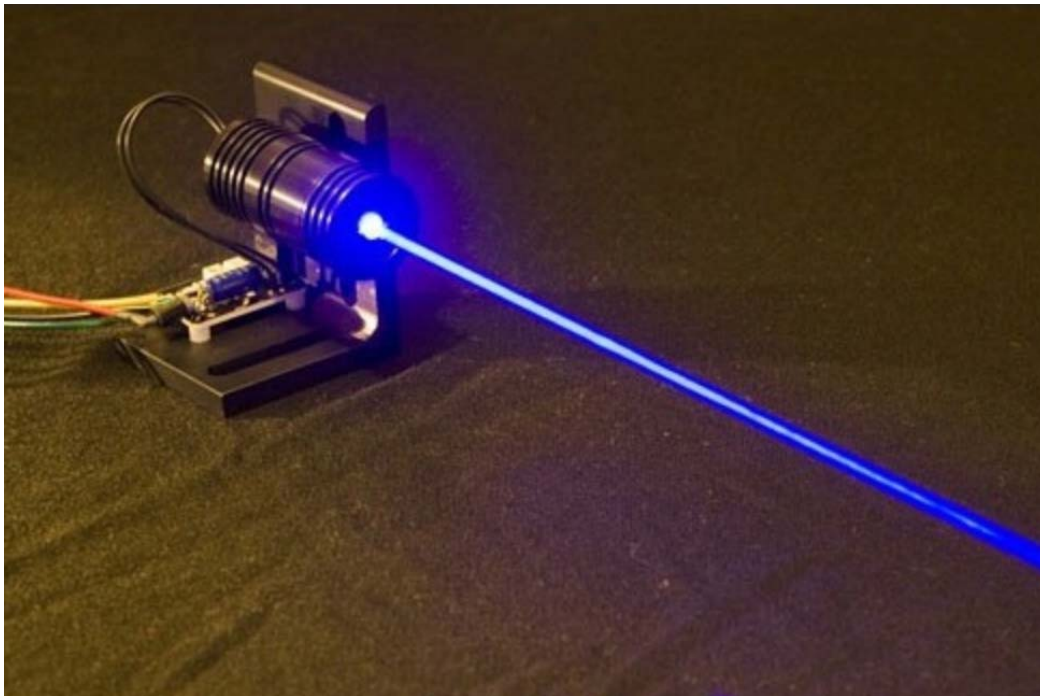


Laser Diodes

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

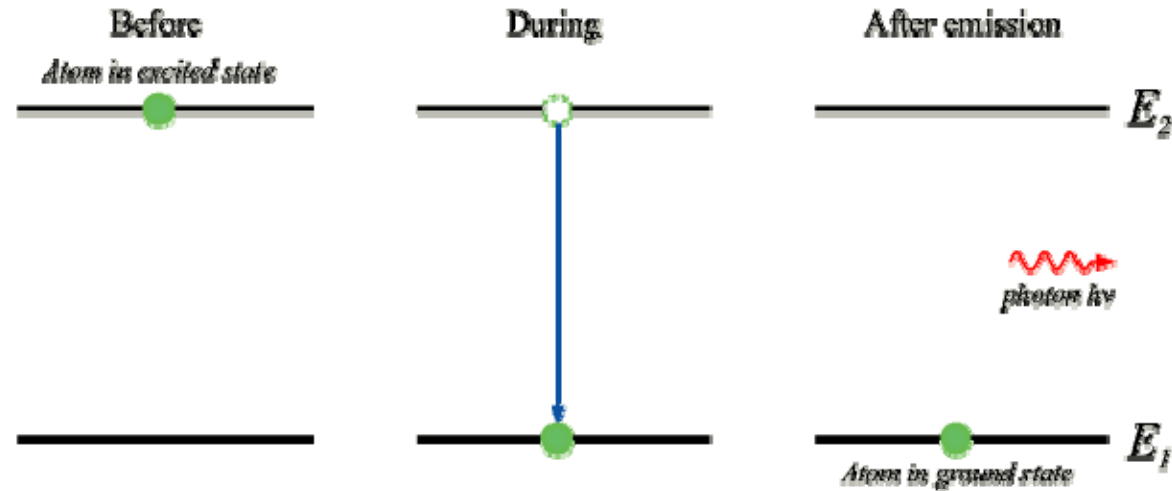


Laser Components
- ...

€30,72

Distrelec Österrei...

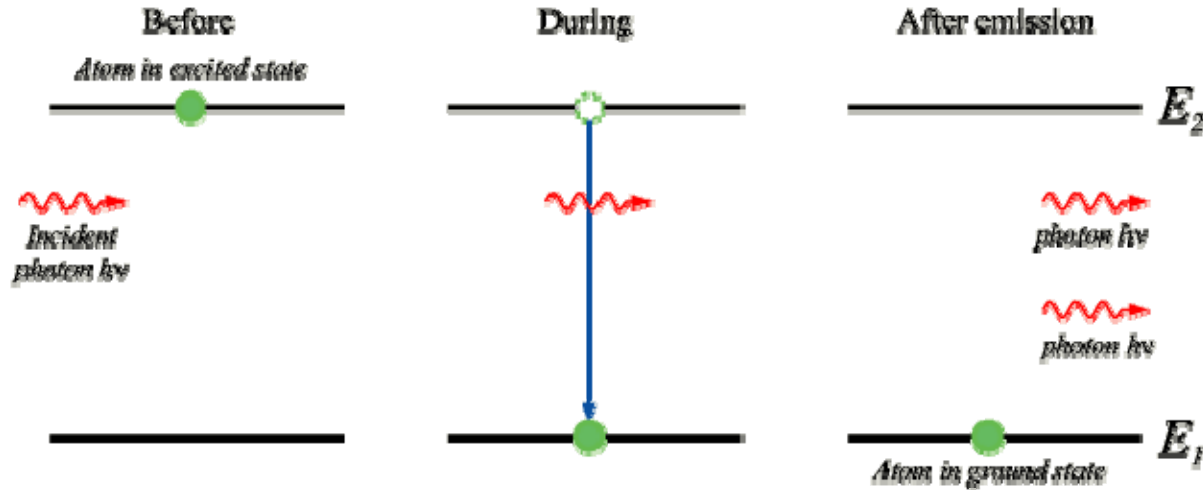
Spontaneous emission



$$h\nu = E_2 - E_1$$

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

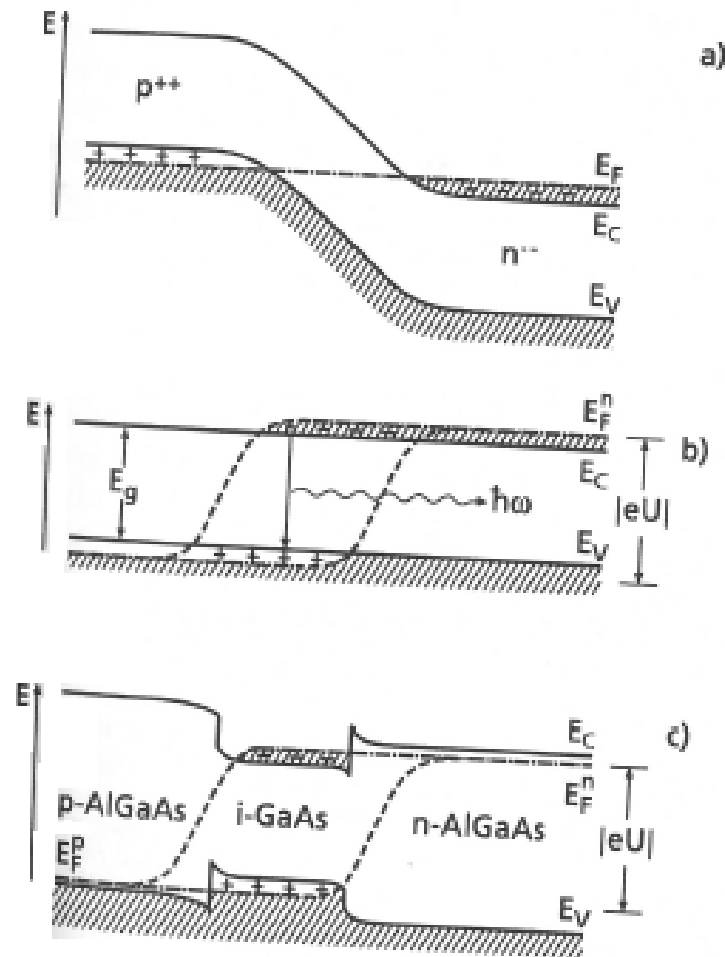
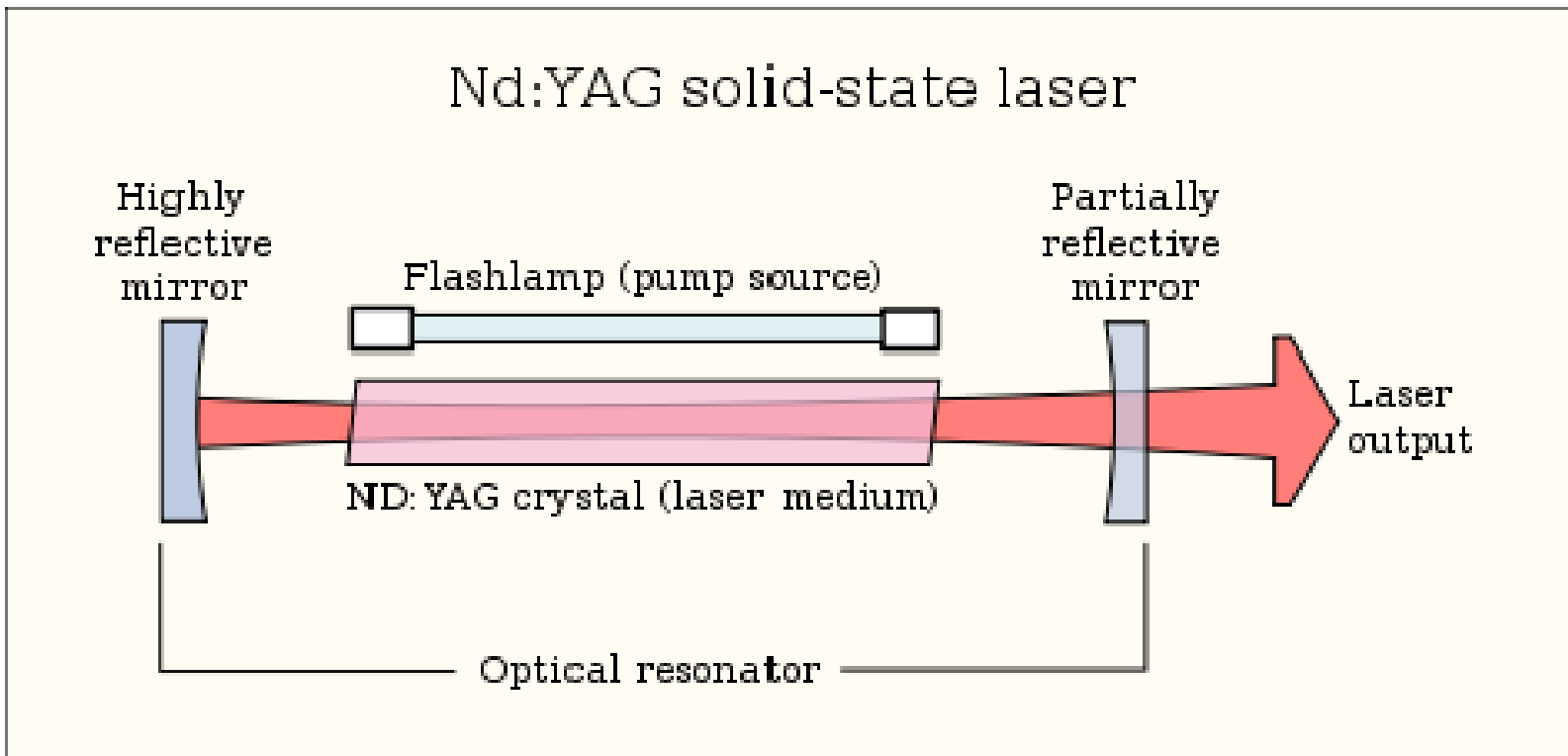


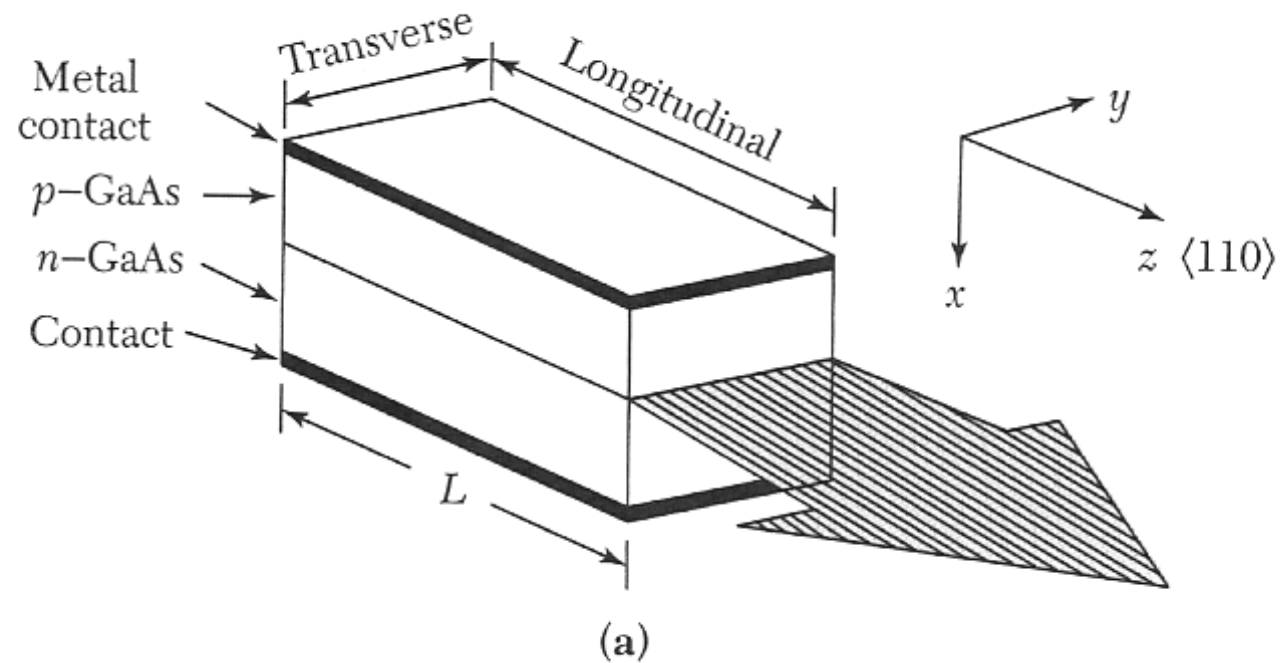
Fig. 12.37. Electronic band schemes $E(x)$ of pn -semiconductor laser structures along a direction x perpendicular to the layer structure: (a) Degenerately doped $p^{++}n^{--}$ junction without external bias (thermal equilibrium); (b) same $p^{++}n^{--}$ junction with maximum bias U in forward direction; (c) double-heterostructure pin junction of $p\text{-AlGaAs}/i\text{-GaAs}/n\text{-AlGaAs}$ 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

Optical cavity



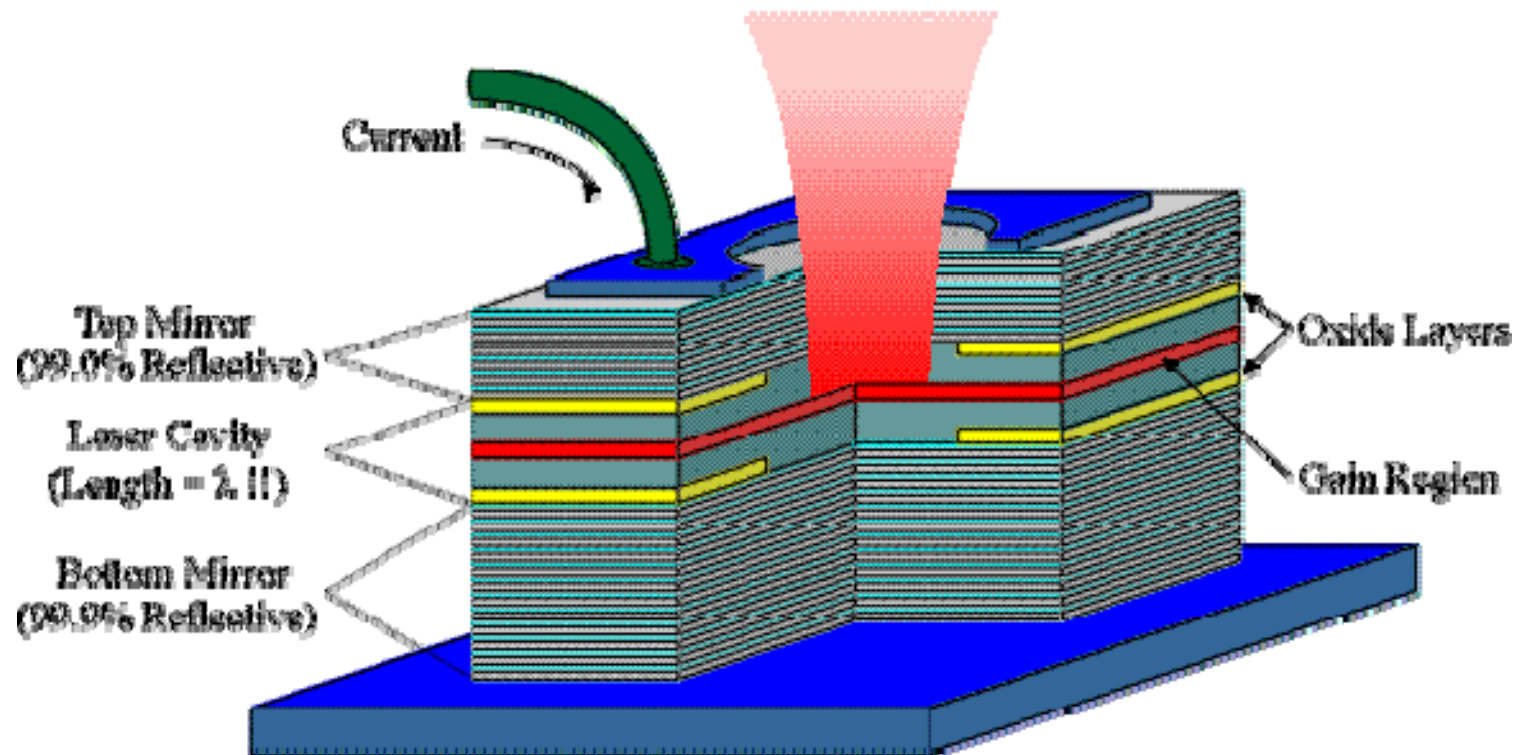
https://en.wikipedia.org/wiki/Laser_construction#/media/File:Lasercons.svg

Laser diode



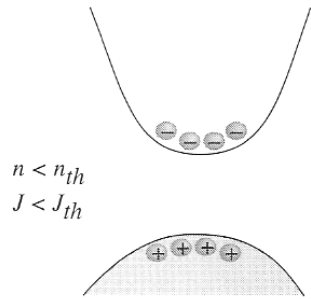
The faces of the crystal are cleaved to make mirrors.

Vertical-cavity surface-emitting laser (VCSEL)

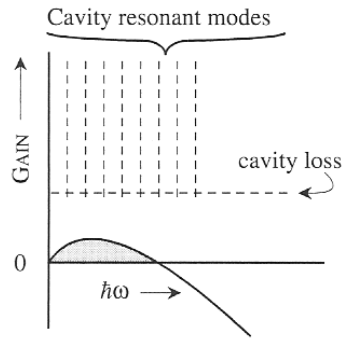


<http://wwwold.fi.isc.cnr.it/users/giovanni.giacomelli/Semic/Samples/samples.html>

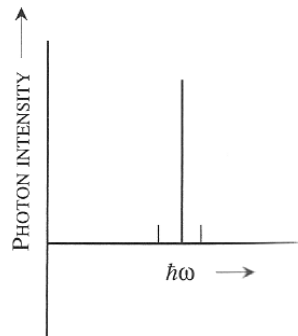
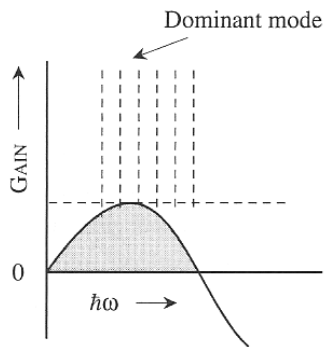
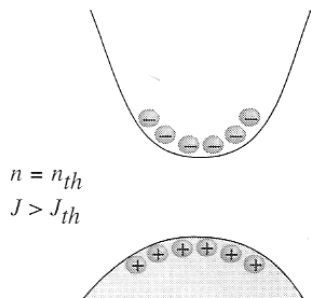
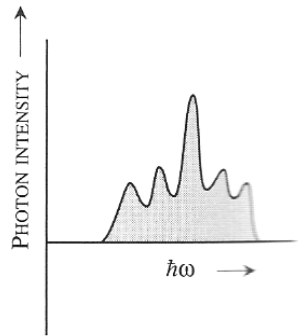
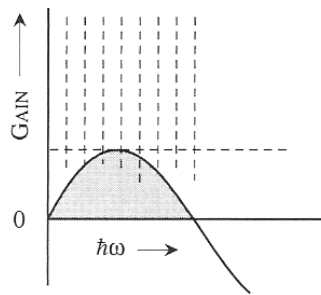
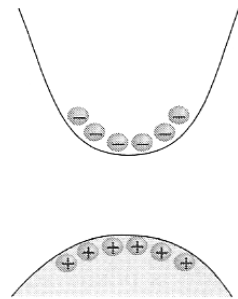
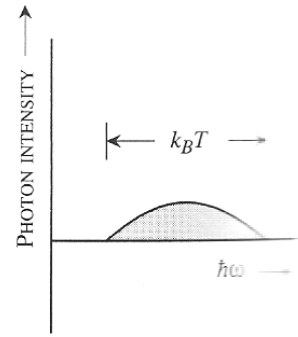
e-h in bands



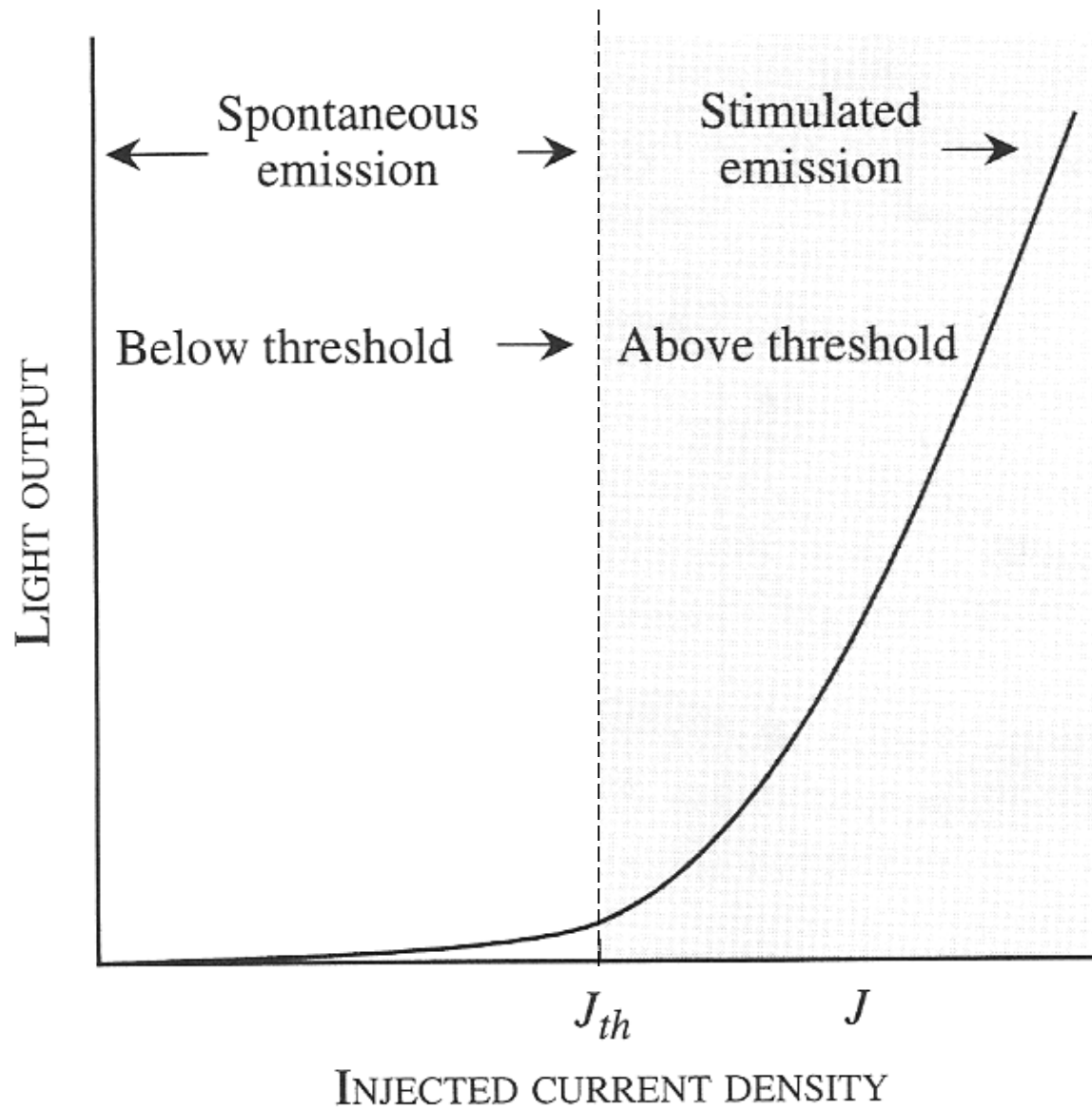
Gain spectrum



Light emission

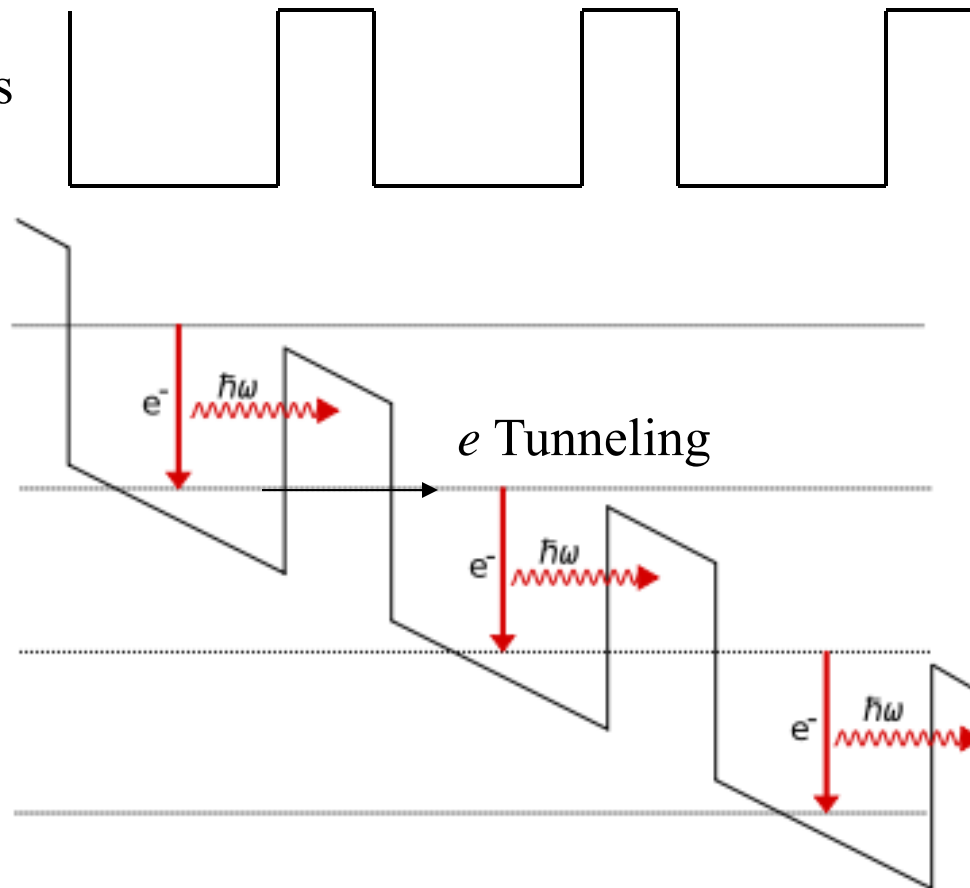


Stimulated emission



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

