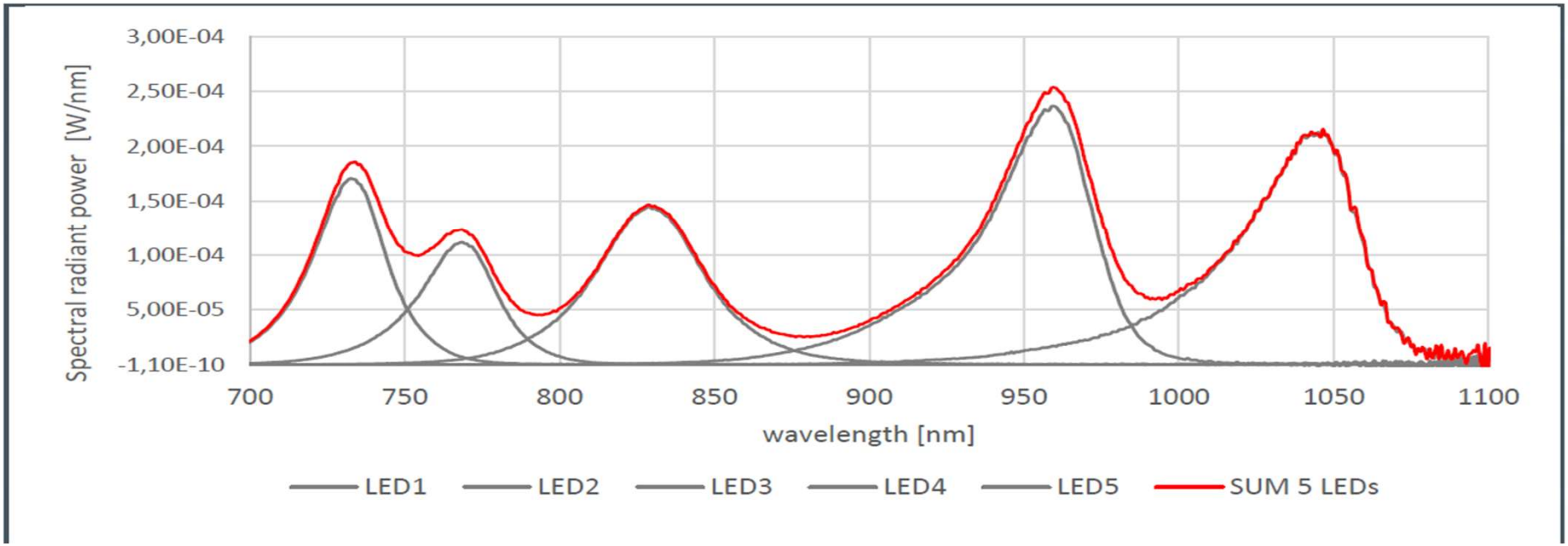
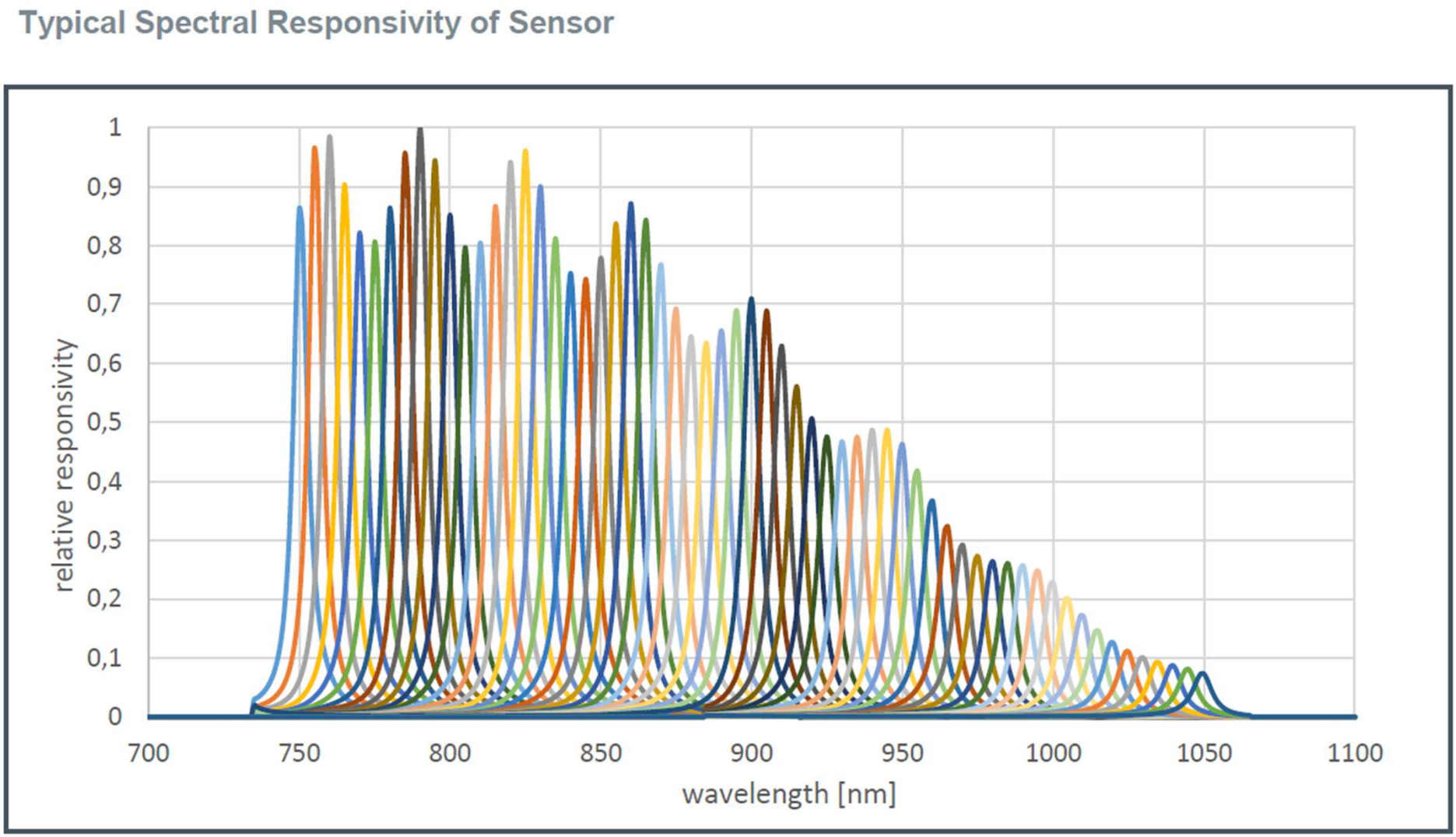
Optoelectronics

AS7420 64-channel hyperspectral near infrared sensor

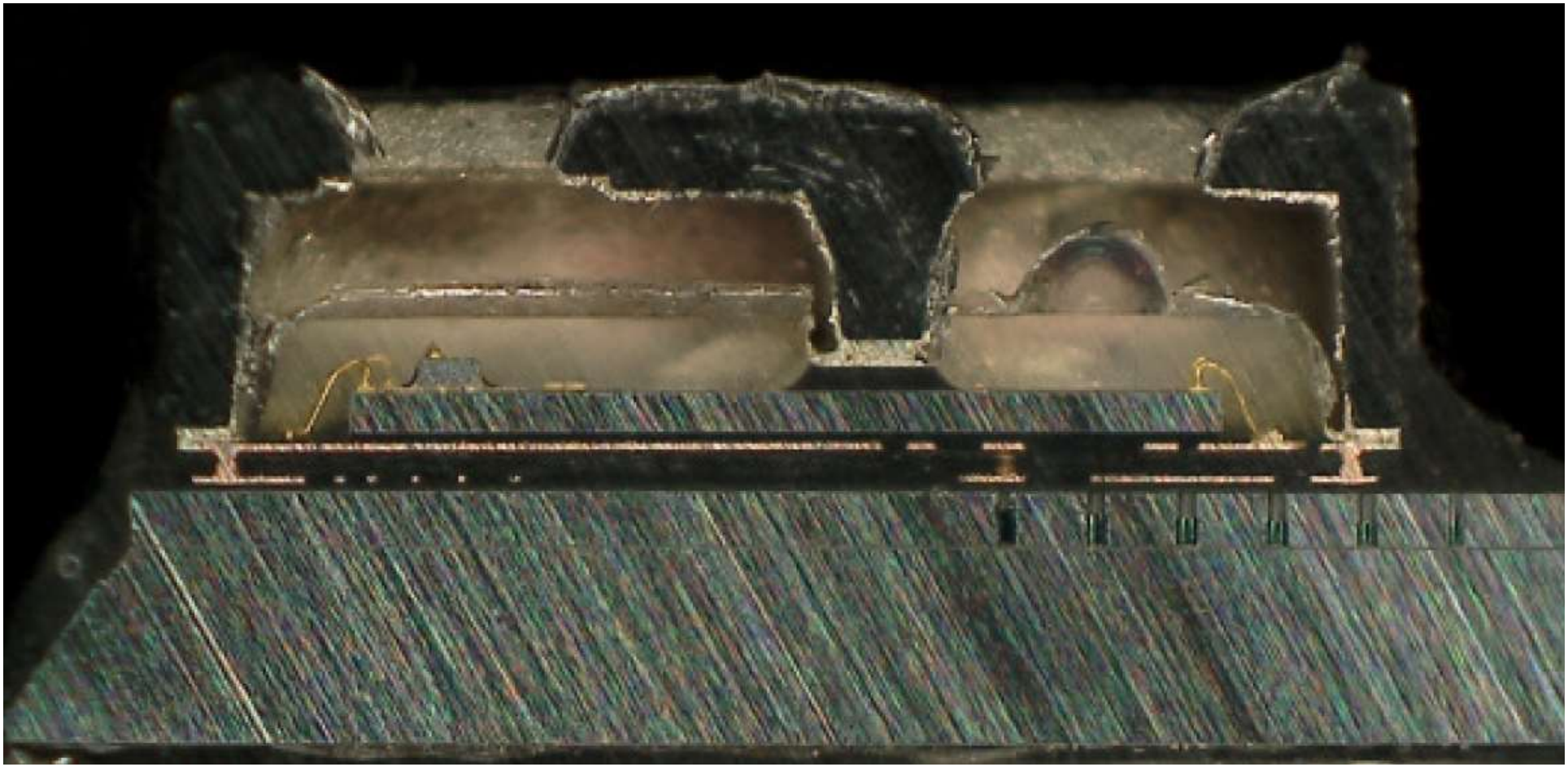
Typical LED Spectral Emission at 50mA LED current



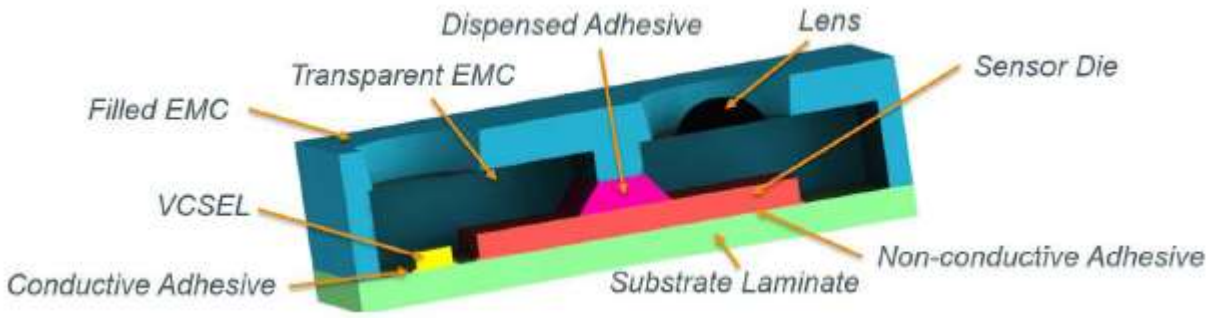
AS7420 64-channel hyperspectral near infrared sensor

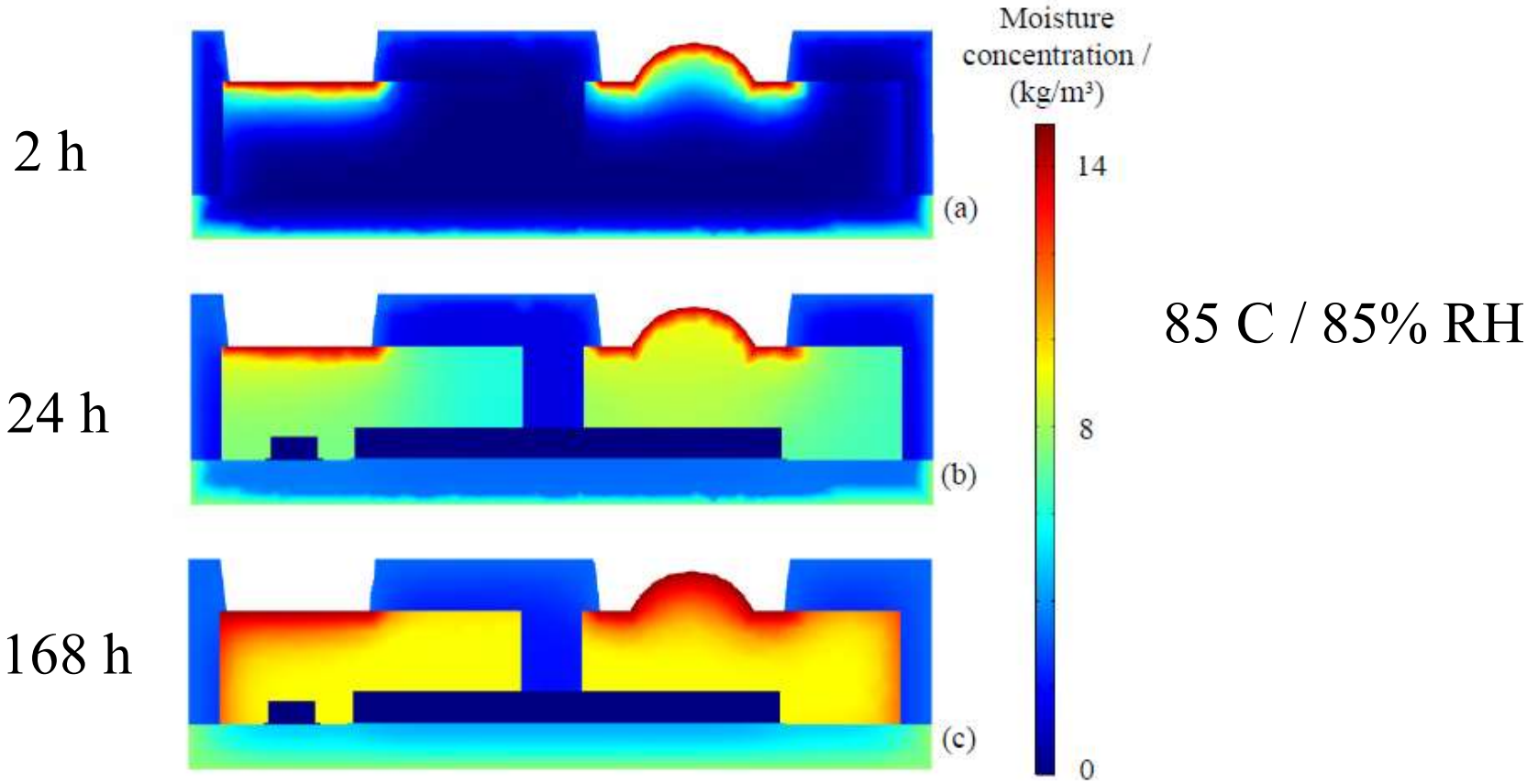


Cross Section



Samuel Hoermann, Master Thesis, TU Graz.

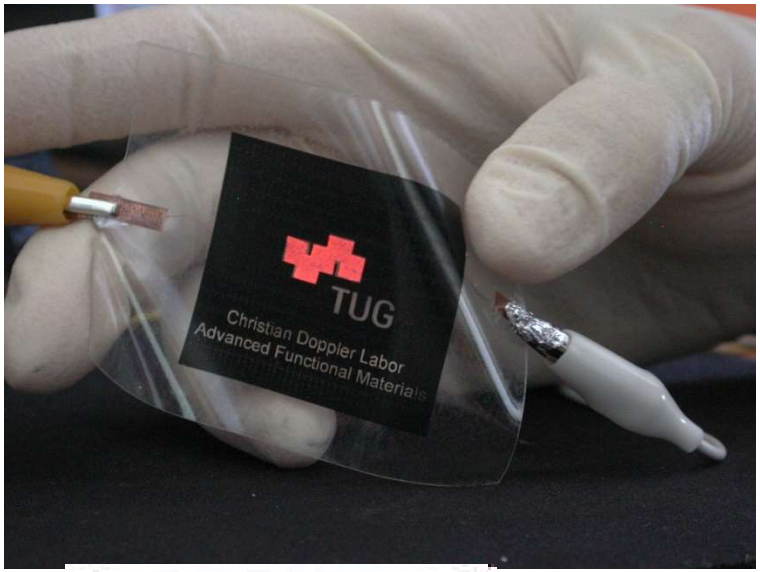


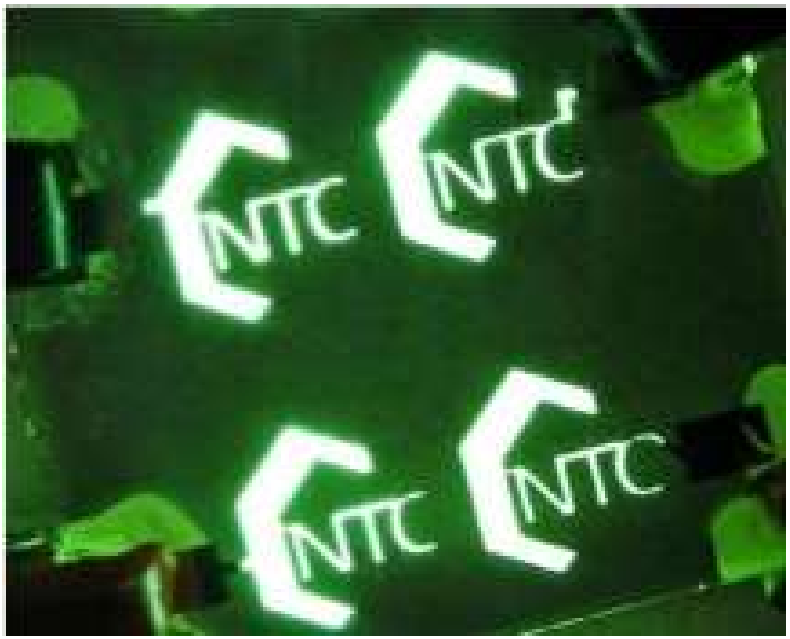


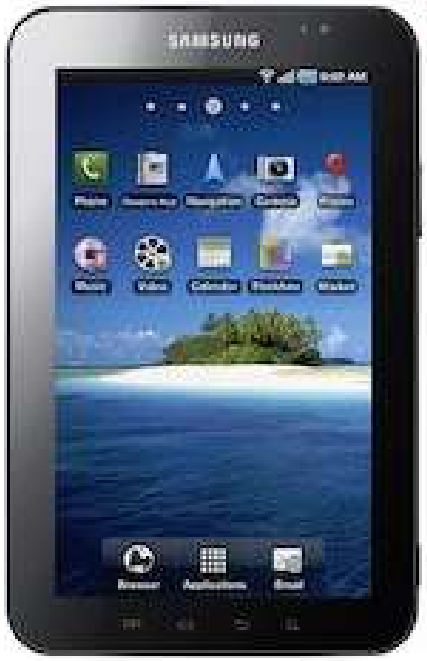
85 C / 85% RH

7th Electronic System-Integration Technology Conference (ESTC) 2018

OLEDs







Galaxy Tab

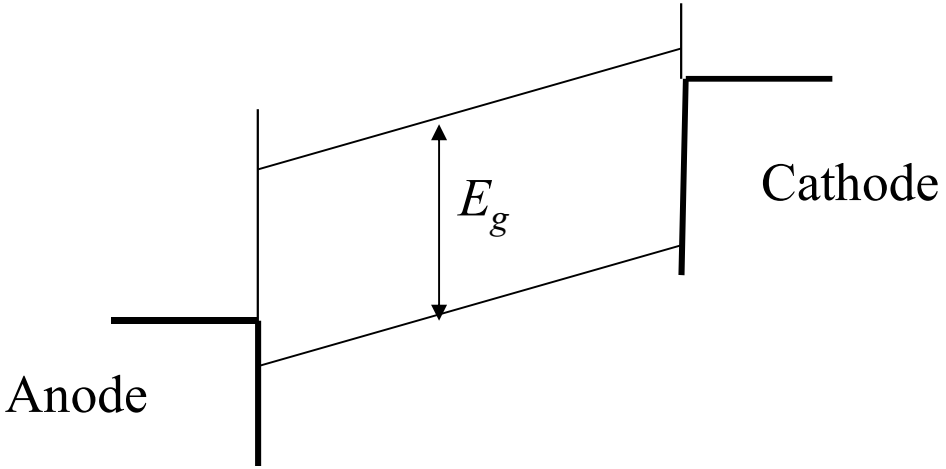
Encapsulation technology

OLEDs

Aluminum cathode
Electron transport layer
Emission layer
Hole transport layer
ITO anode
Glass

Cathode is typically a low work function material Al, Ca - injects electrons

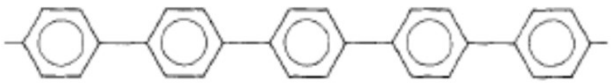
Anode is typically a high work function material ITO - injects holes



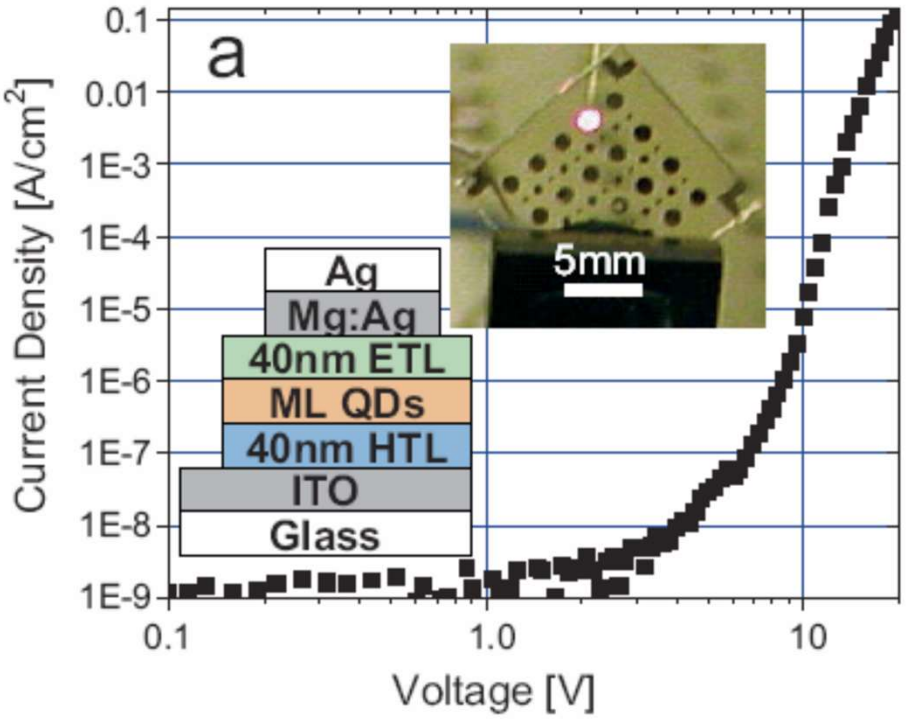
Electroluminescence in poly(p-phenylene)

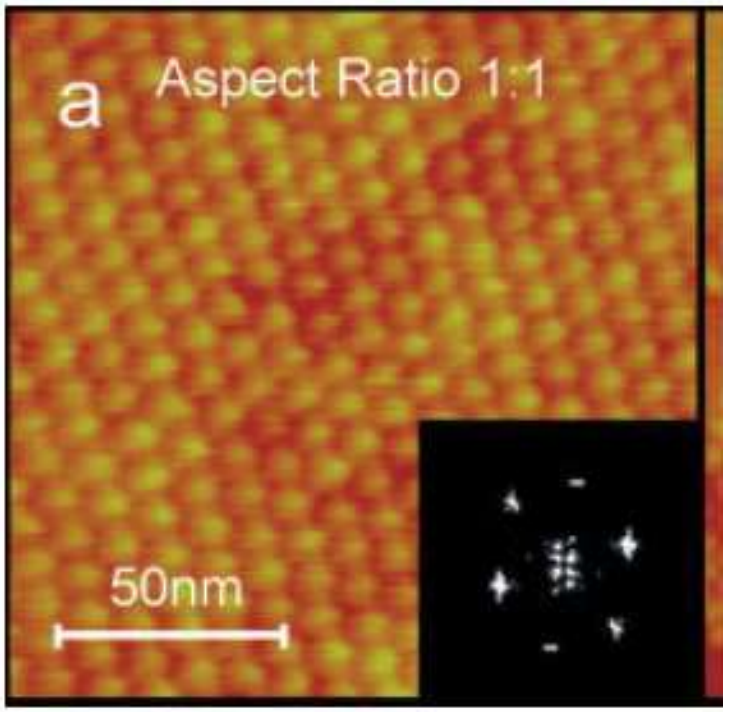
Prof. Günther Leising

In 1992, Leising et al. for the first time reported on blue electroluminescence from OLEDs containing poly(p-phenylene) (PPP).



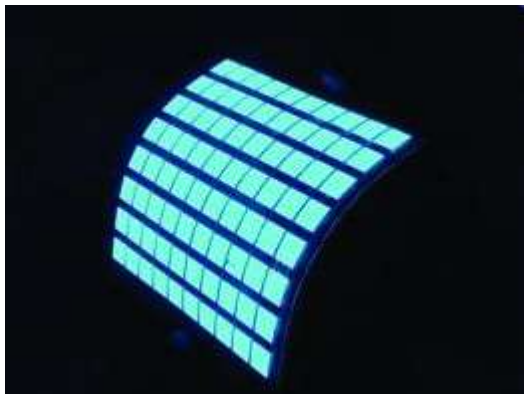
Q-dot LEDs





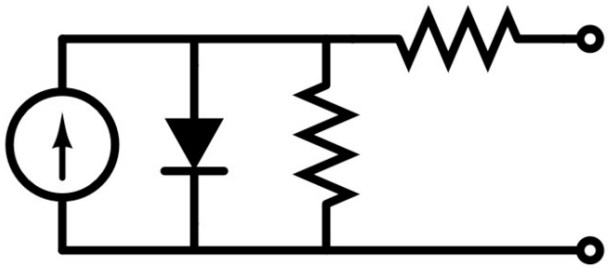
Coe-Sullivan, et al. Advanced Functional Materials, 10.1002/adfm.200400468

Efficient lighting

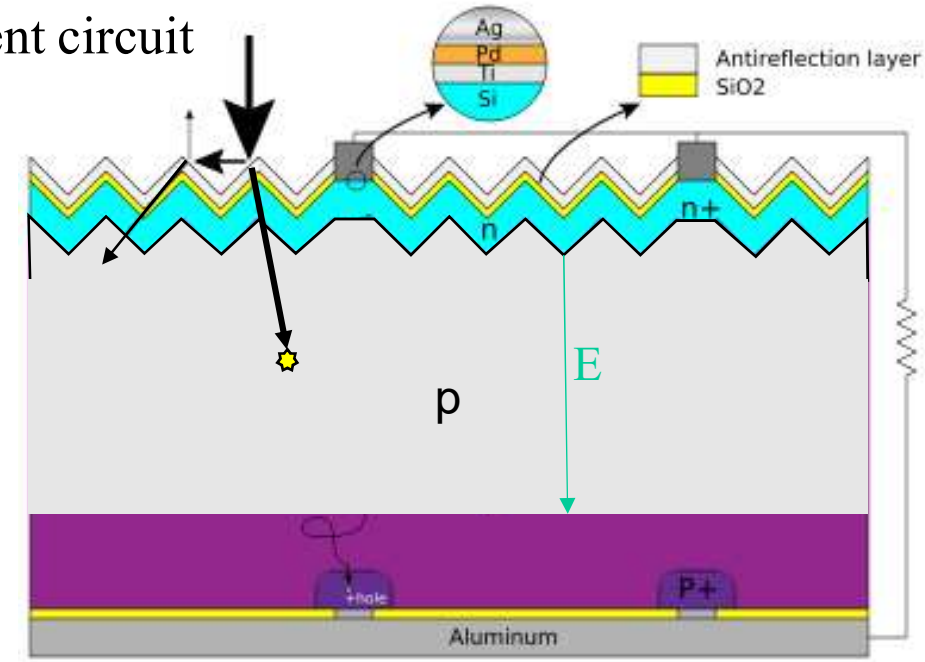


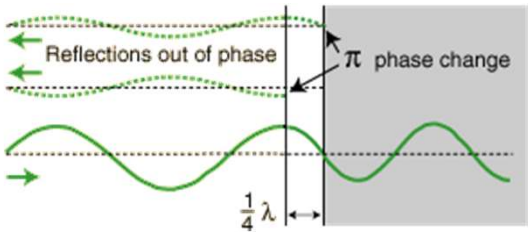
Very efficient
Many colors possible
No toxic chemicals

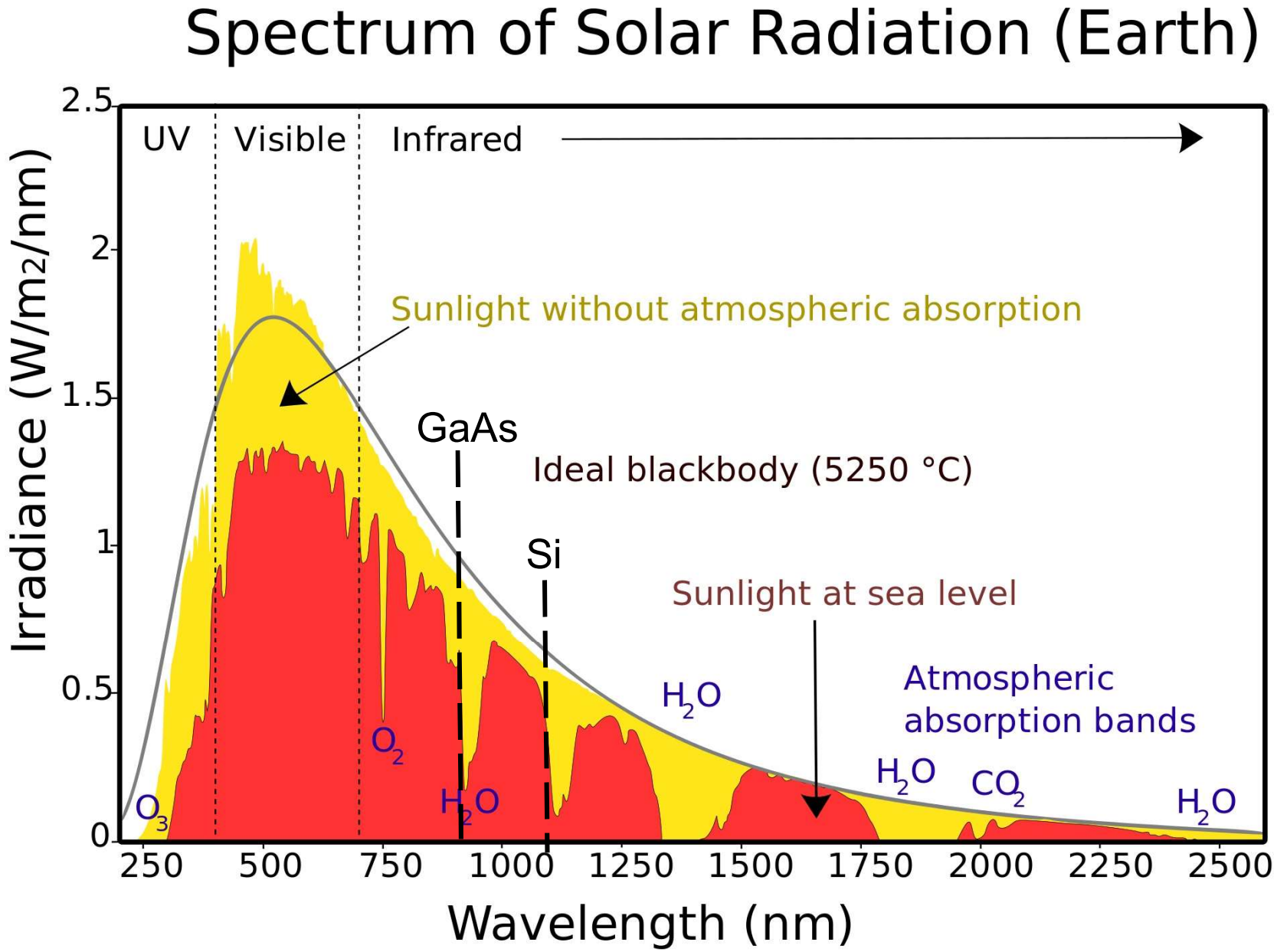
Solar cell



Equivalent circuit

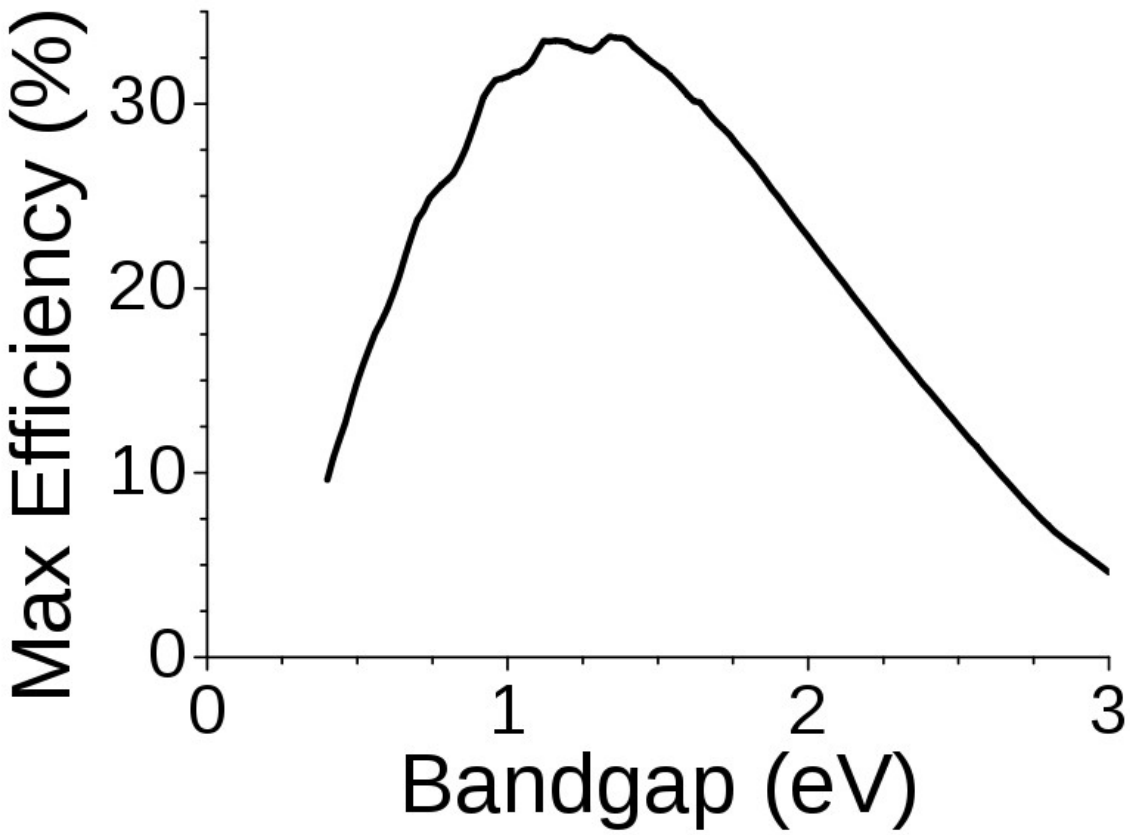




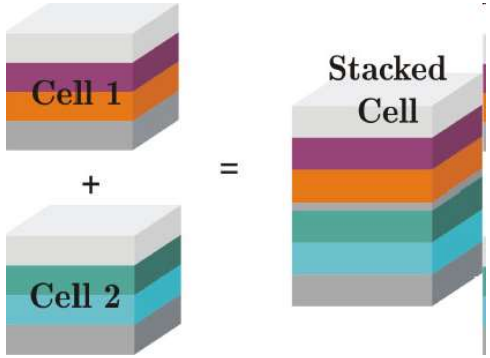


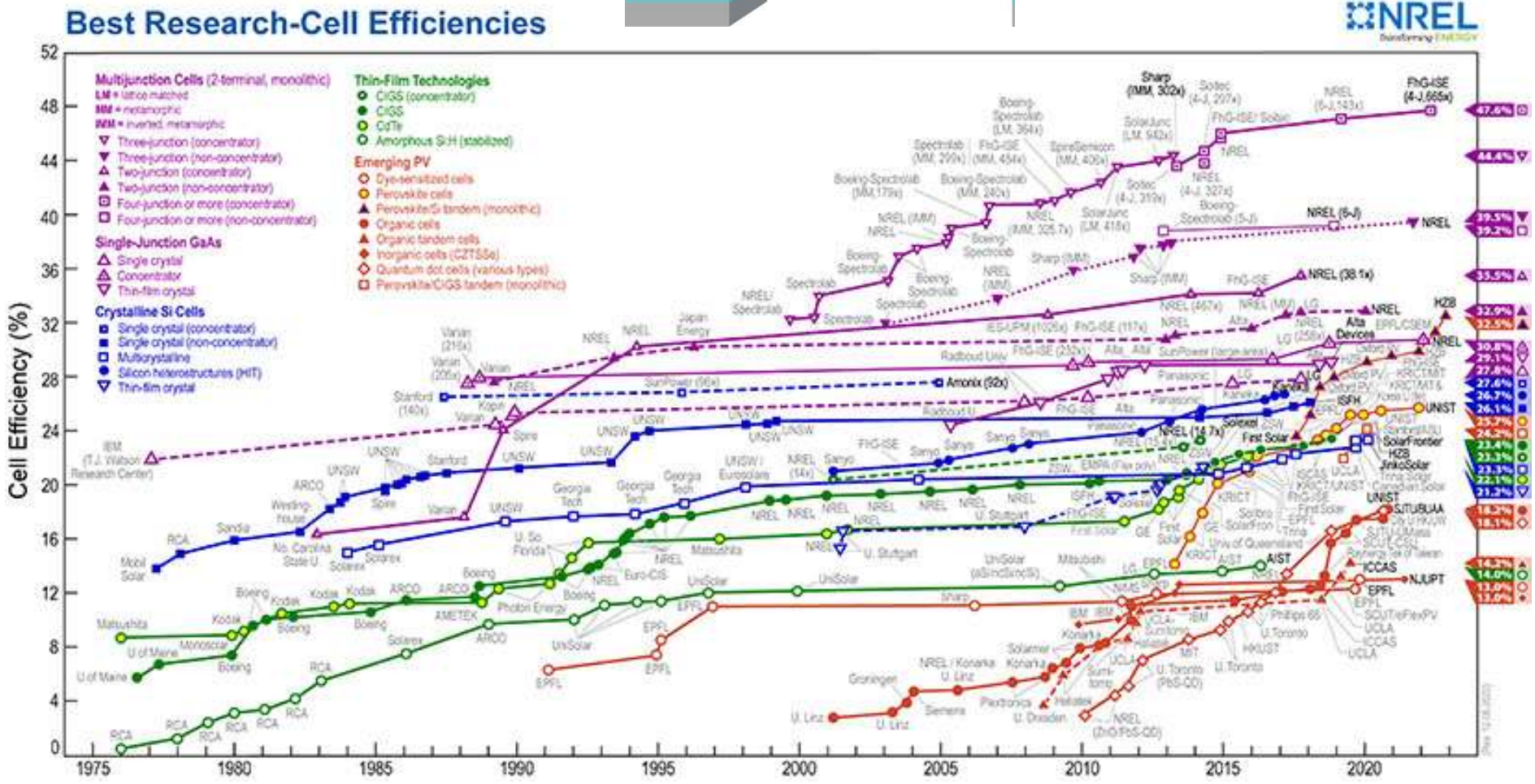
Wu, H.W. & Emadi, A & Graaf, G & Leijtens, Johan & Wolffenbuttel, R.F.. (2011). Design and Fabrication of an Albedo Insensitive Analog Sun Sensor. Procedia Engineering. 25. 527-530. 10.1016/j.proeng.2011.12.131.

Shockley–Queisser limit



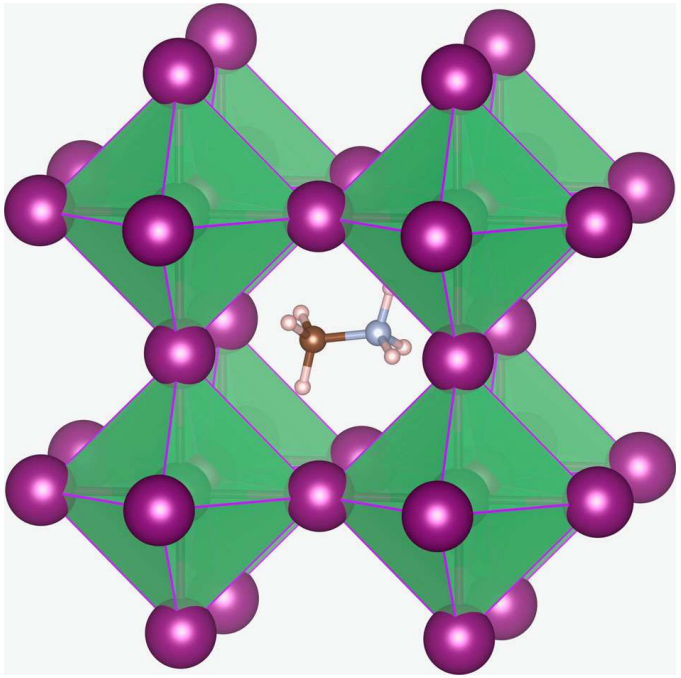
http://en.wikipedia.org/wiki/Shockley-Queisser_limit





Biofuel efficiency ~ 1%

Perovskite solar cells



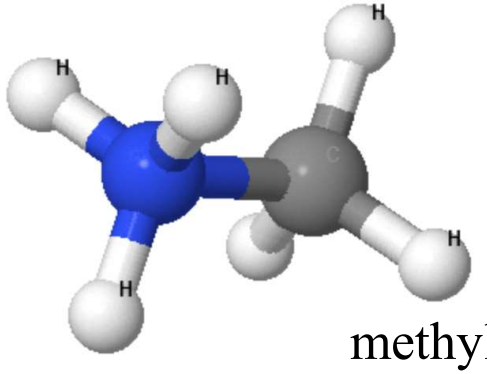
https://en.wikipedia.org/wiki/Perovskite_solar_cell#/media/File:CH3NH3PbI3_structure.png

methylammonium lead trihalide ABX_3
$CH_3NH_3PbX_3$, where X is I, Br or Cl
Optical bandgap 1.5 - 2.3 eV

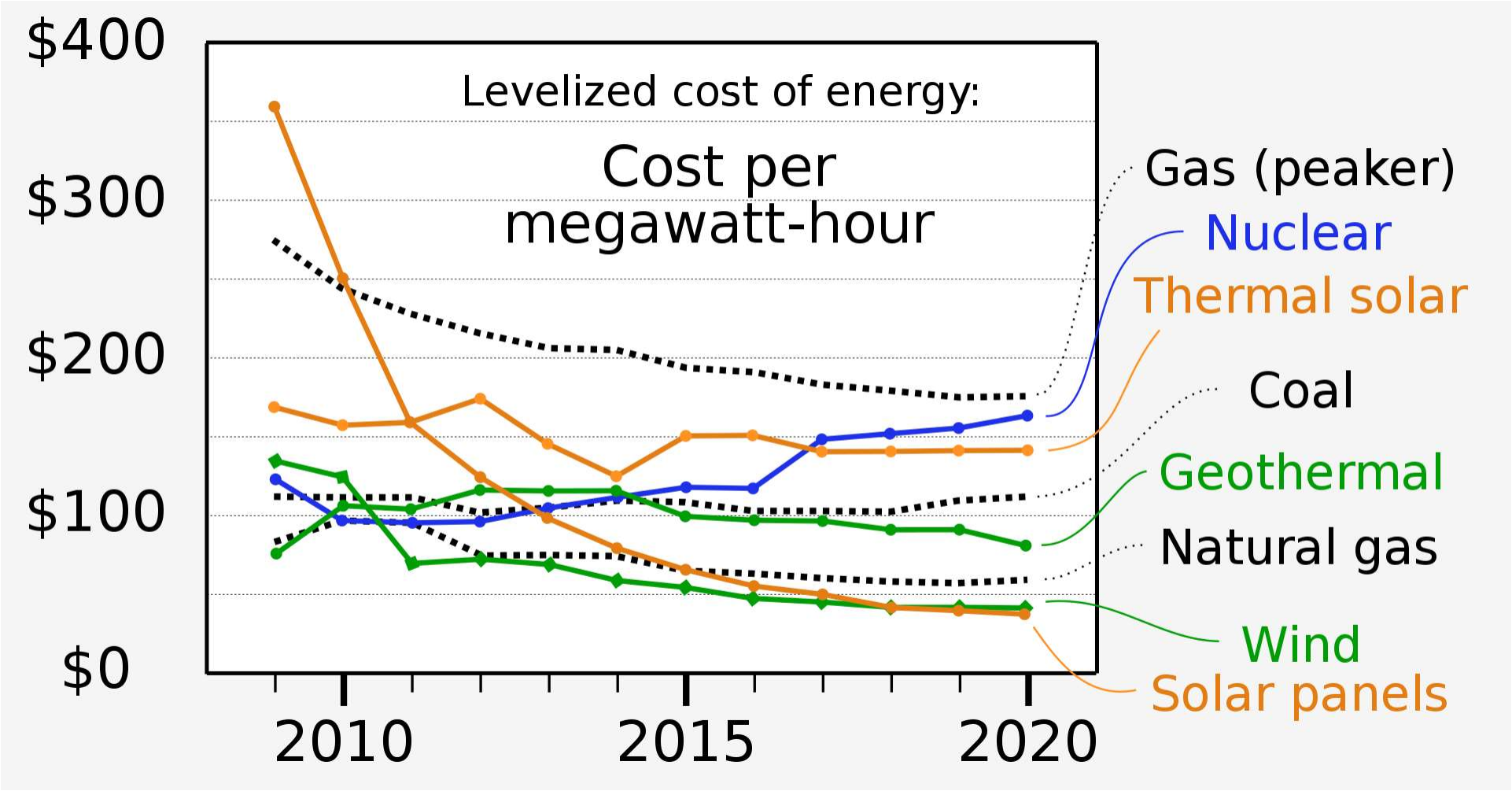
+ Cheaper to fabricate than Si solar cells.
(silicon cells require > 1000 C)

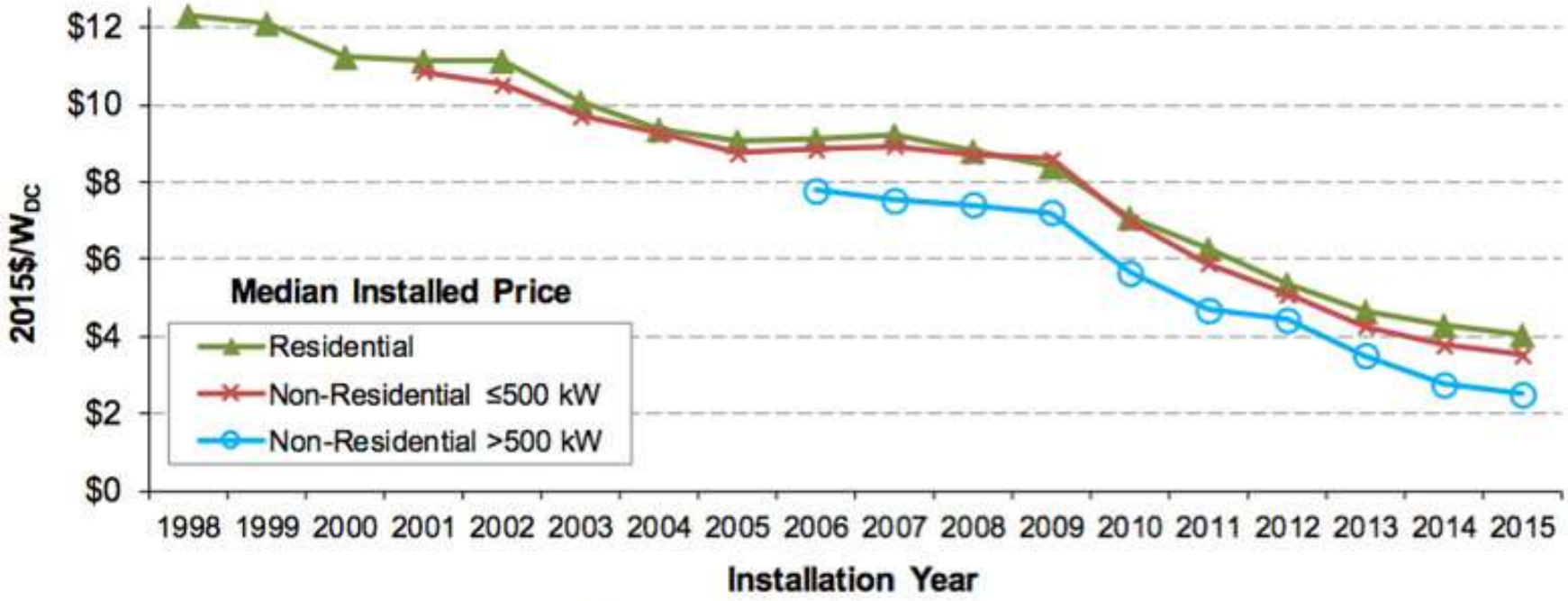
- Contains lead
Also less efficient $CH_3NH_3SnI_3$ version

- Not stable



methylammonium

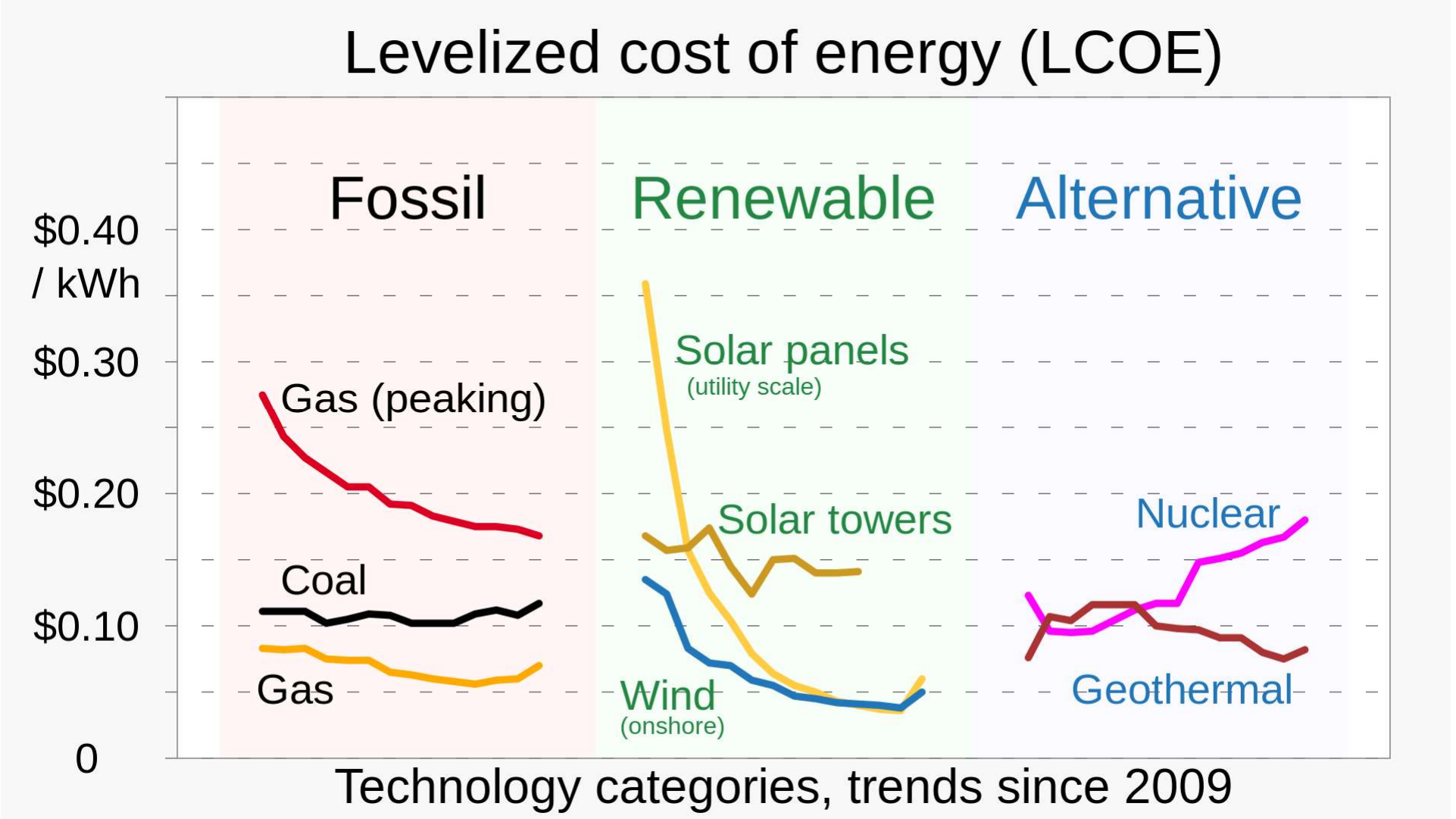




Notes: See Table 1 for sample sizes by installation year. Median installed prices are shown only if 20 or more observations are available for a given year and customer segment.

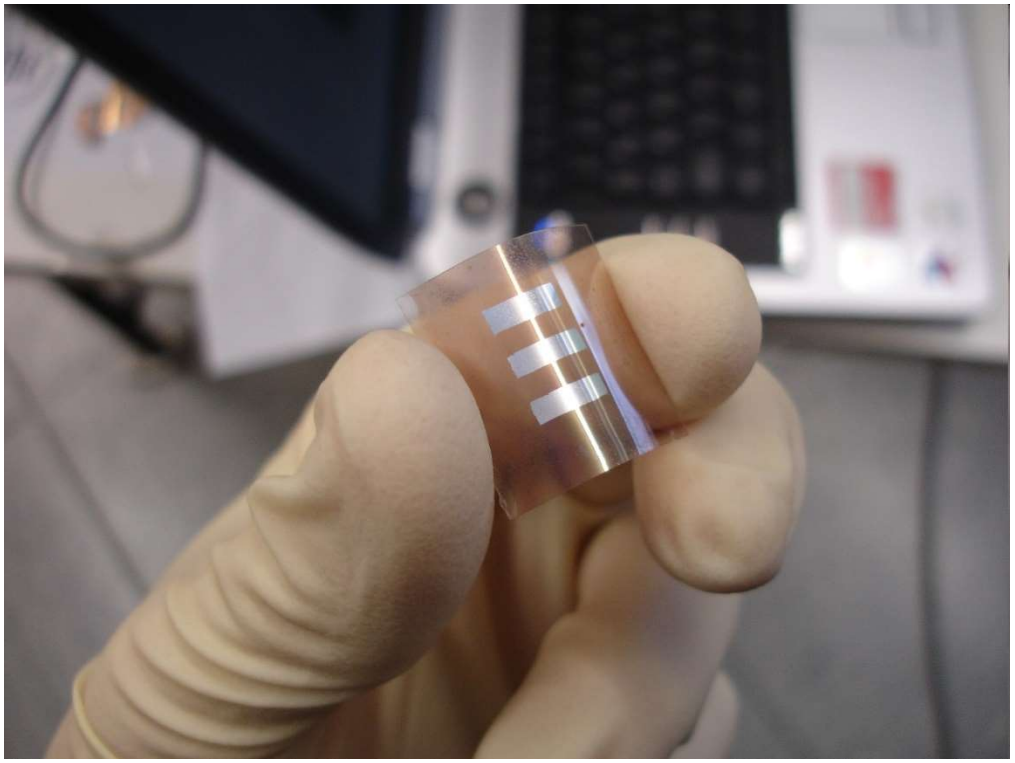
Figure 6. Median Installed Price Trends over Time

https://www.vox.com/2016/8/24/12620920/us-solar-power-costs-falling



https://en.wikipedia.org/wiki/Cost_of_electricity_by_source#/media/File:20201019_Levelized_Cost_of_Energy_(LCOE,_Lazard)_-_renewable_energy.svg

Printable solar cells

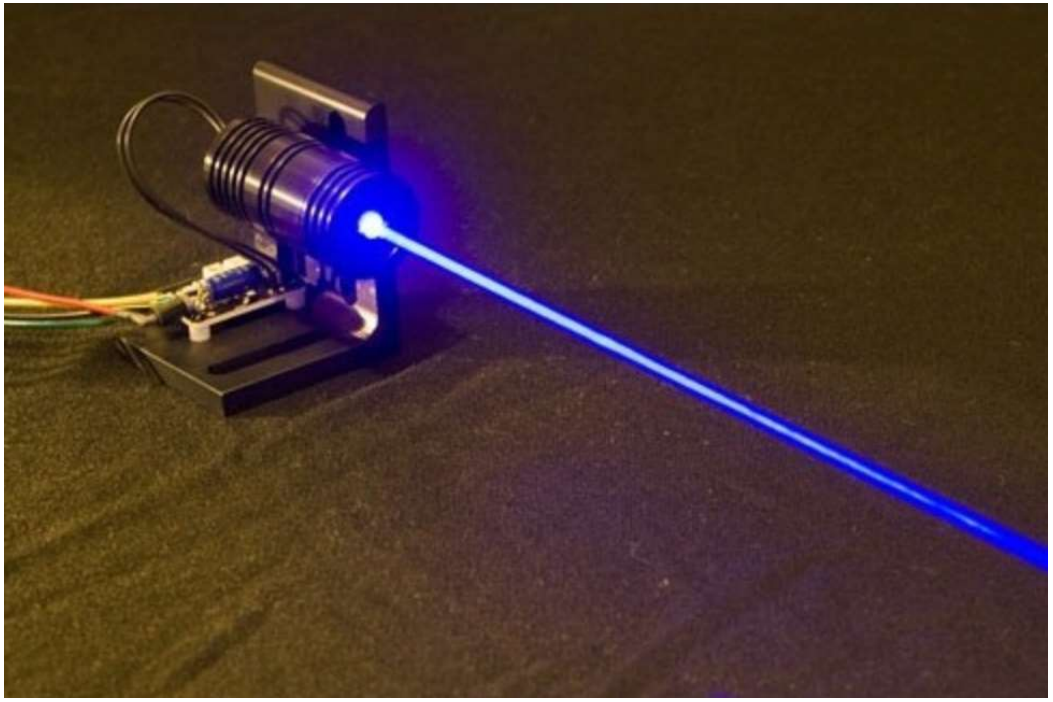


CD labor - TU Graz

Konarka

Laser Diodes

laser diodes



http://www.aliexpress.com/item/445nm-laser-diode/767127021.html

Shop on Google Sponsored

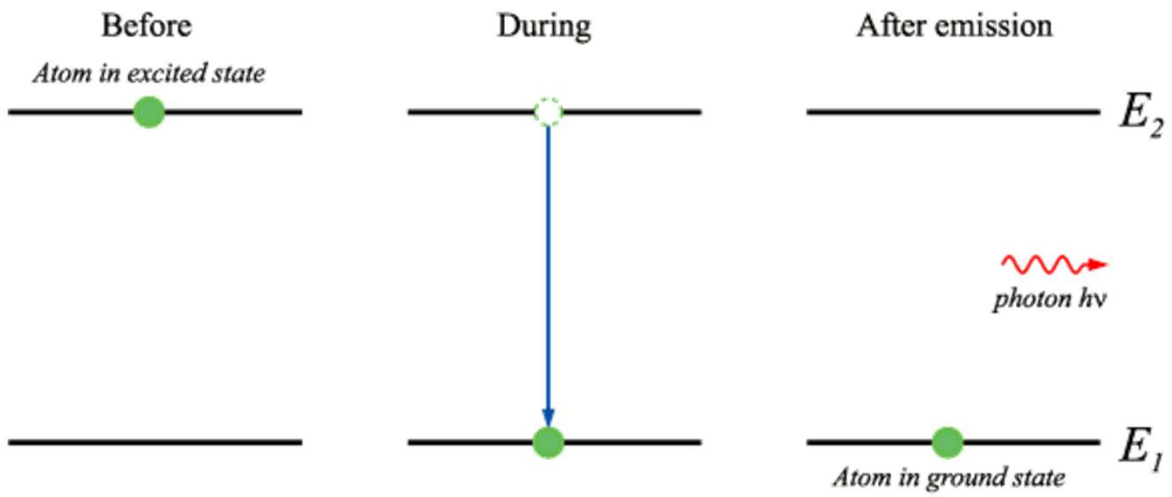
Laserdiode Rot 650 nm 2 mW ...
€23,99
Conrad.at

Laserdiode Rot 670 nm 5 mW U- ...
€9,19
Conrad.at

3V 6mm 5mW 650nm rote Laser-
€2,43
DX.com

Laser Components - ...
€30,72
Distrelec Österrei...

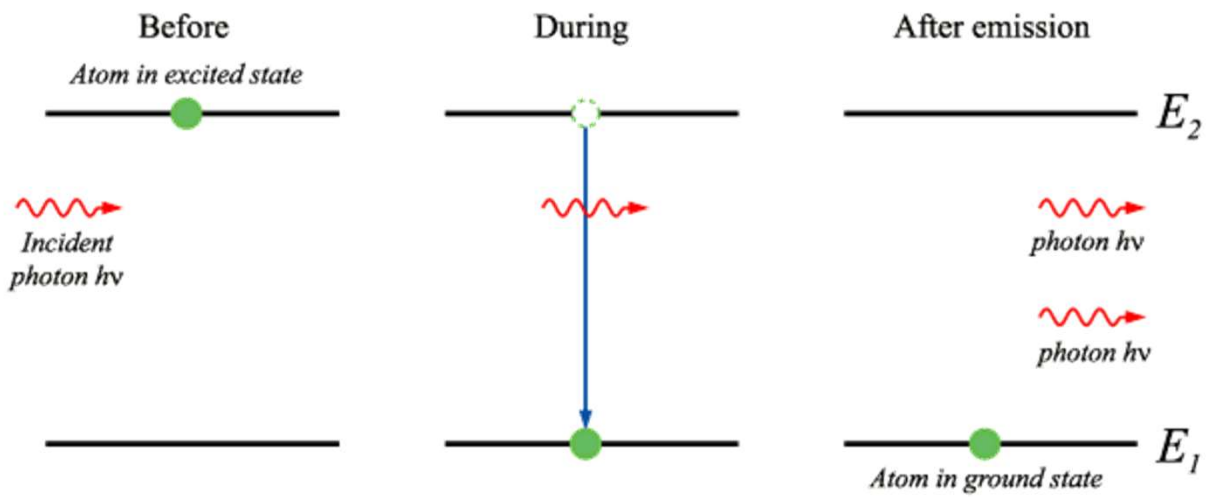
Spontaneous emission



$$h\nu = E_2 - E_1$$

Spontaneous emission dominates in fluorescent lighting and light emitting diodes. In a gas, the conservation of momentum is easily maintained. For a semiconductor, a direct bandgap material is necessary.

Stimulated emission



Stimulated emission is responsible for the coherent light of lasers.

$$W_{\text{stimulated}}(\omega) = W_{\text{spontaneous}}(\omega) \cdot n_{ph}(\omega)$$

laser diodes

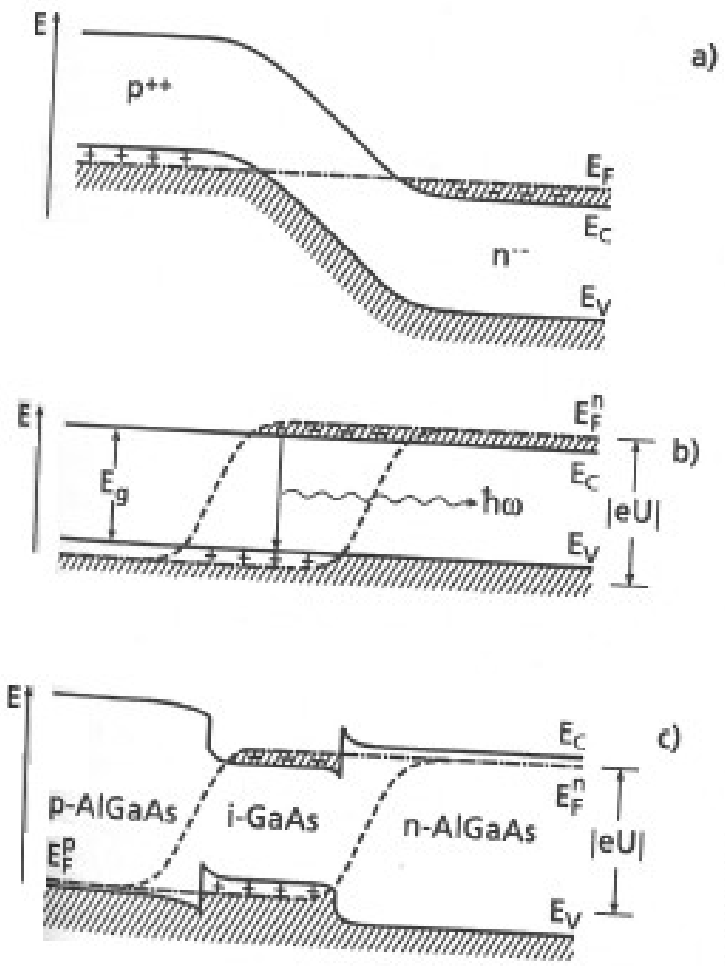
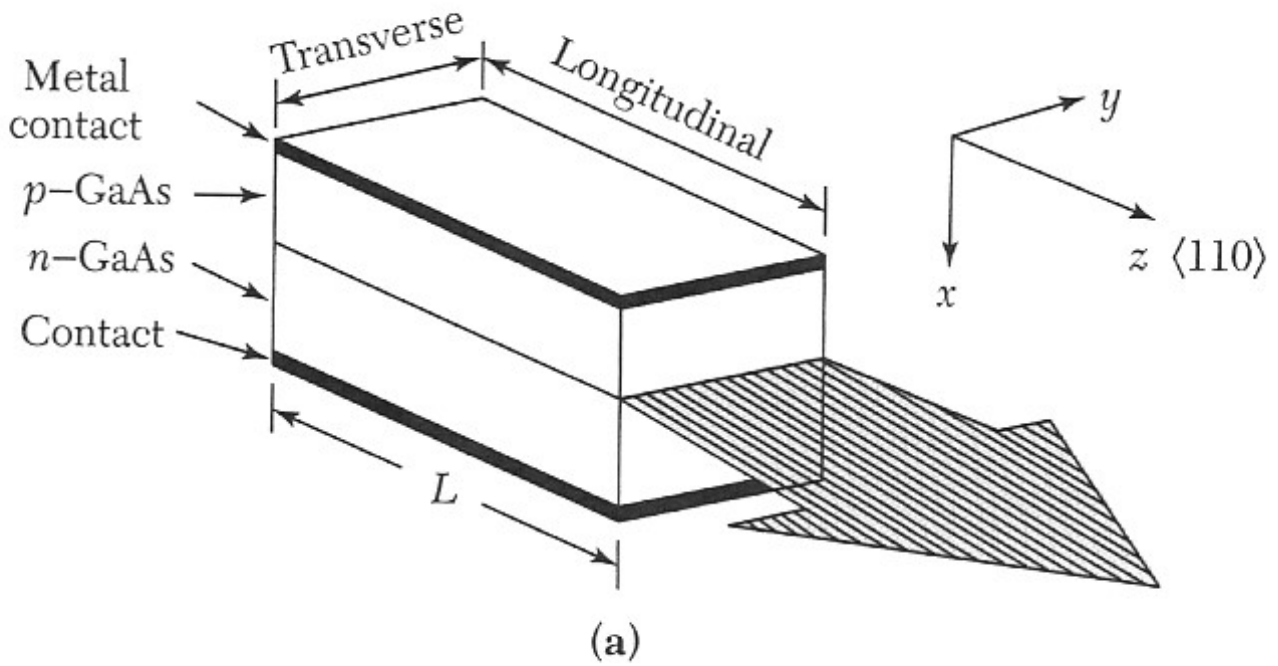


Fig. 12.37. Electronic band schemes $E(x)$ of *pn*-semiconductor laser structures along a direction x perpendicular to the layer structure: **(a)** Degenerately doped $p^{++}n^{--}$ junction without external bias (thermal equilibrium); **(b)** same $p^{++}n^{--}$ junction with maximum bias U in forward direction; **(c)** double-heterostructure pin junction of *p*-AlGaAs/*i*-GaAs/*n*-AlGaAs with maximum bias U in forward direction. E_F^n, E_F^p are the quasi-Fermi levels in the *n*- and *p*-region, respectively; E_C and E_V are conduction and valence band edges

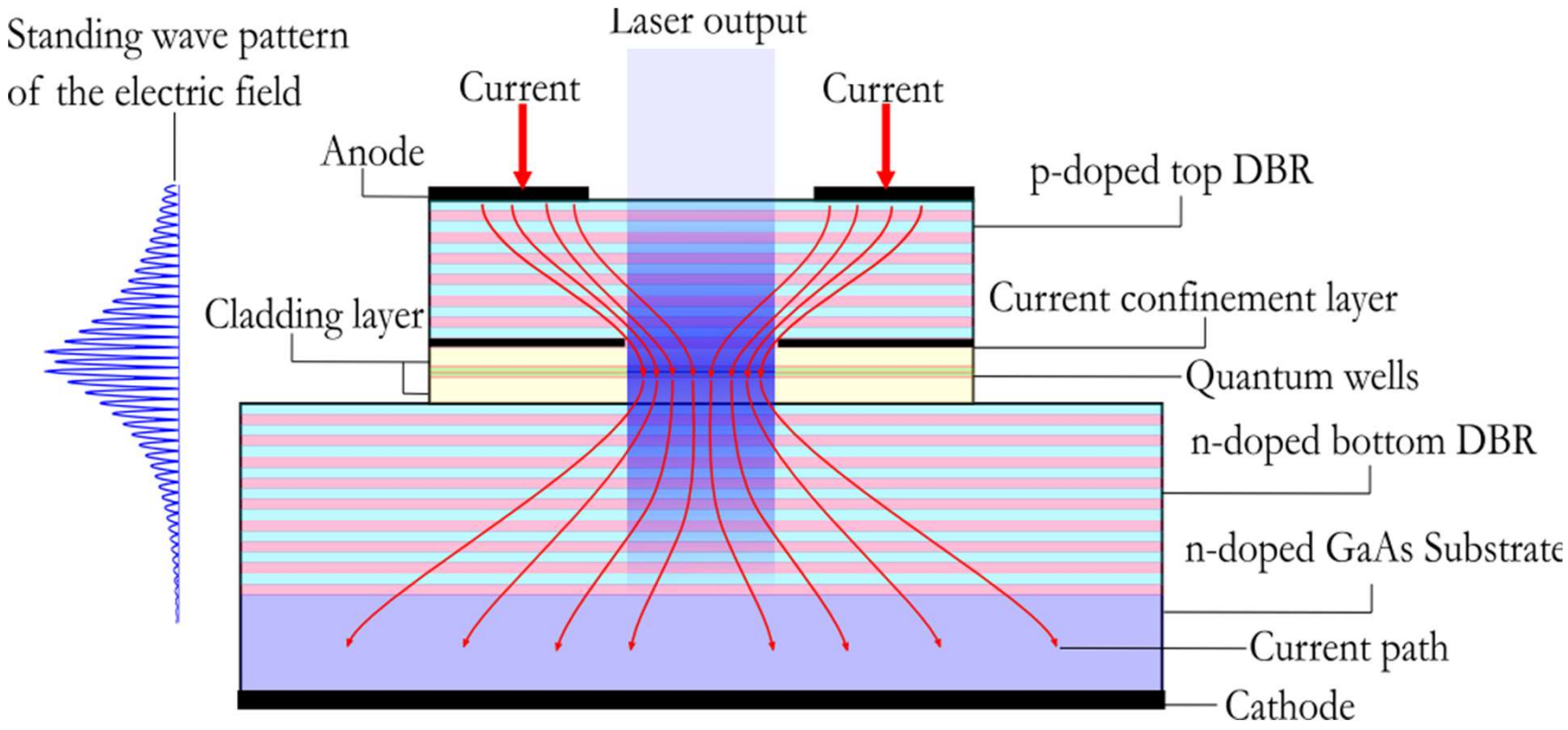
Ibach & Lueth, *Solid-State Physics*

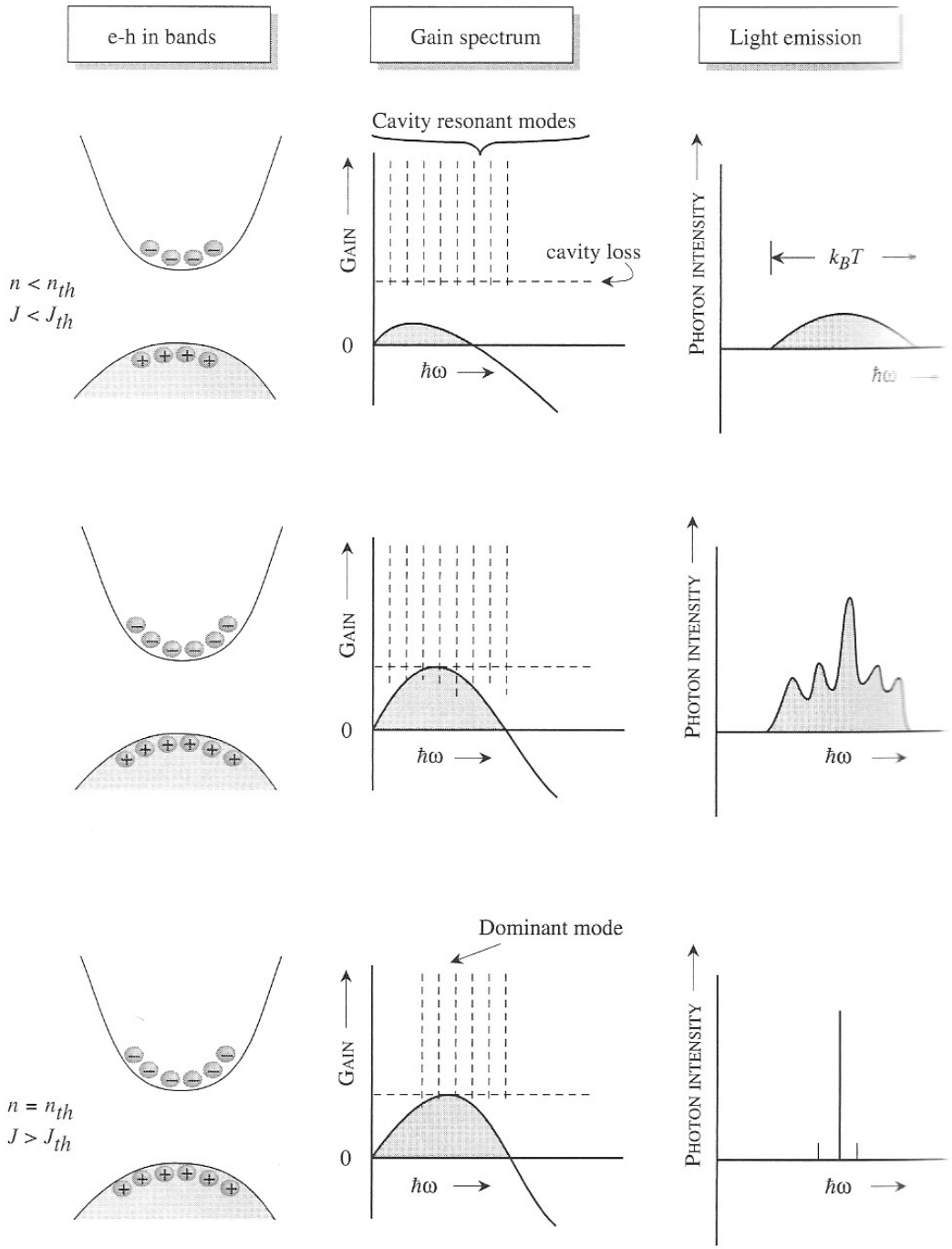
Laser diode



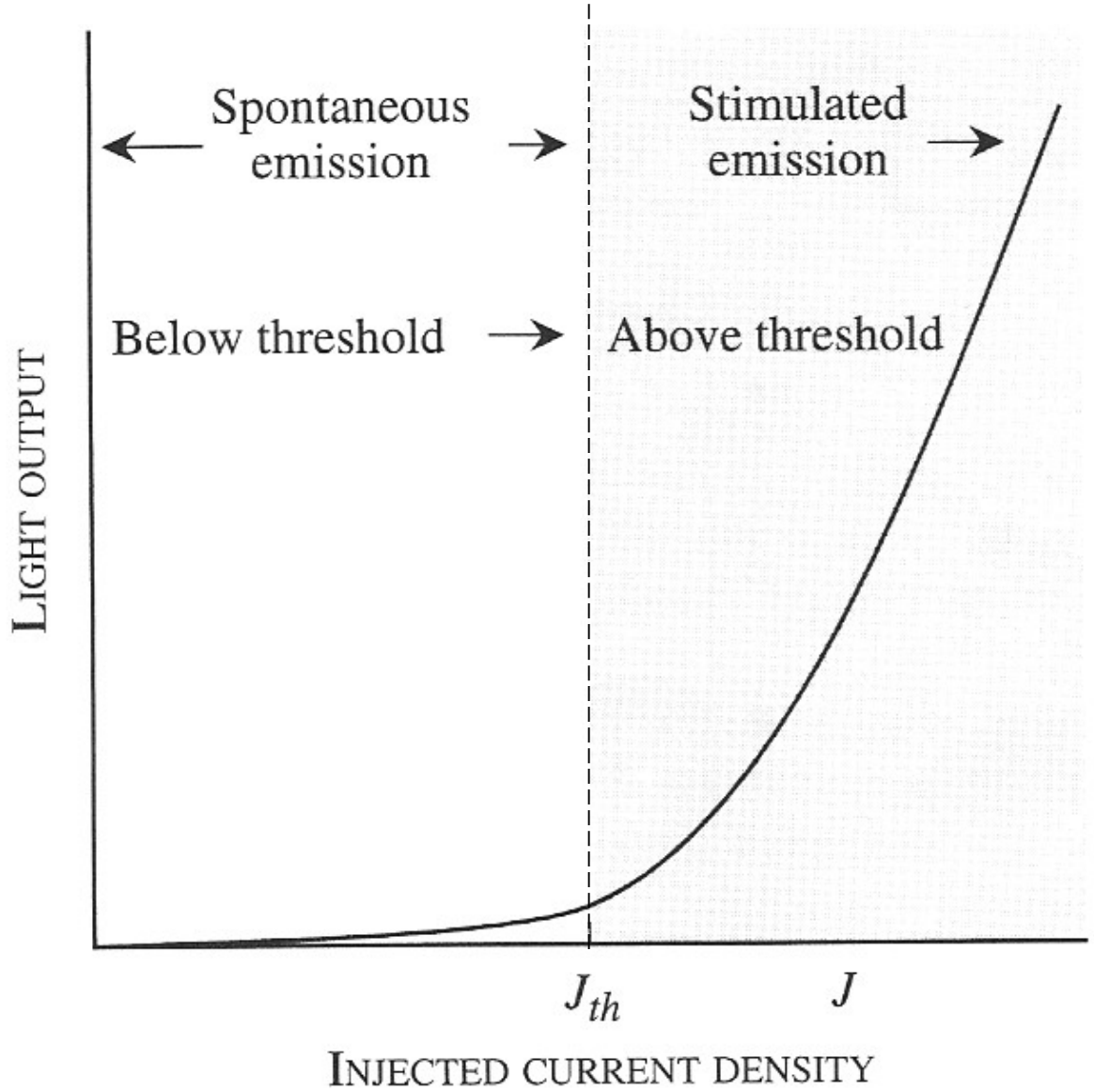
The faces of the crystal are cleaved to make mirrors.

Vertical-cavity surface-emitting laser (VCSEL)

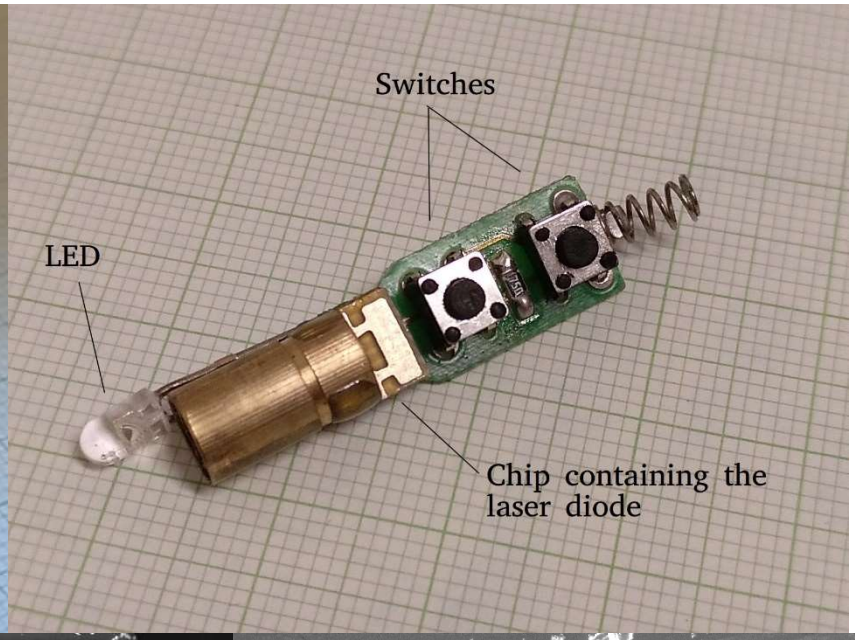


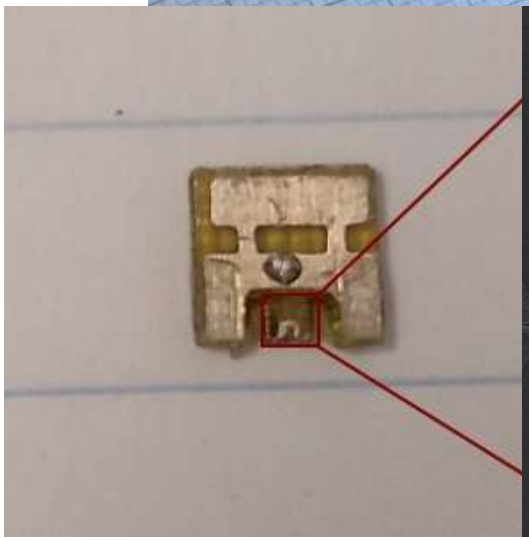

e-h in bands
Gain spectrum
Light emission
Cavity resonant modes
cavity loss
$n < n_{th}$
$J < J_{th}$
GAIN
0
$\hbar\omega$
PHOTON INTENSITY
$k_B T$
$\hbar\omega$
$n = n_{th}$
$J > J_{th}$
Dominant mode

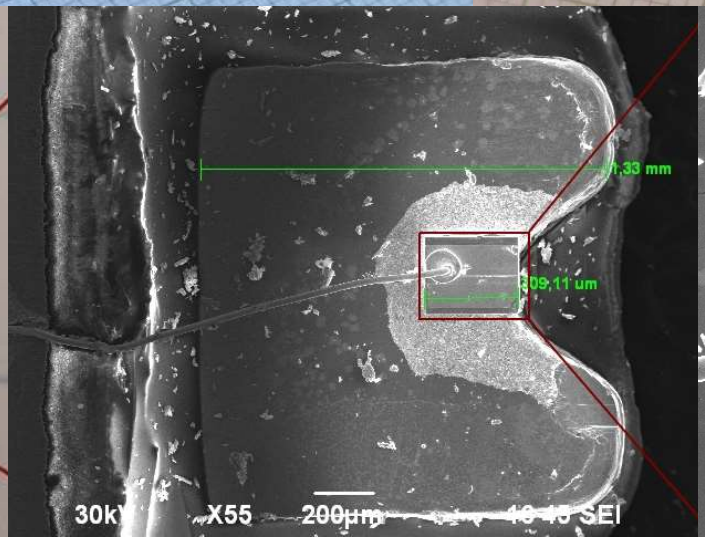
Stimulated emission

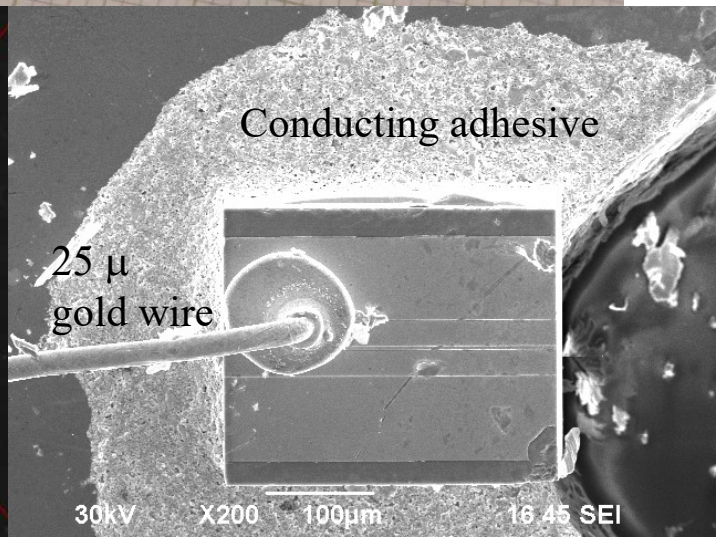


Laser pointer

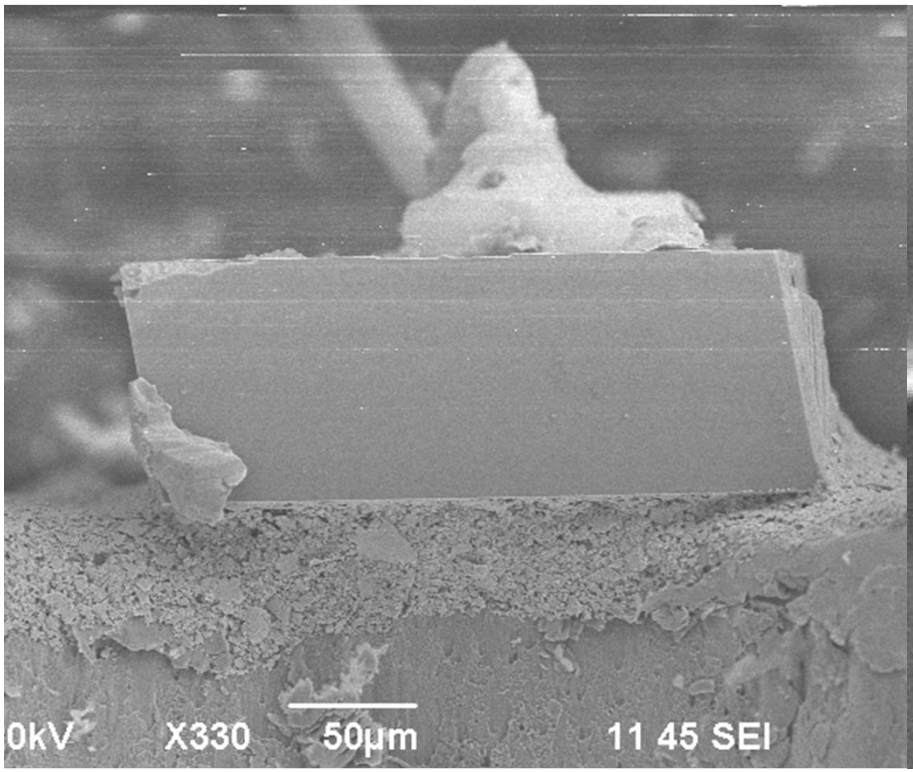


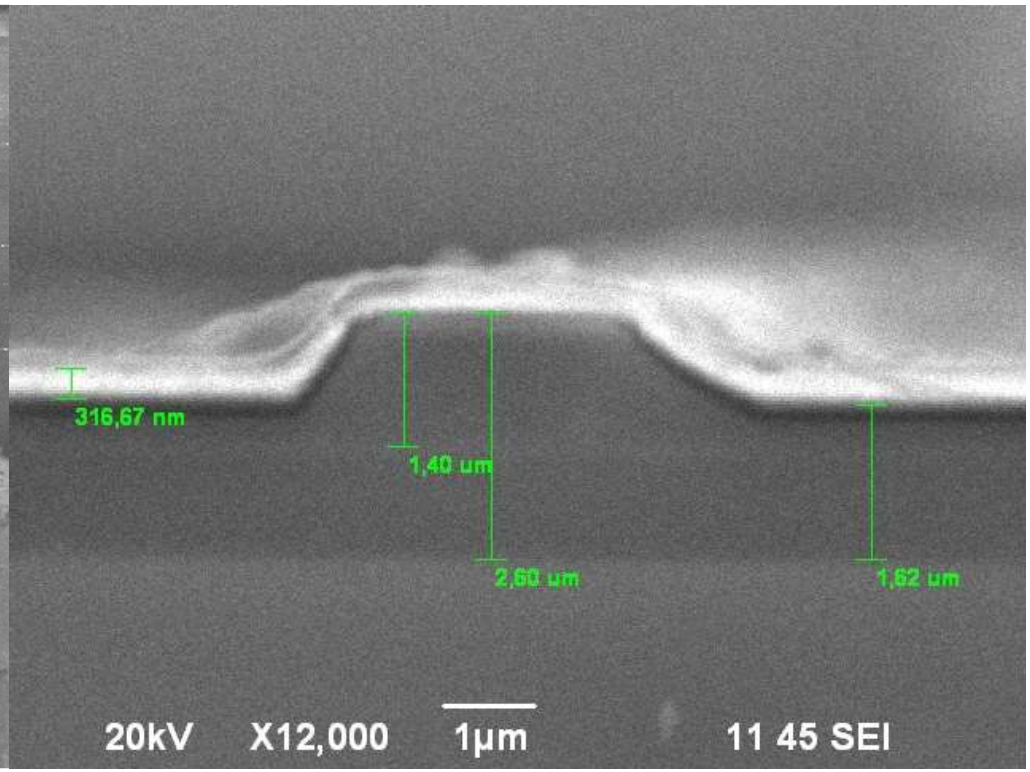






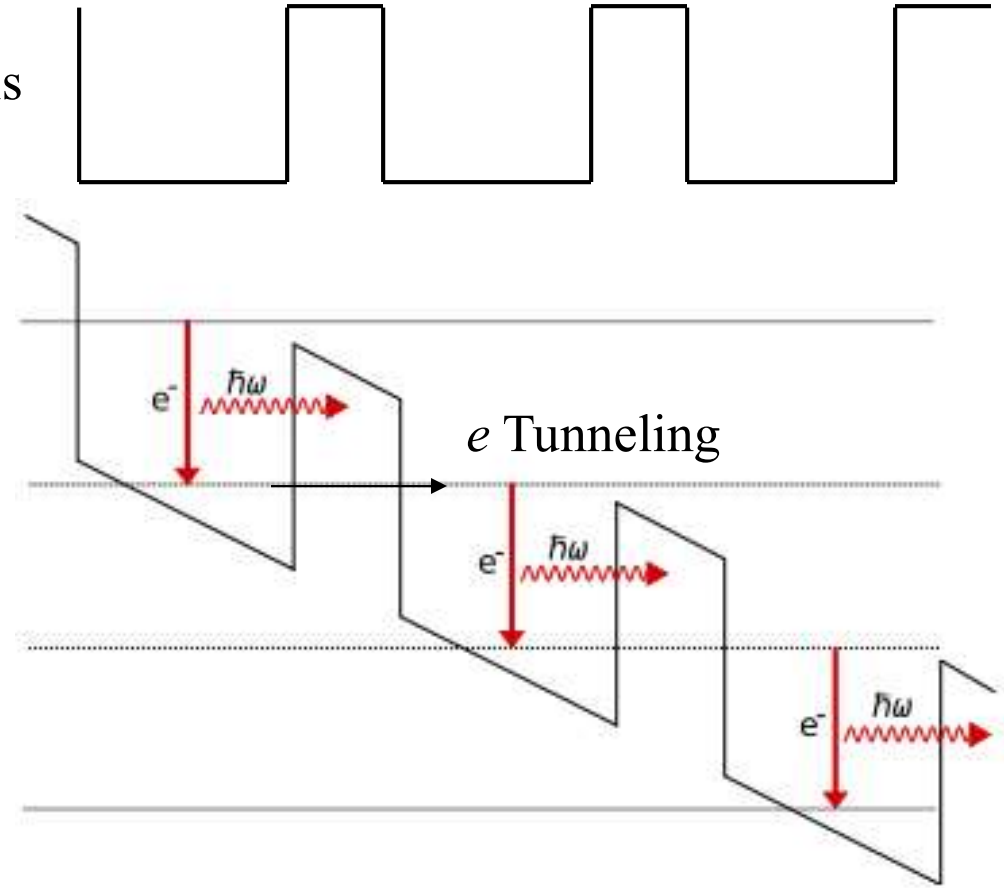
Laser pointer





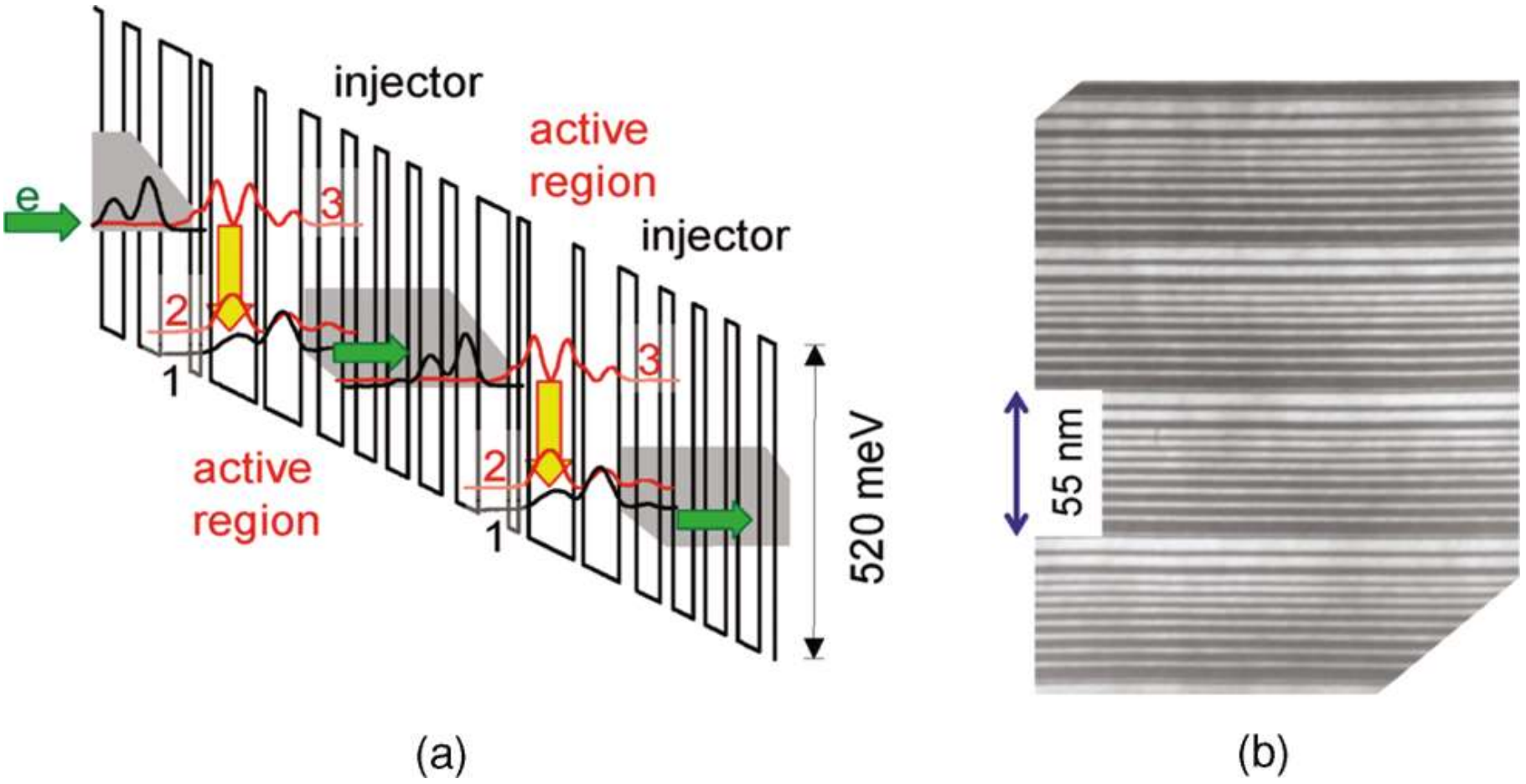
Quantum cascade lasers

Quantum wells



Energy levels depend on the width of the wells so lasers can be made at many frequencies (mid to far infrared 2.75 - 250 μm).
Many colors can be made with one materials system.
Window in atmosphere at 5 μm used for point-to-point communications.

Quantum cascade lasers



http://opticalengineering.spiedigitallibrary.org/article.aspx?articleid=1096486