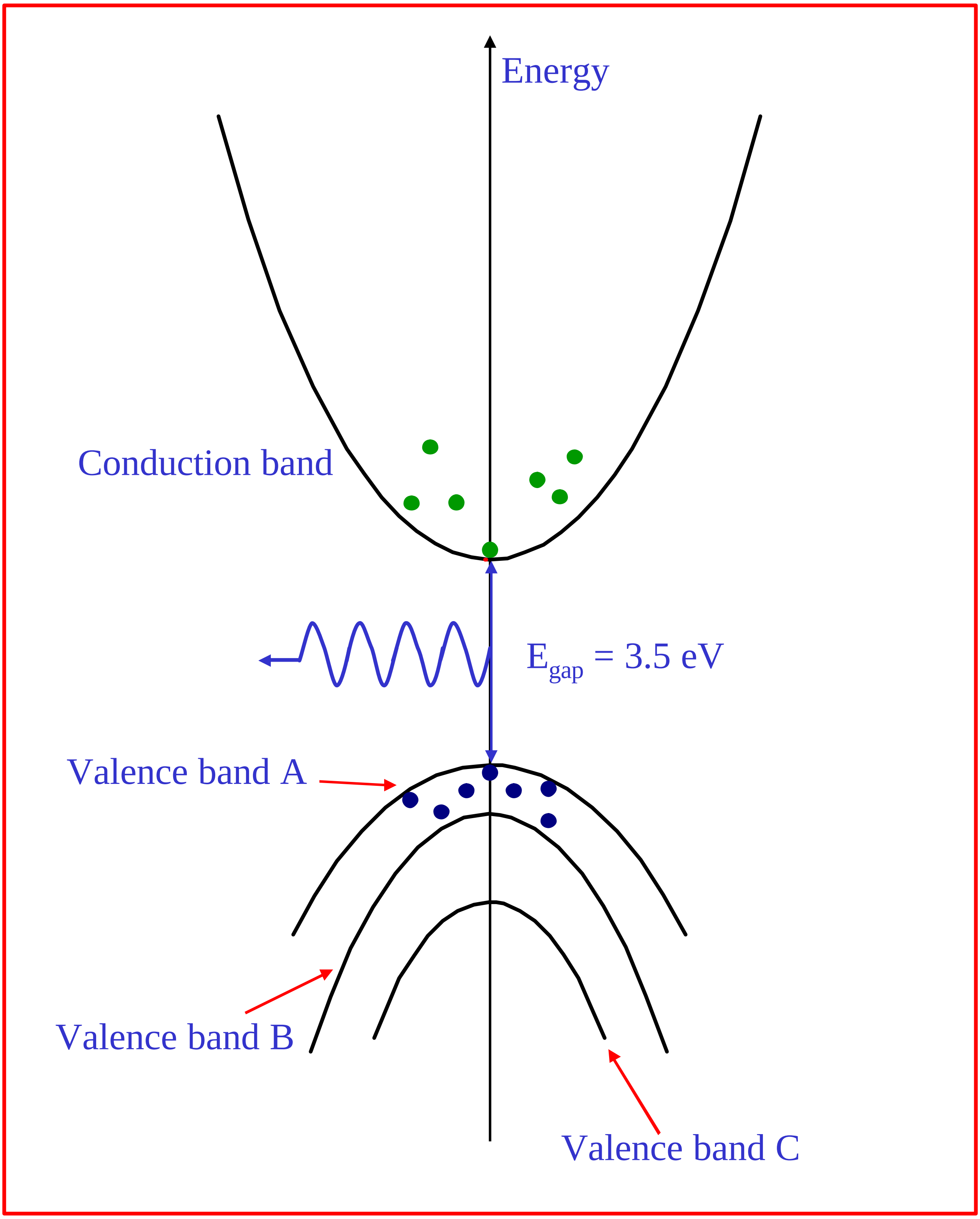
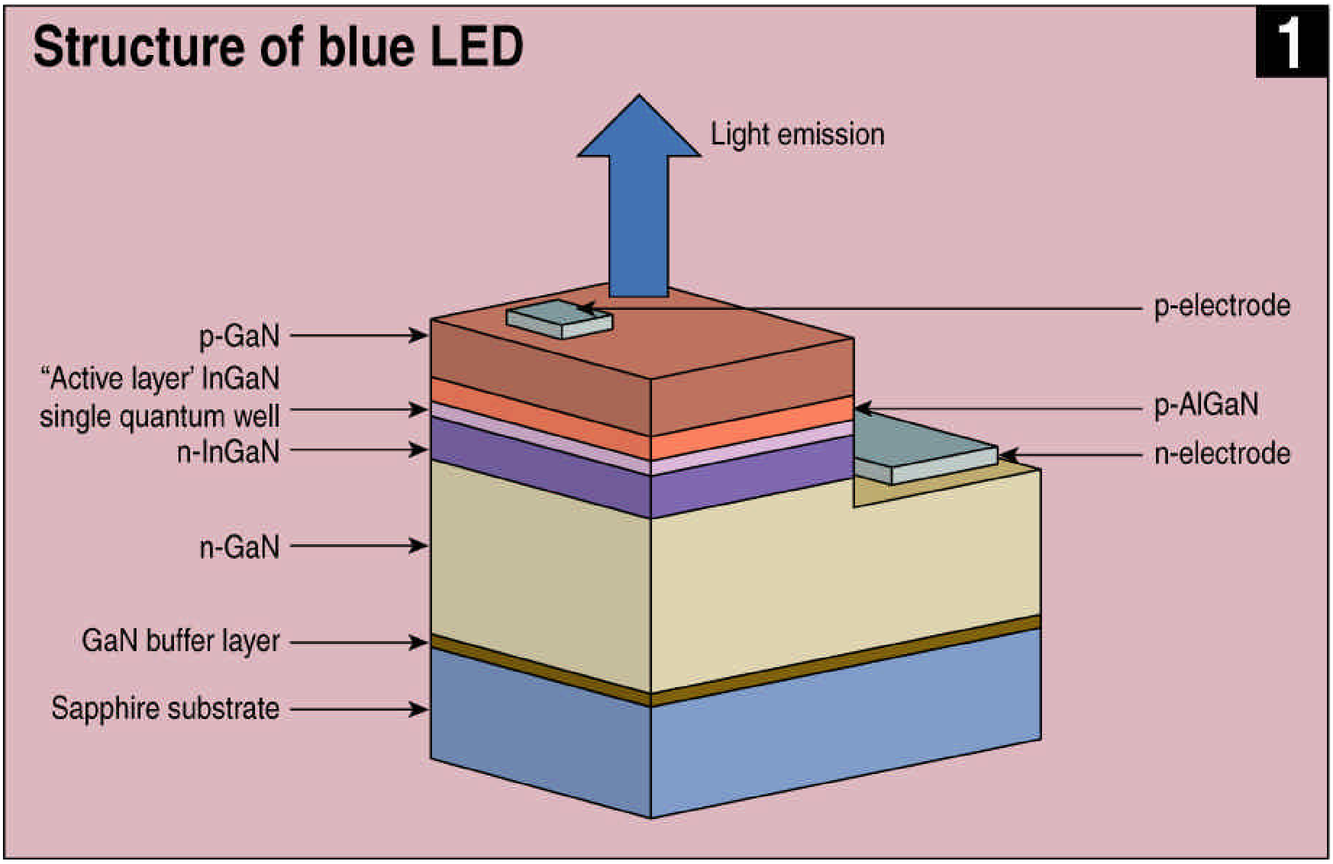
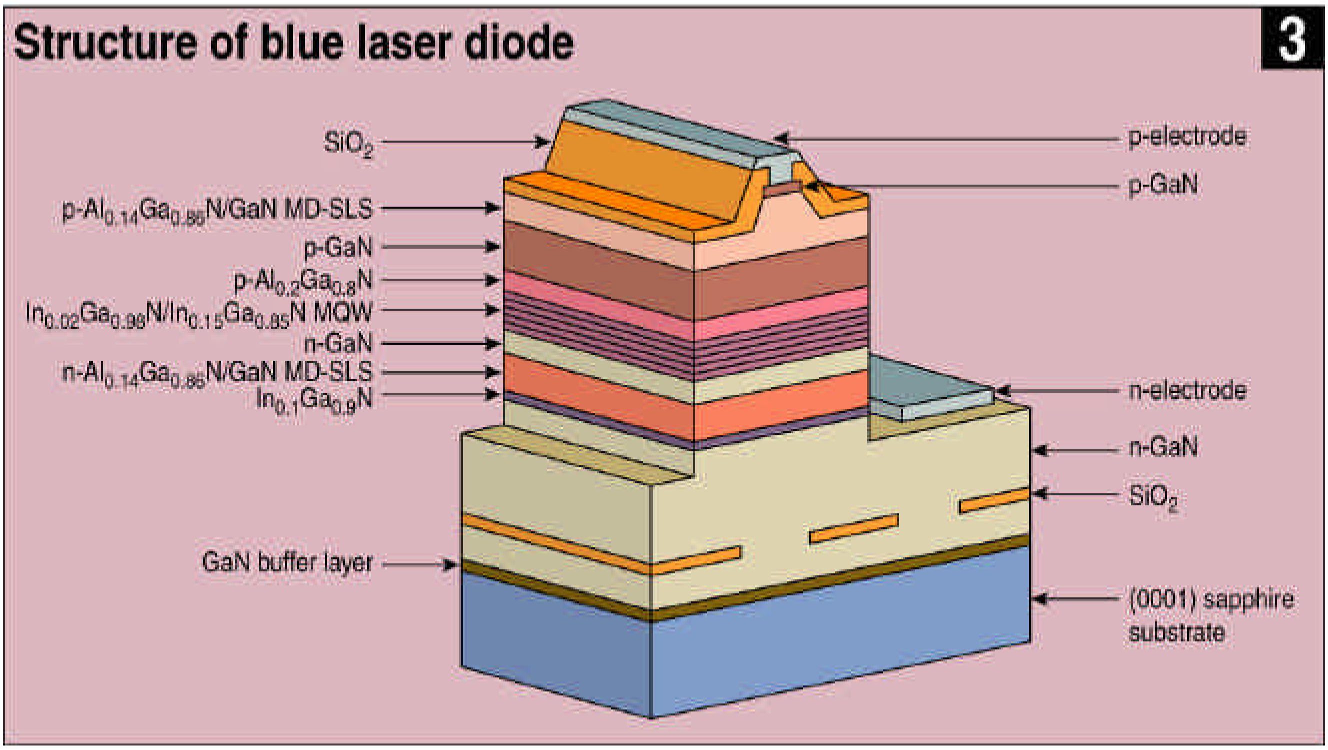
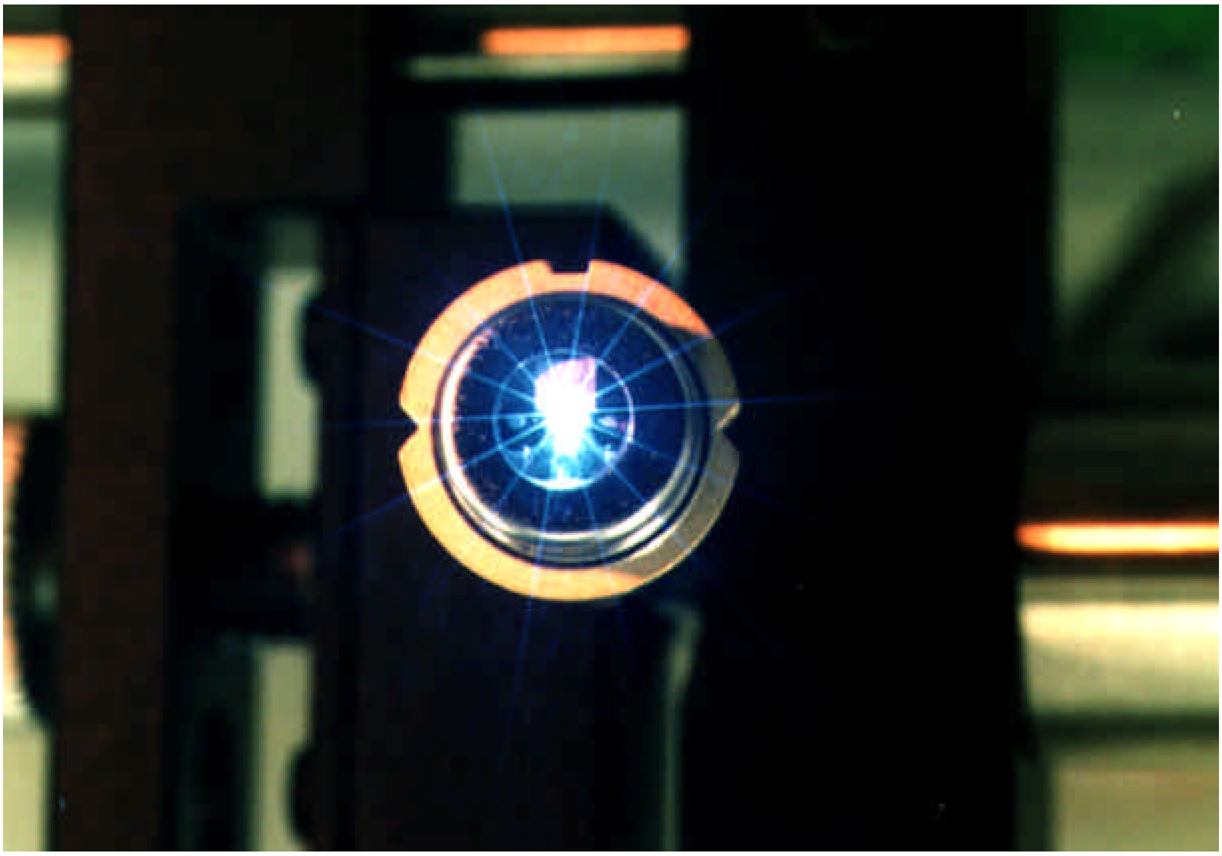
Band Structure of Hexagonal GaN

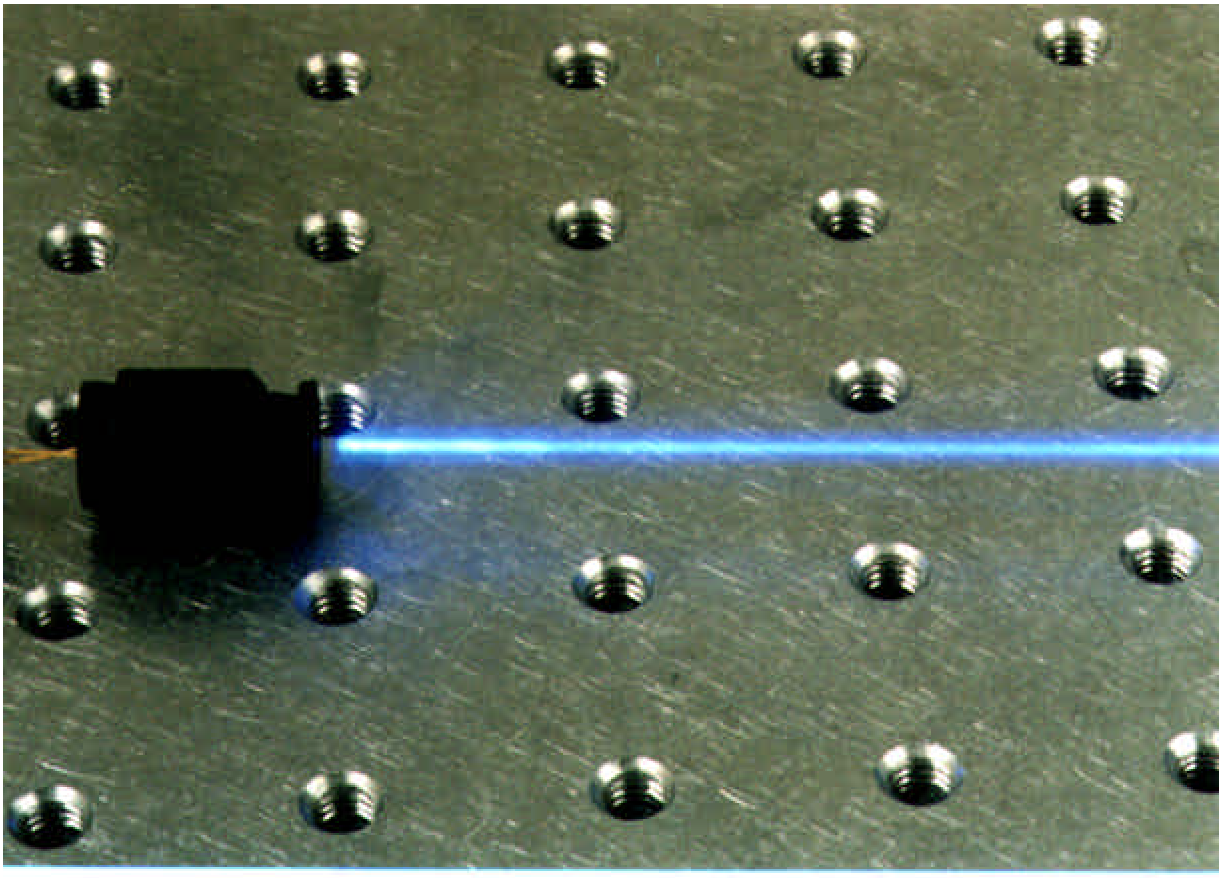



Structure of blue LED
1
Light emission
p-electrode
p-GaN
"Active layer' InGaN
single quantum well
n-InGaN
p-AlGaN
n-electrode
n-GaN
GaN buffer layer
Sapphire substrate

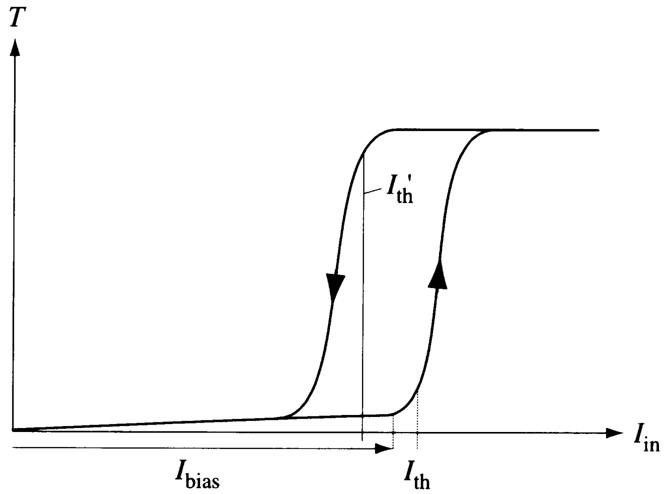

Structure of blue laser diode
3
SiO_2
p-electrode
p-GaN
p-$Al_{0.14}Ga_{0.86}N$/GaN MD-SLS
p-GaN
p-$Al_{0.2}Ga_{0.8}N$
$In_{0.02}Ga_{0.98}N/In_{0.15}Ga_{0.85}N$ MQW
n-GaN
n-$Al_{0.14}Ga_{0.86}N$/GaN MD-SLS
$In_{0.1}Ga_{0.9}N$
n-electrode
n-GaN
SiO_2
GaN buffer layer
(0001) sapphire
substrate

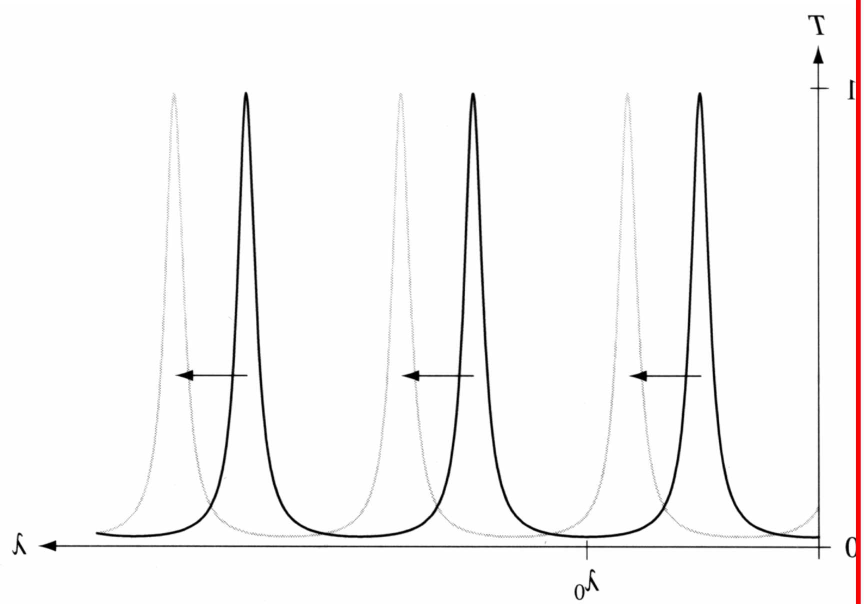


GaN laser diode operating at ~400 nm.

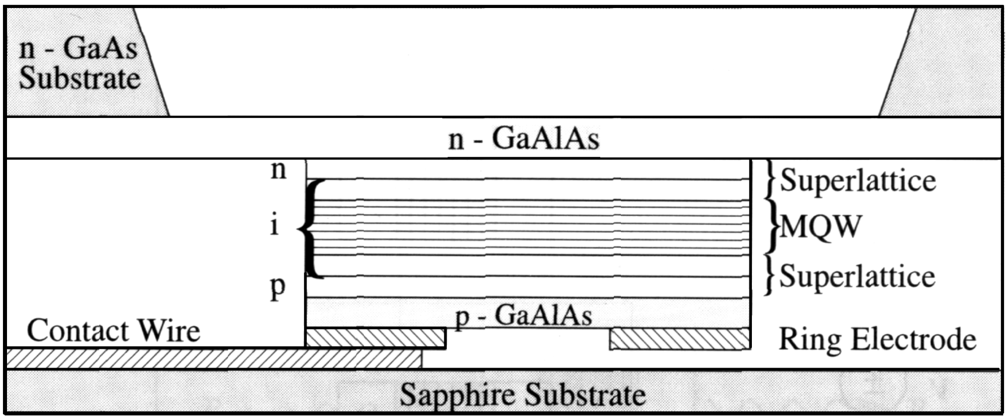


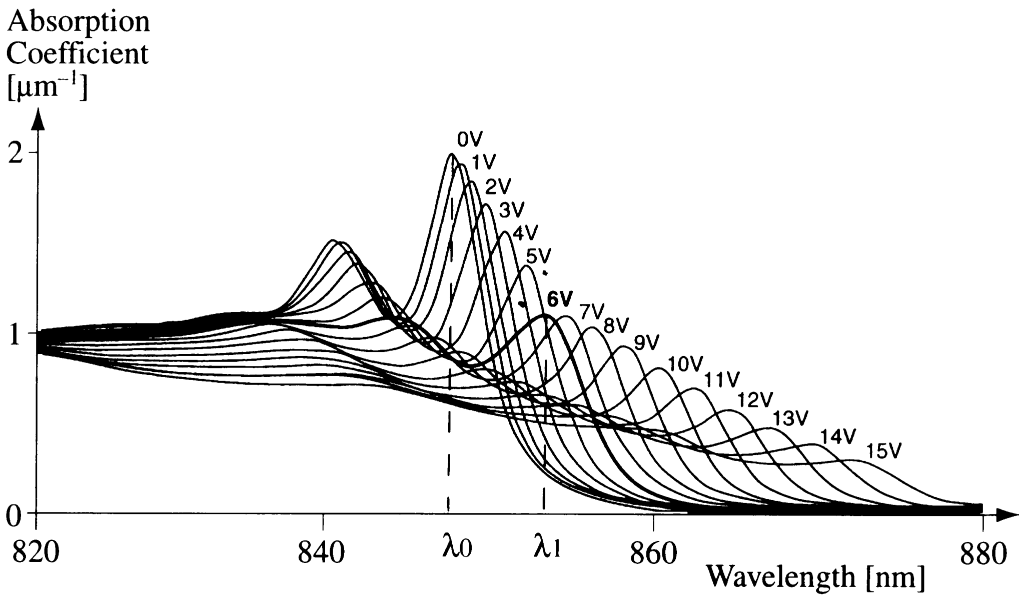
Optical Bistability in Semiconductors



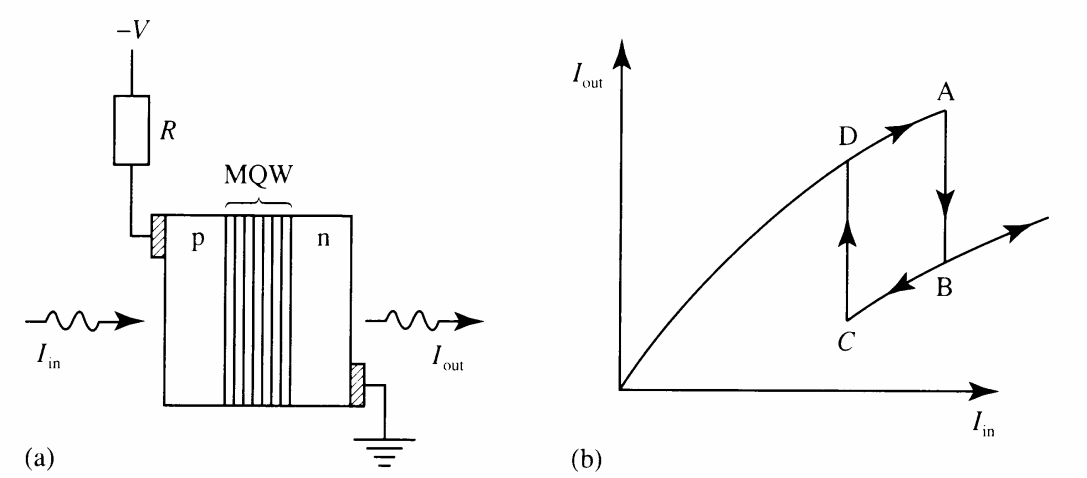


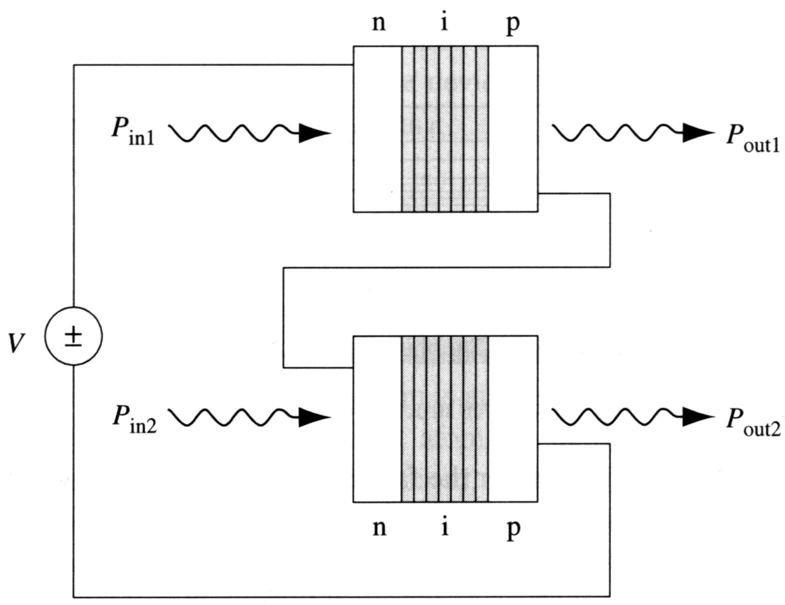
The Self-Electrooptic Effect Device (SEED)



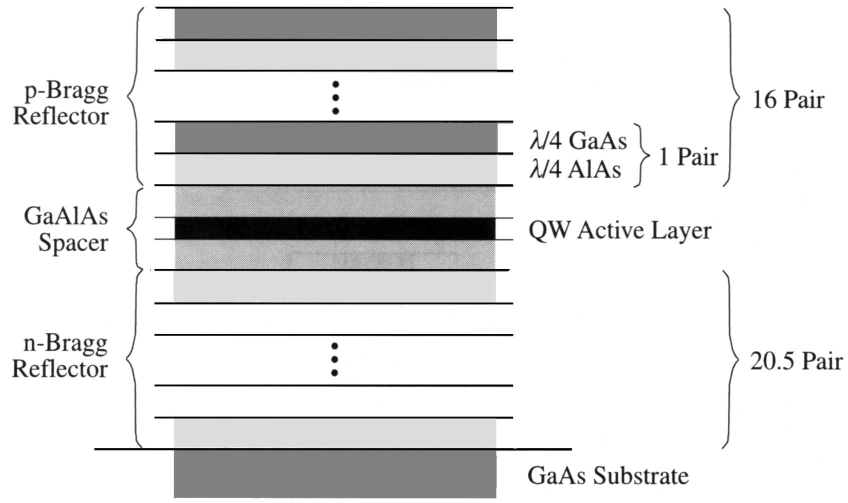


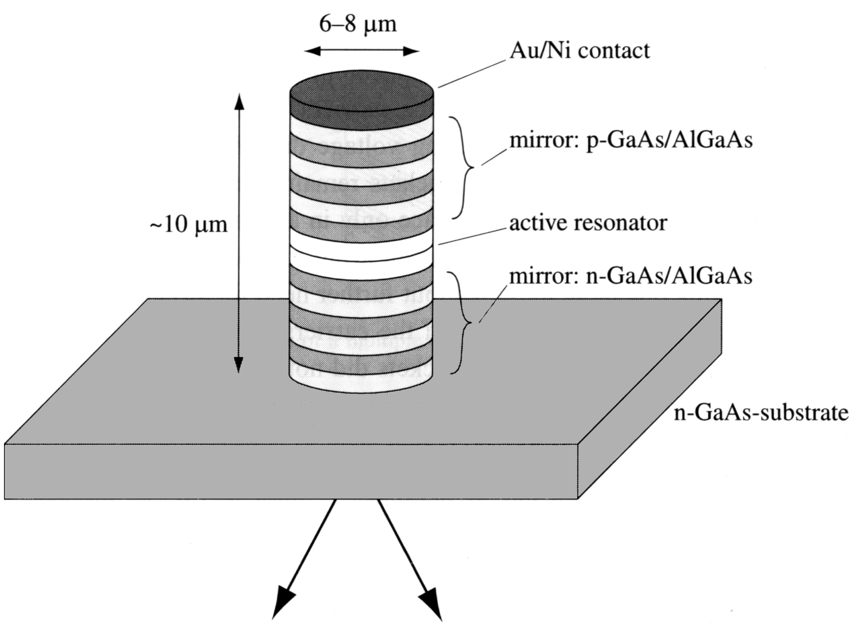
The SEED device for Optical Computing



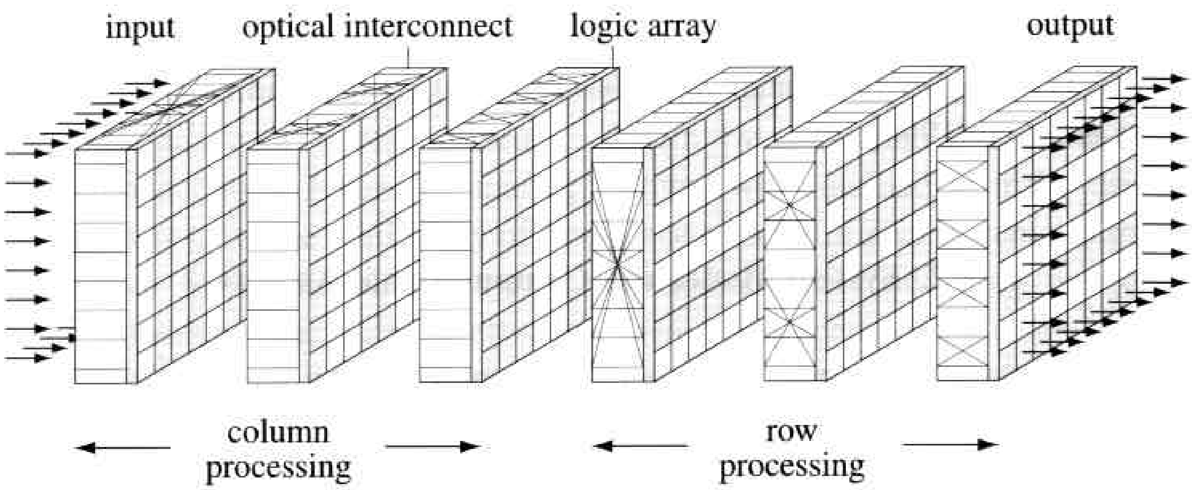


The VCSEL Laser



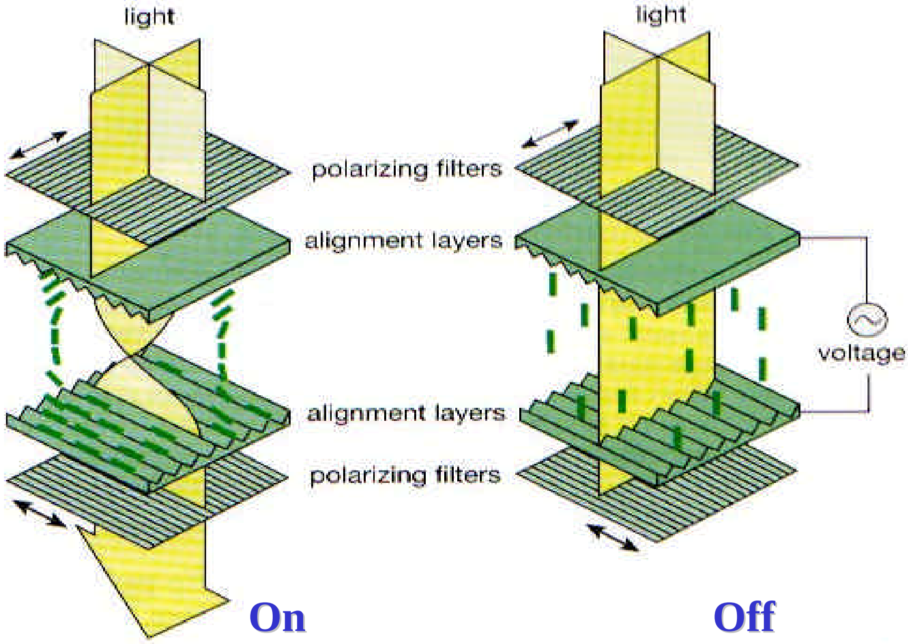


The Optical Computer - A Complex System?



- Optical computers are inherently parallel
- They are potentially high speed devices
- To achieve parallelism, new architectures are needed
- Figure above shows model of a digital computer used in Bell Labs in the late 1980s
- Here 2-D arrays of optical switching devices are interconnected through free-space
- Architecture has thousands of channels
- Suitable only for certain kinds of problems

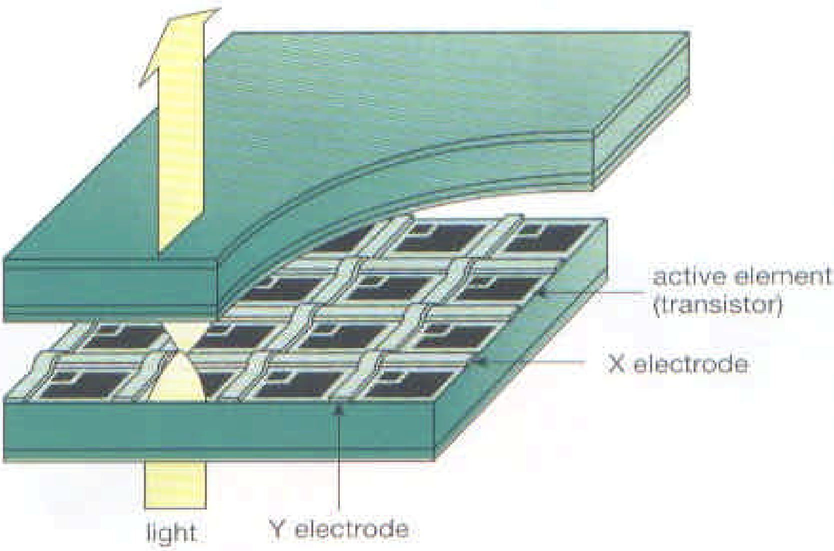
Liquid Crystal Displays



Twisted Nematic Display

- Liquid Crystals display anisotropy in nematic range
- High birefringence twists polarised light
- Anisotropic dielectric constant changes molecules’ alignment with applied field
- No field applied - On state
- Field applied - Off state

Liquid Crystal Displays



TFT LCD display

Improvements

- STN
- TFT
- Plasma Addressed?

Liquid Crystal Displays

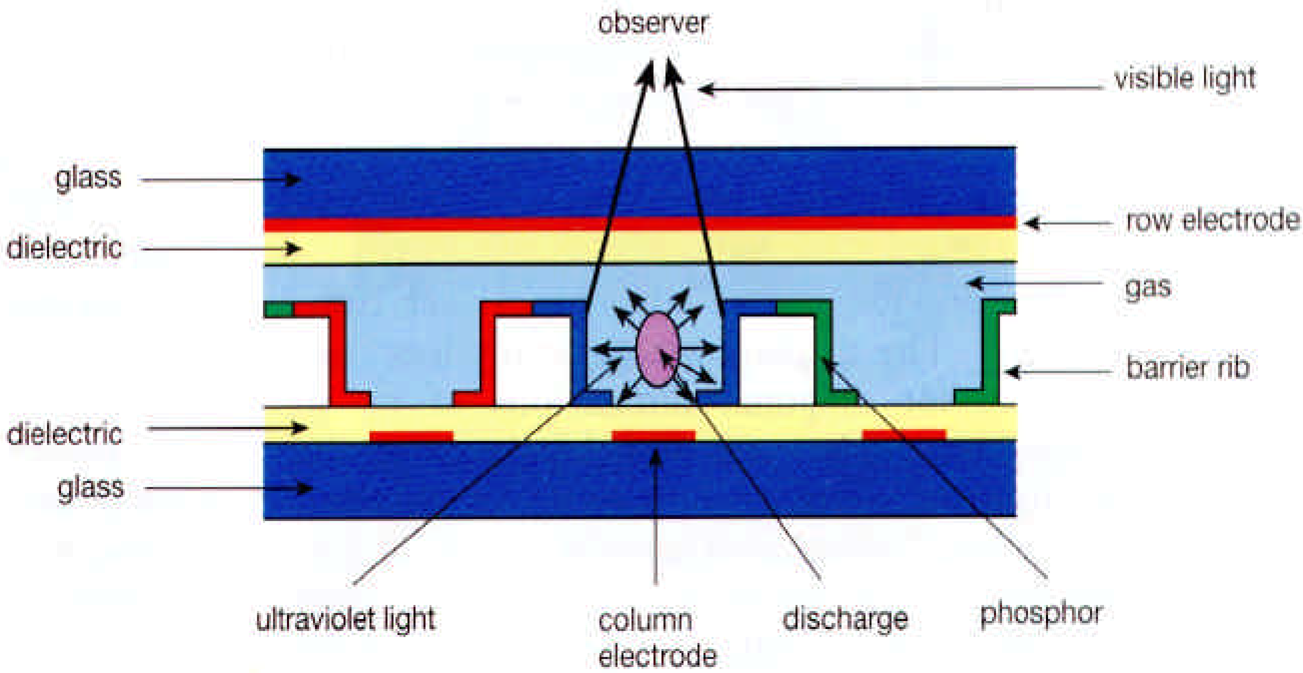
Advantages

- Flat screen
- Portable
- Light

Disadvantages

- Inefficient power use
- Viewing angle limitation
- Poor moving images
- Limited temperature range
- Limited screen size
- Low Brightness
- High Manufacturing Cost

Plasma Display Panels



Gas discharge plasma converts electrical energy to UV light, which excites surrounding phosphor by *photoluminescence*

Plasma Display Panels

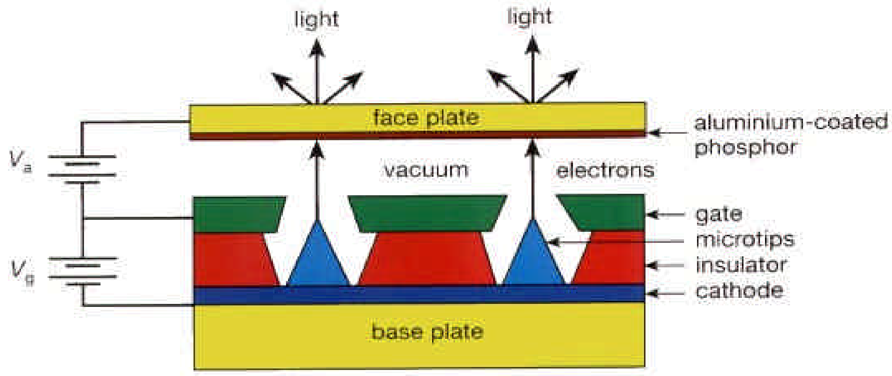
Advantages

- Flat screen
- Excellent viewing angle
- Large screens possible (>40”)

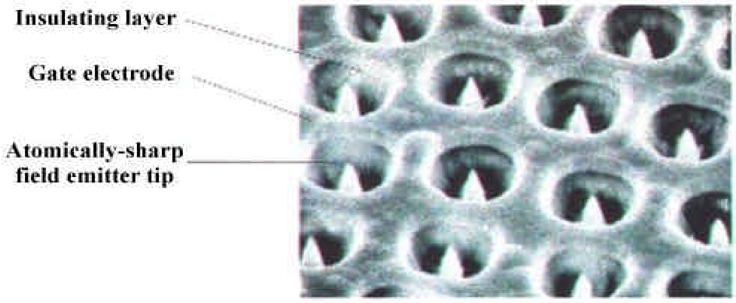
Disadvantages

- Heavy power use
- High cost drive electronics
- Low average brightness
- Poor minimum pixel size
- Moving image problems
- High Manufacturing cost
- Shorter life than CRT

Field Emission Displays



Gated microtip emmitter system. The pitch of the emitter cells is a few to ten microns



Present designs

- Microtips produce high localised electric field.
- Electrons are emitted from tips, focused through gates and excite phosphor coated anode by *cathodoluminescence*.

Cathode

- Manufactured from amorphous silicon or diamond.
- Lithographic or electrochemical tip formation.
- Expensive to produce reliably.
- New designs ?

Field Emission Displays

Advantages

- Flat Panel
- Excellent viewing angle
- Wide temperature range
- Low power consumption could increase laptop battery lifetime considerably
- Relatively cheap drive electronics

Disadvantages

- High cost due to cathode design
- Limited screen size
- Some moving image problems
- Present display phosphors give poor brightness at low voltage excitation and require high vacuum levels (10^{-7} Torr)