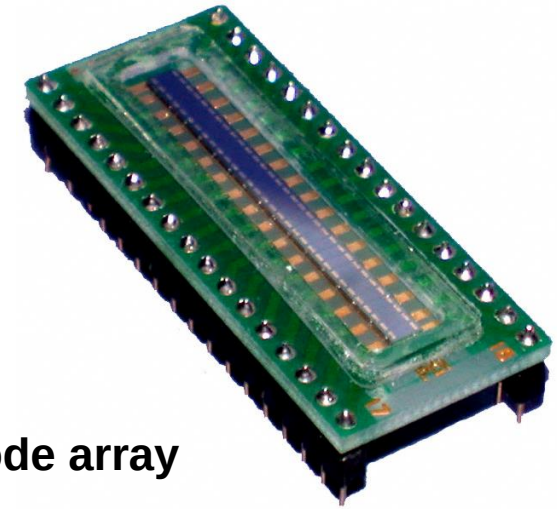


position sensor

TV remote

color sensor

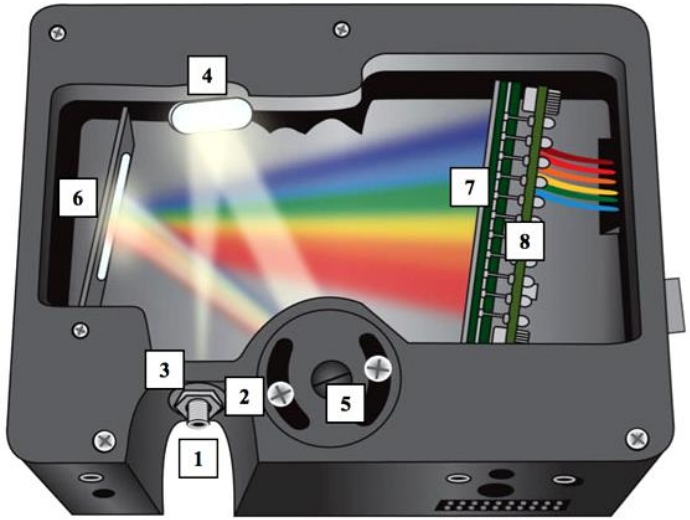
GaP photodiode UVvis



diode array

spectrophotometer

Czerny-Turner monochromator



CMOS (Complementary Metal Oxide Semiconductor)

low energy consumpion

low production cost

fast reading

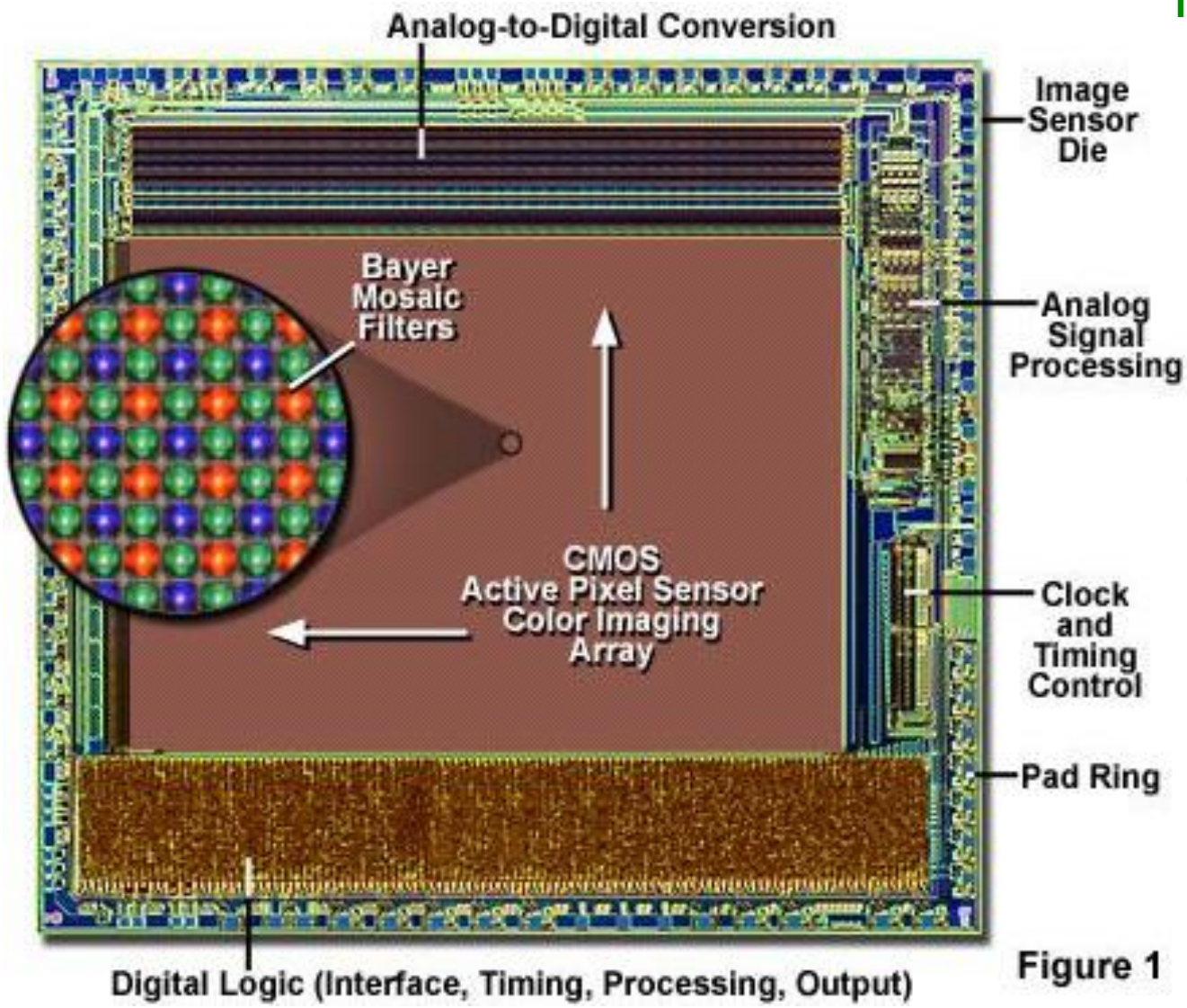
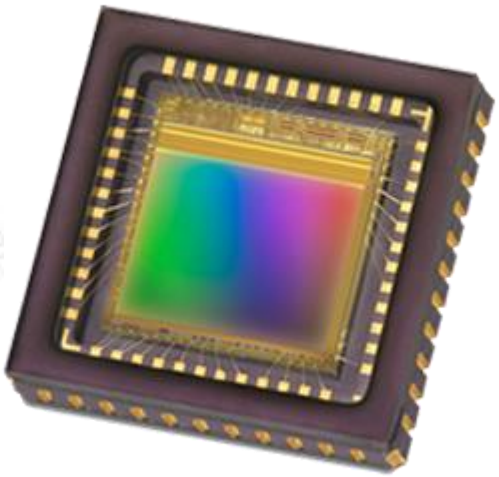
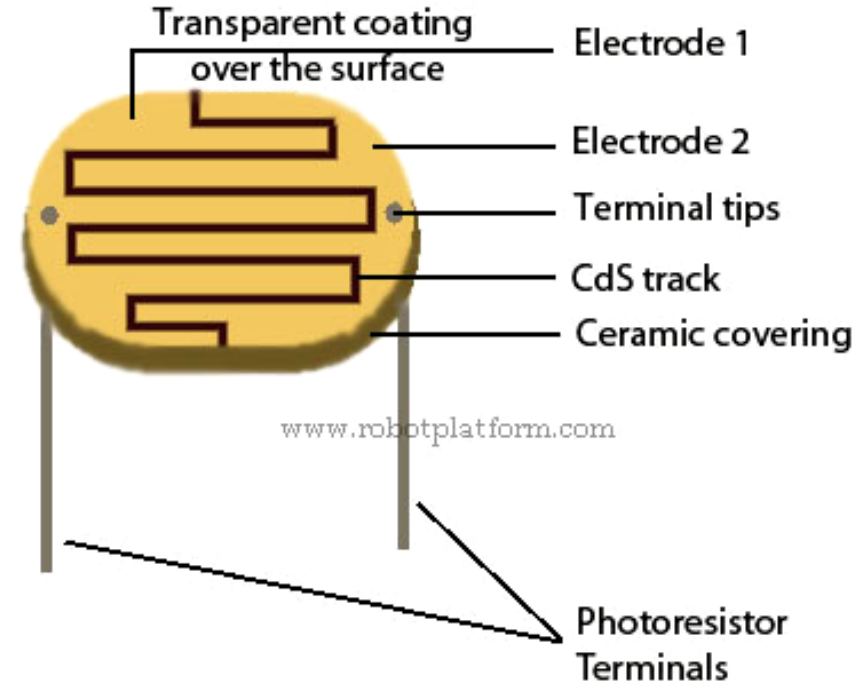


Figure 1

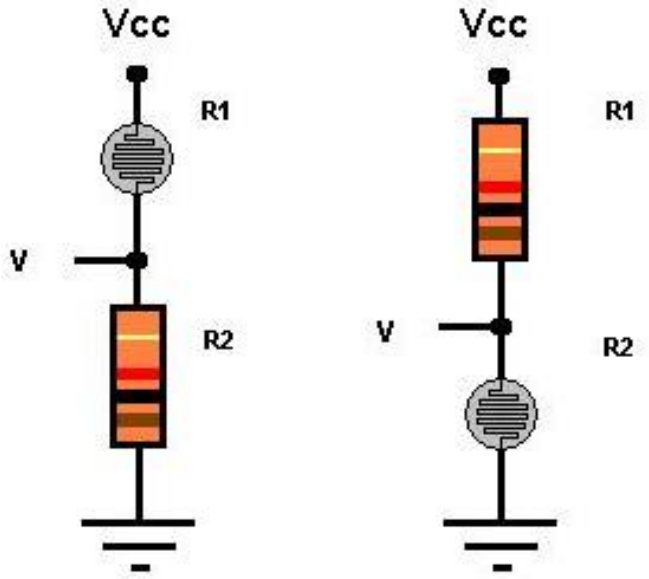


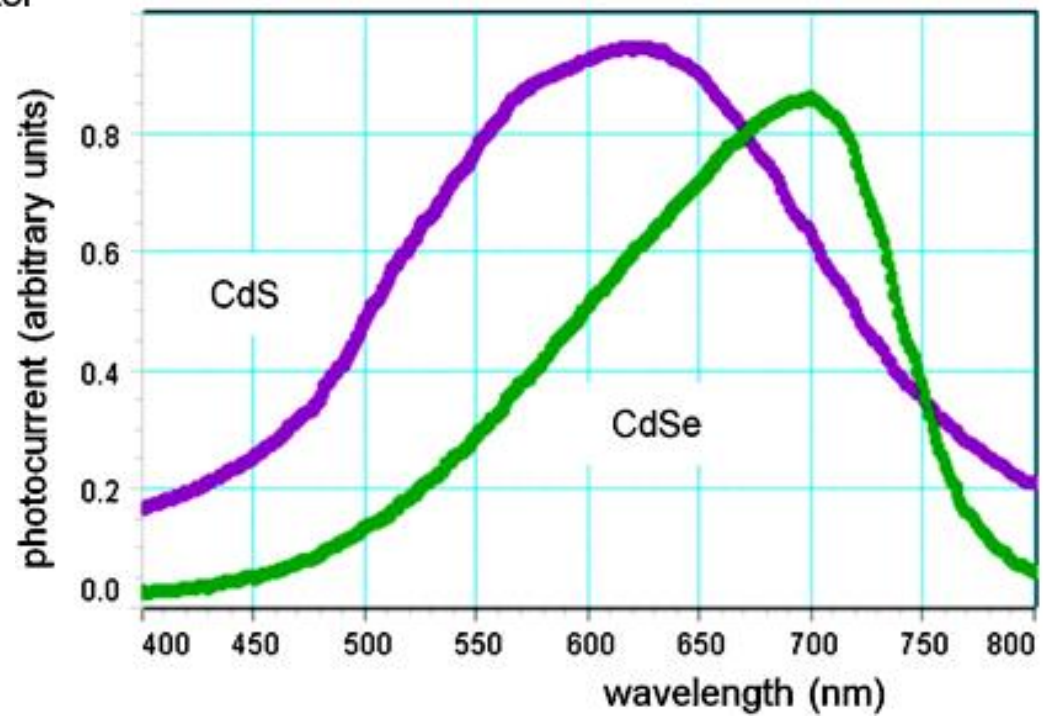


photoresistor

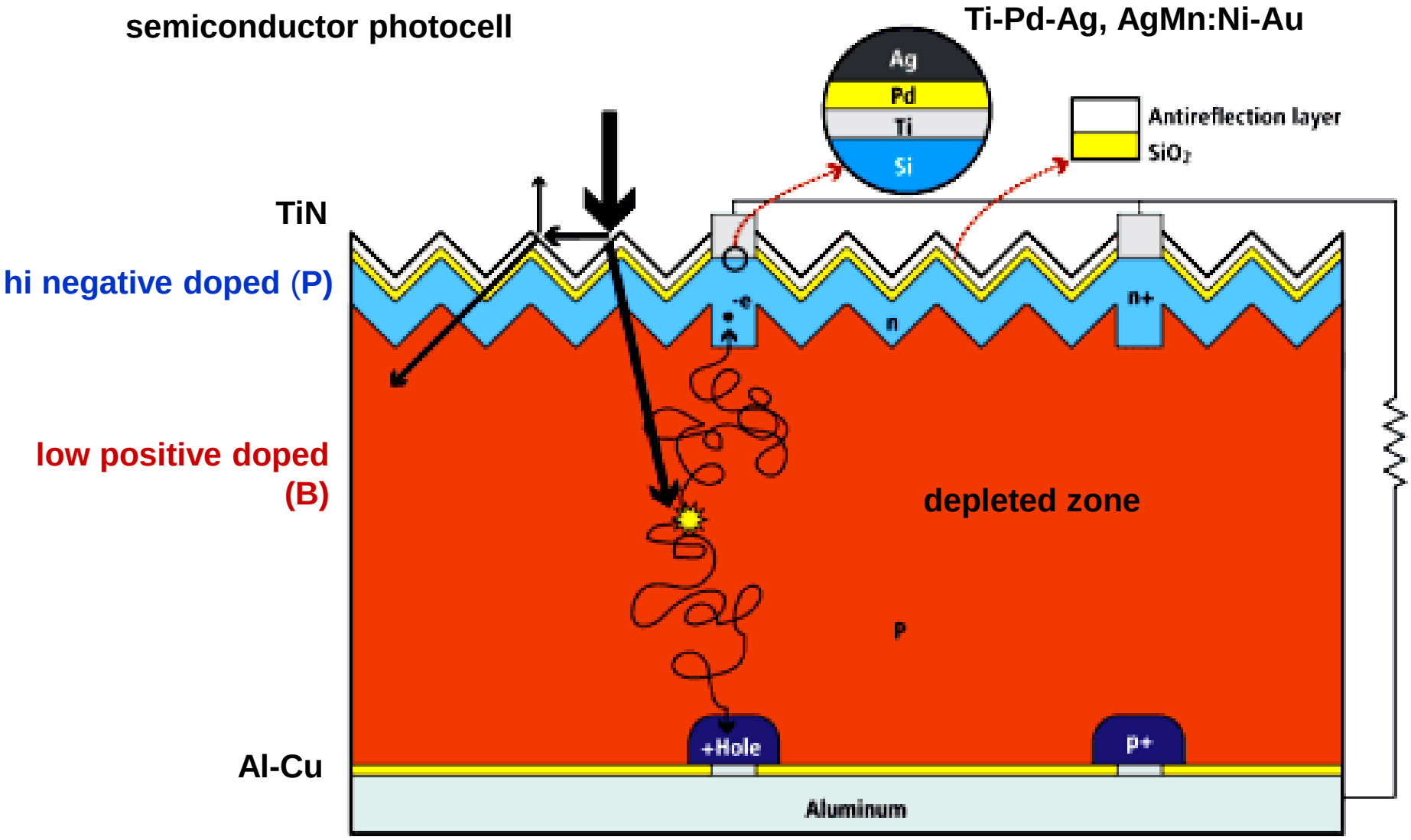
CdS
CdSe

PbS
InSb
Ge:Cu



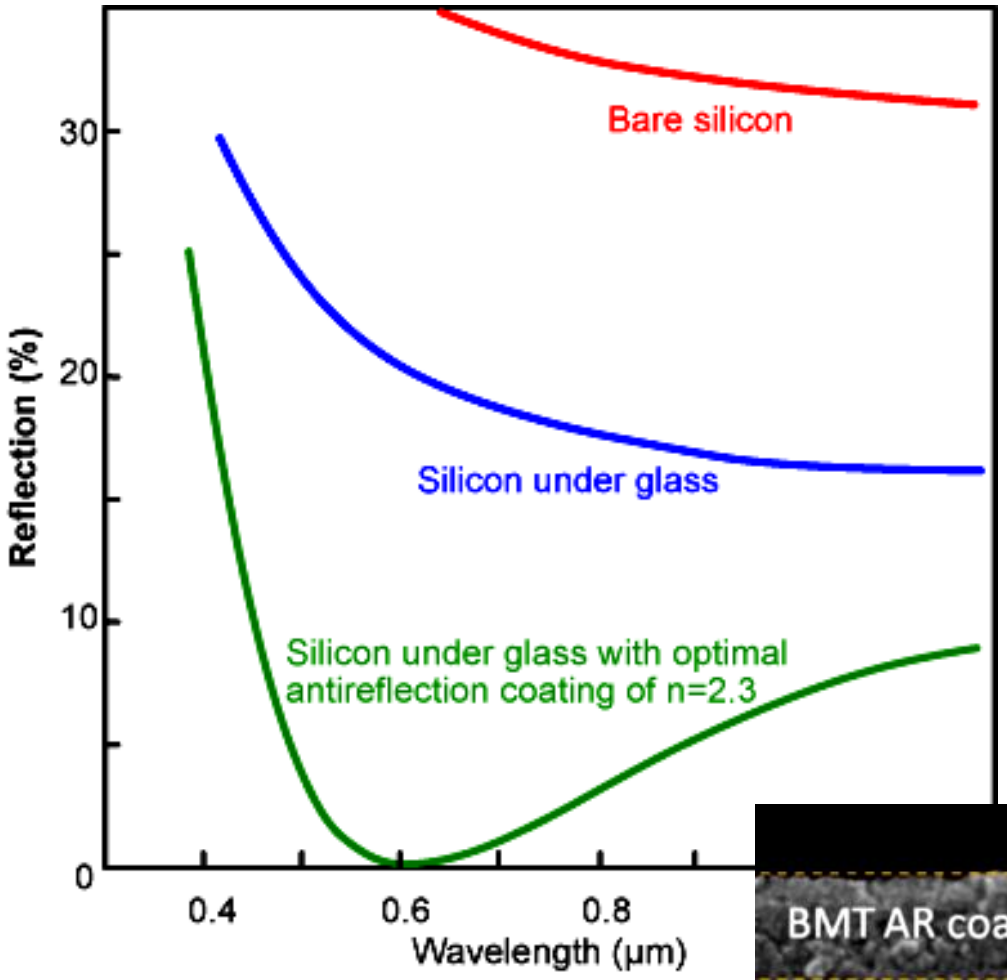


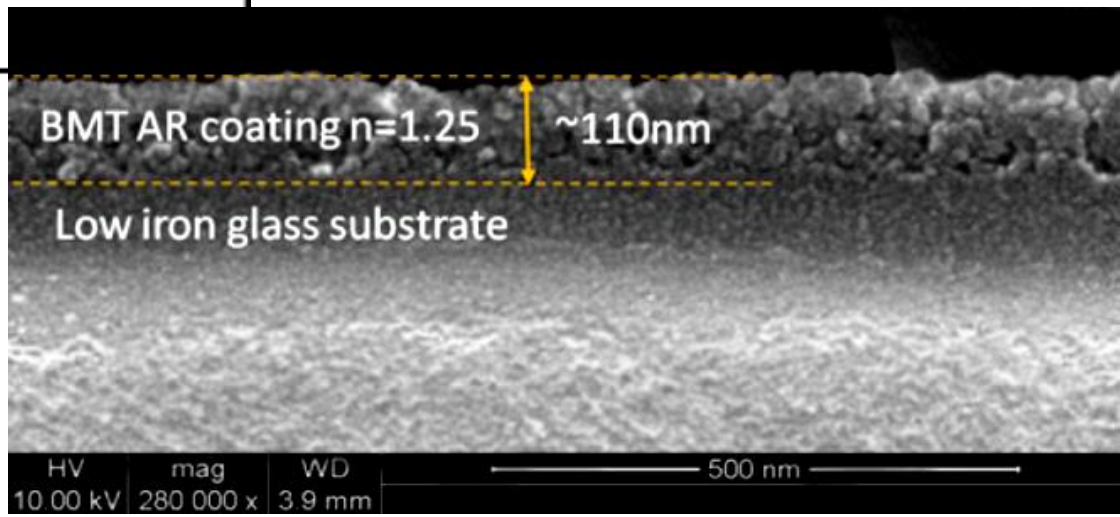
semiconductor photocell



- in-built electric field
- segregation of free carriers

potential about 0.4 V

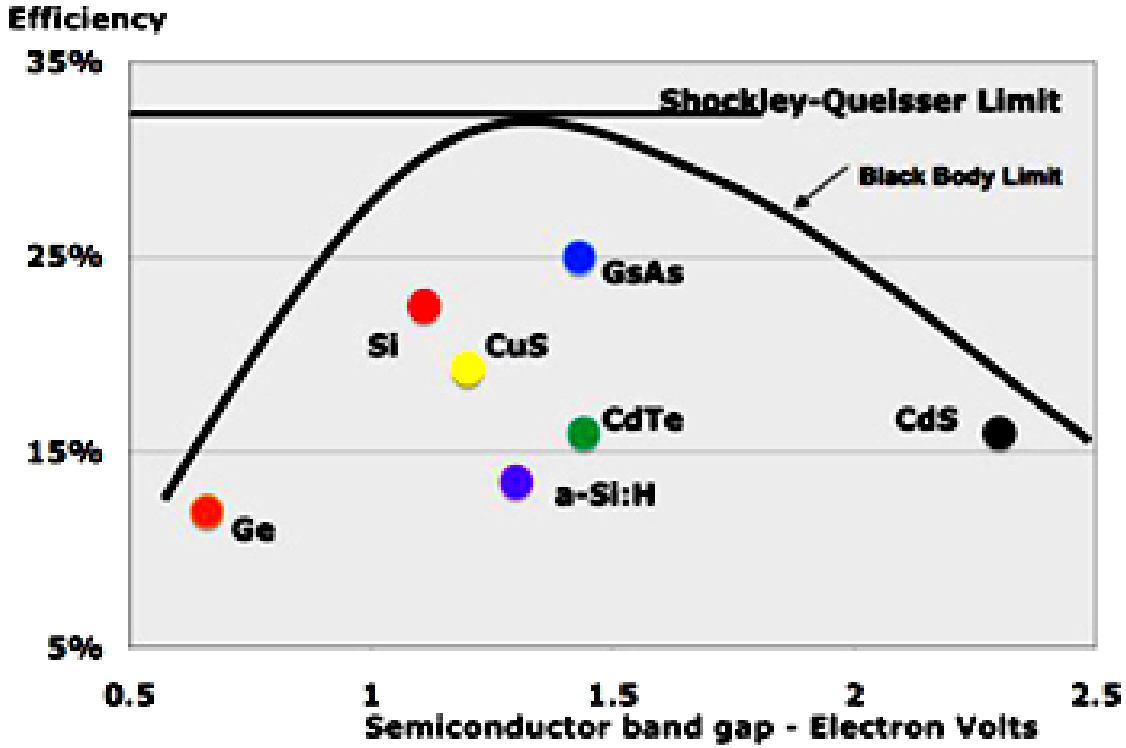

Bare silicon
Silicon under glass
Silicon under glass with optimal antireflection coating of n=2.3
Reflection (%)
30
20
10
0
0.4
0.6
0.8
Wavelength (μm)

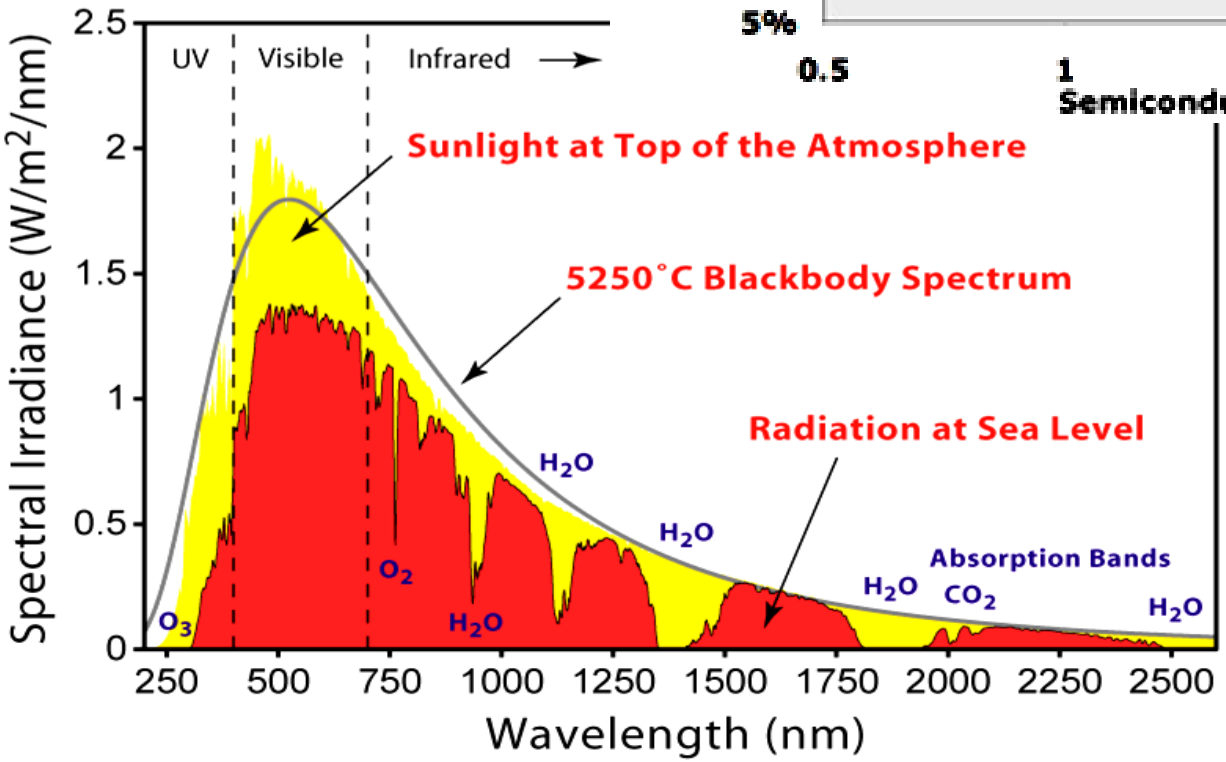

BMT AR coating n=1.25
~110nm
Low iron glass substrate
HV
10.00 kV
mag
280 000 x
WD
3.9 mm
500 nm

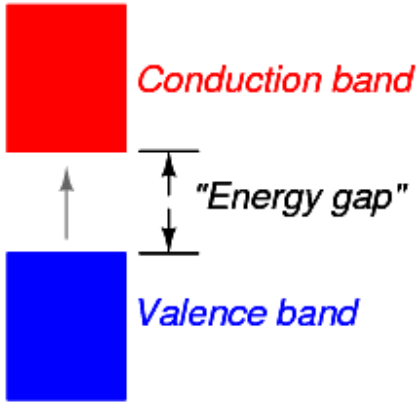
energy gap – match to Sun

optimal 1,4 eV

GaAs
Si
CdTe, CdS
CuS, CuSe, $Cu(InGa)Se_2$
InGaP, AlGaP, InGaAs

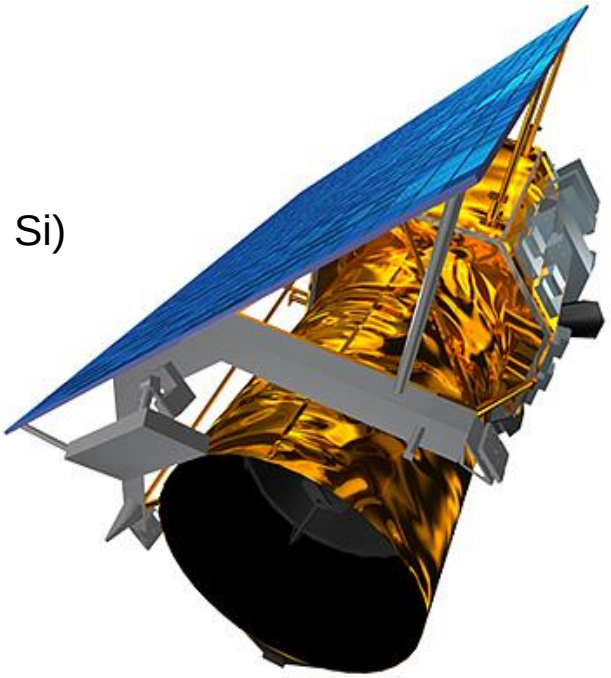






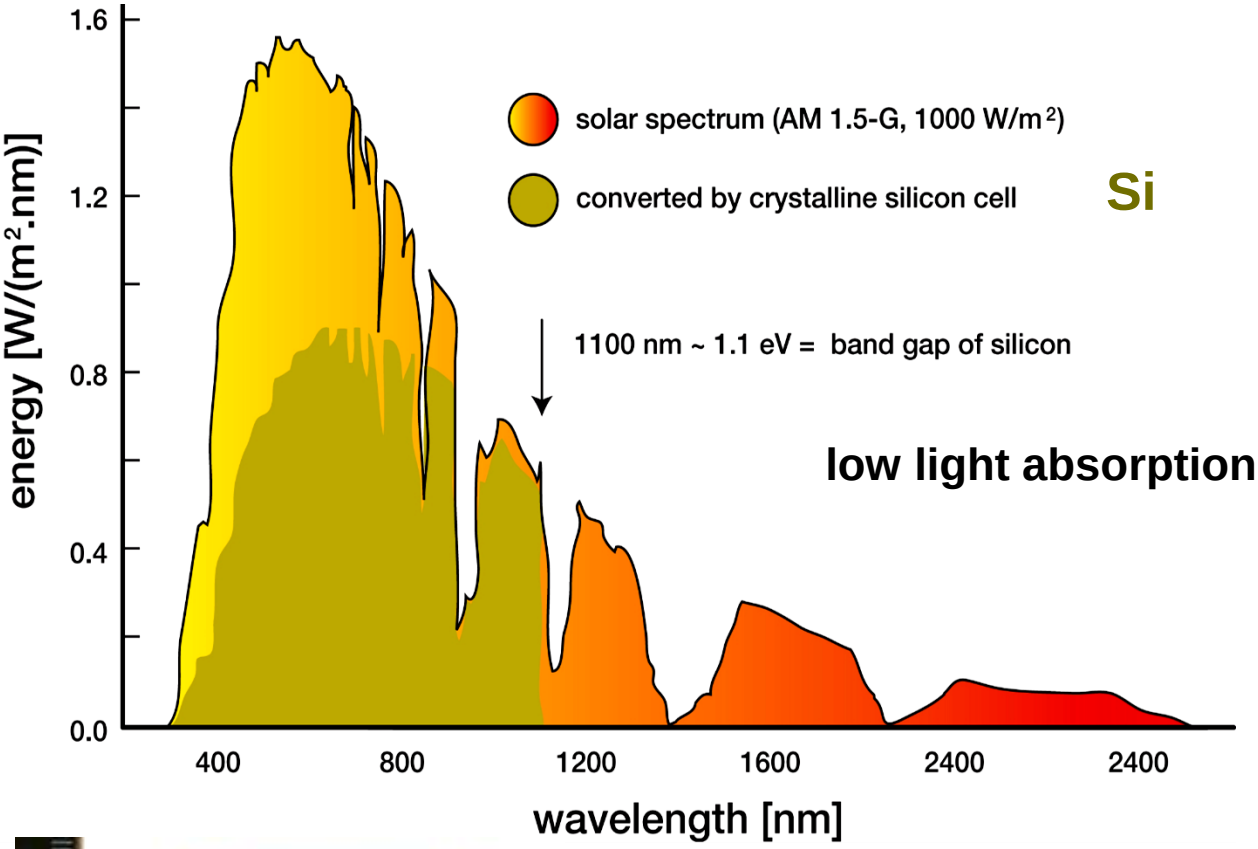
GaAs:
+ direct band gap1,42 eV (1,1 eV Si)
+ **good light absorption** – 90% per 1 μm (100 μm Si)
+ **hi power/mass ratio**
+ stable against radiation (x1000 Si)

- **expensive**
- **toxic**
- fragile



lightweight energy panels
→ **satellites**, jeeps, drones

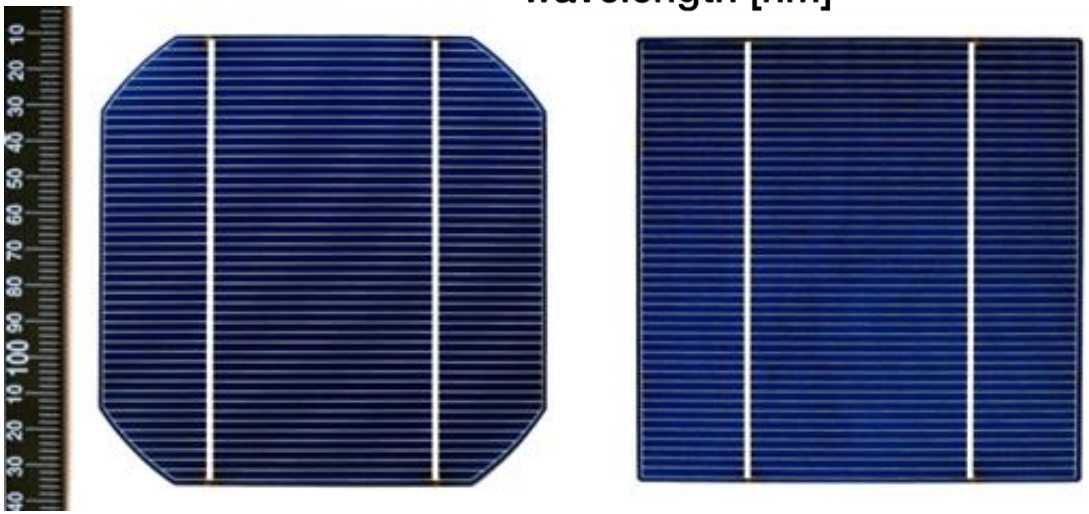
GaP, GaInP



Si

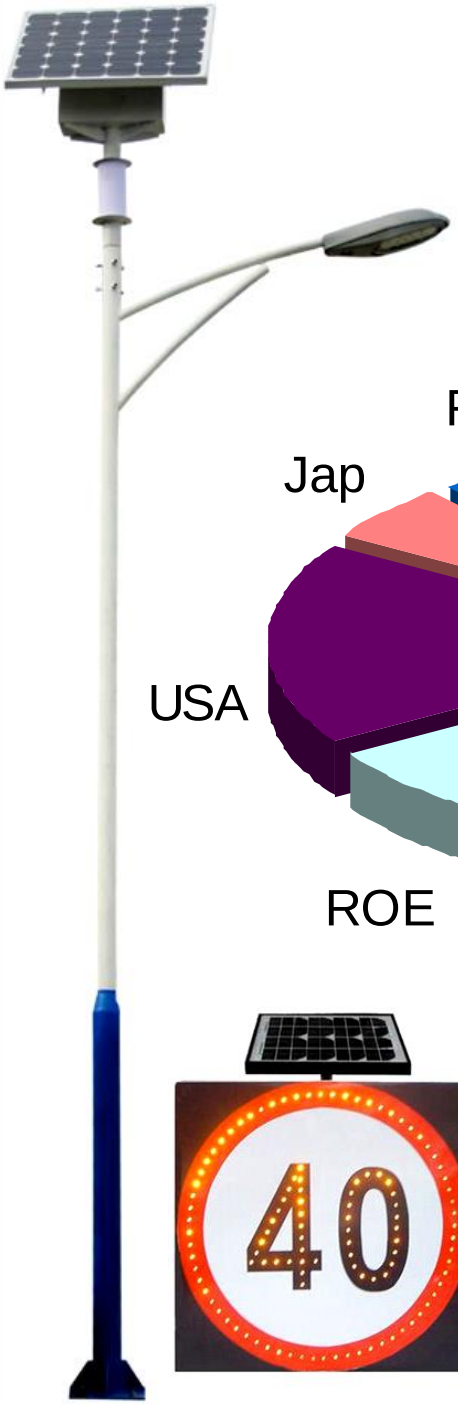
++ abundant
+ non-toxic

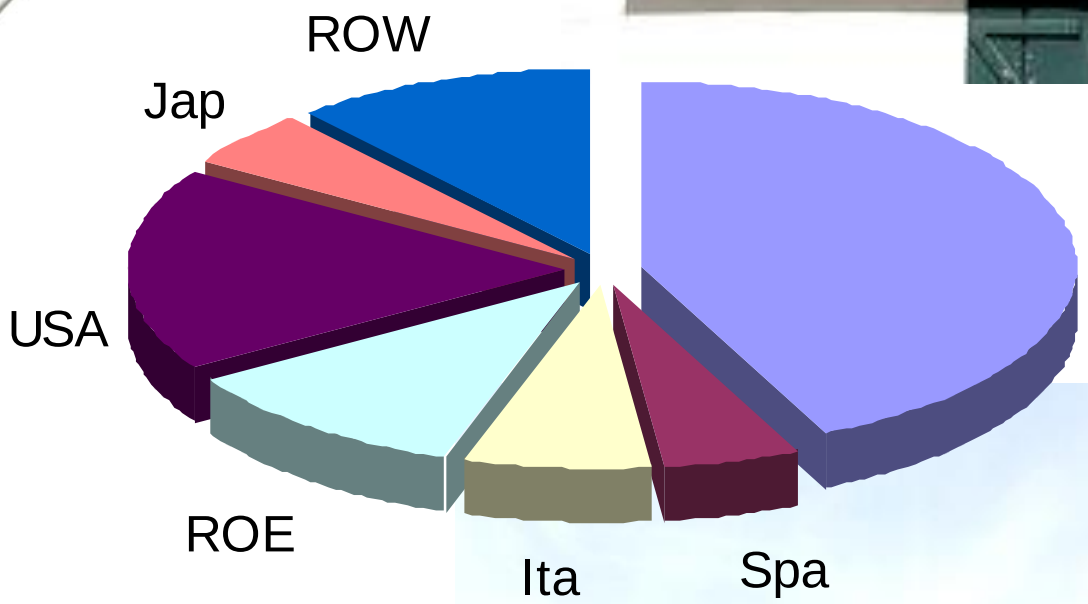
low light absorption – 100 µm needed



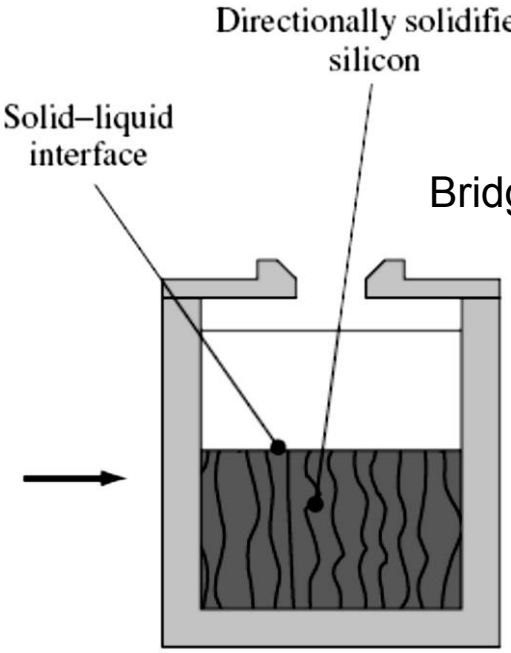
width 10-15 cm

thickness 0,2-0,35 mm




ROW
Jap
USA
ROE
Ita
Spa
Ger

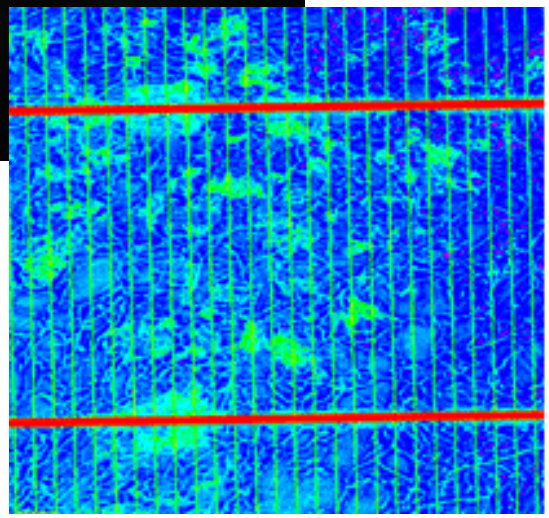
40

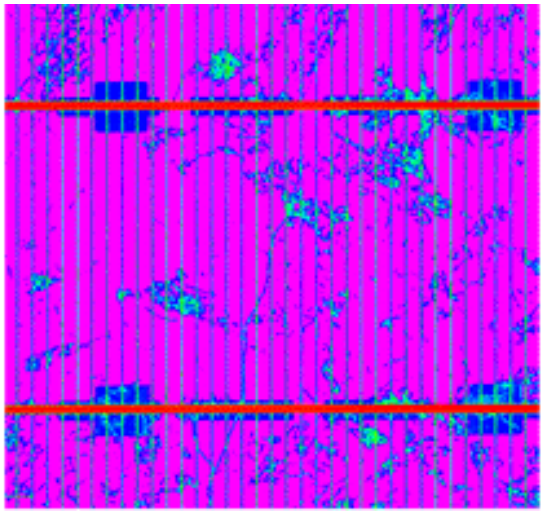


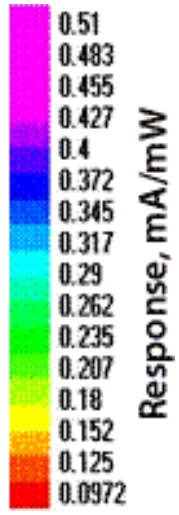
Bridgman'a

mono	14-17 %
poly	**13-16 %**
amorph	5-7 %

SoG-Si = Solar-Grade Silicon ≈ $100/kg

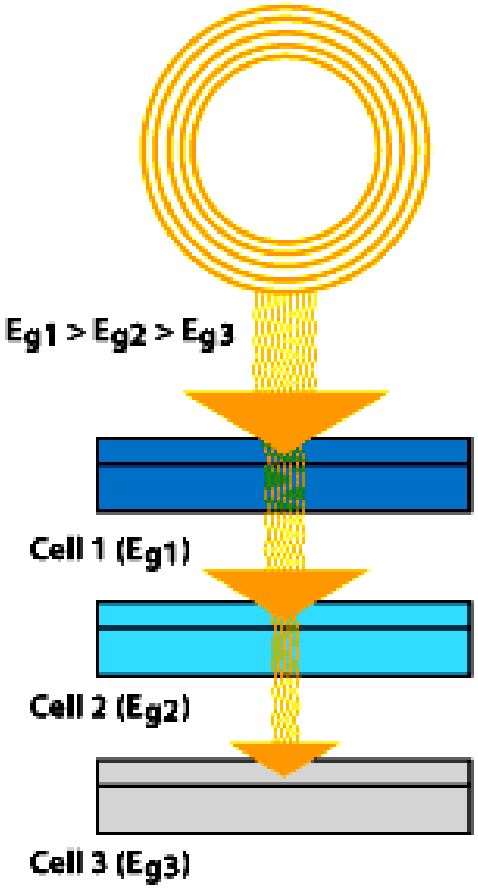


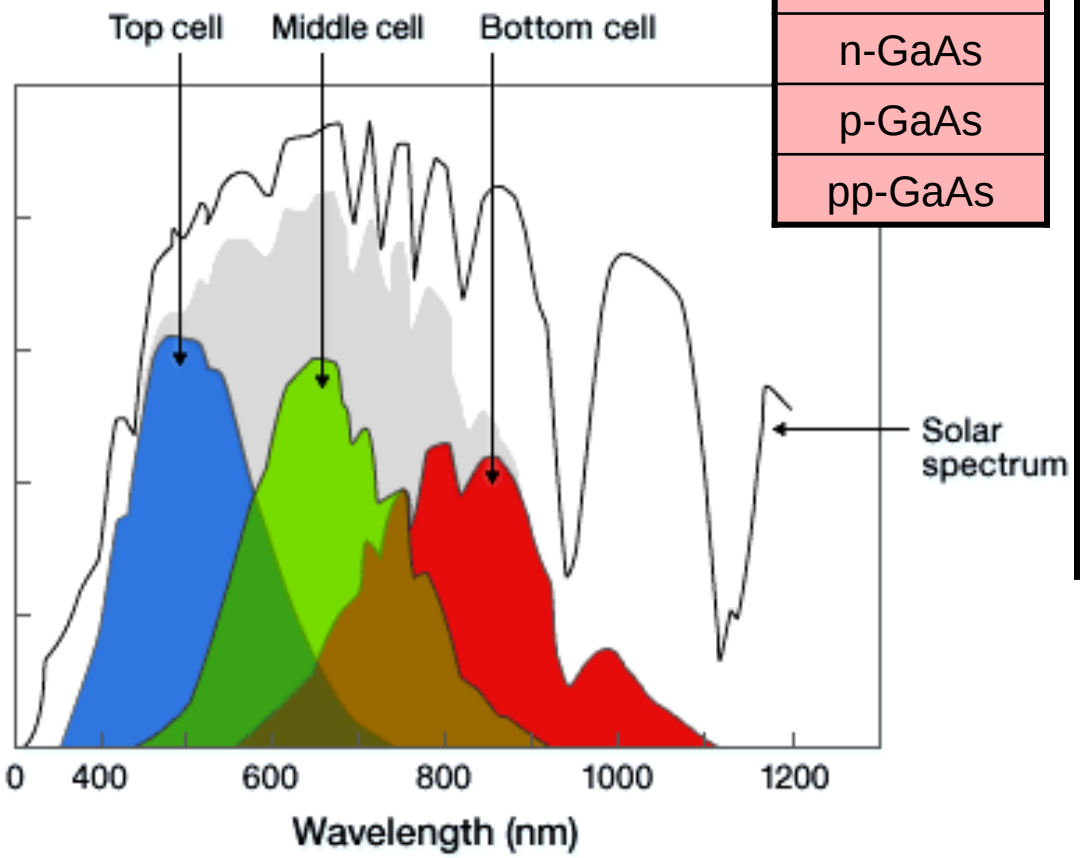




efficient up to 32 %

multilayer cell





n-$AlInP_2$
n-$InGaP_2$
p-$InGaP_2$
n-AlGaAs
n-GaAs
p-GaAs
pp-GaAs

nn-AlInP
n-InGaP
p-InGaP
pp-AlGaInP
nn-InGaP
n-InGaAs
p-InGaAs
pp-InGaP
n-InGaAs
InGaP
n-Ge
p-Ge