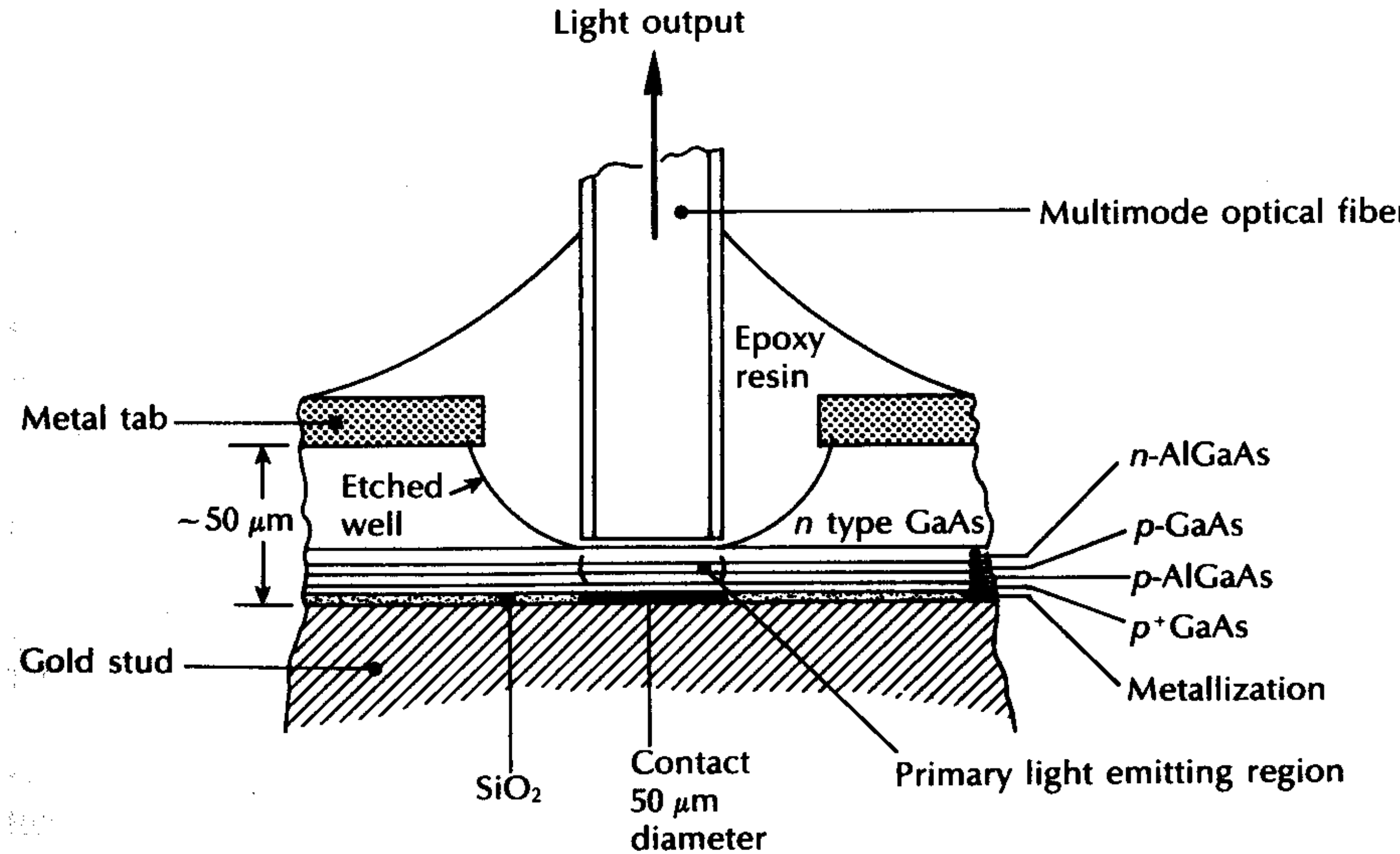
Topic 15

15 Light emitting diodes (LEDs) -2

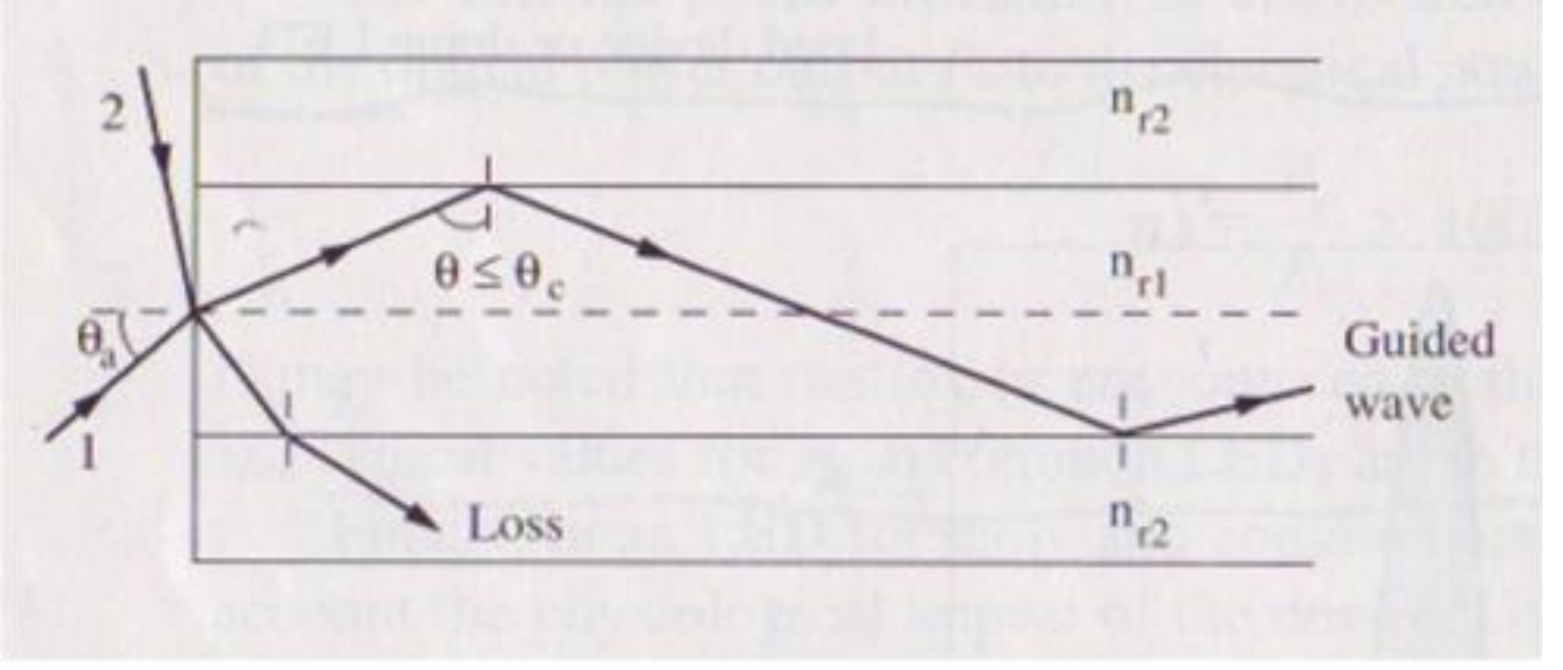
- 15.1 Burrus surface emitter
- 15.2 Edge emitter
- 15.3 Coupling to fibre
- 15.4 Fabrication of LEDs
- 15.5 Superluminescent Diodes

Burrus Type Surface Emitting LED



- Avoid reabsoprtion of the emitted light in the top of n-GaAs
- Selective etching of GaAs, but not AlGaAs (using chemical solution)
- The thin SiO2 layer in the back isolates the contact layer (heat-sink)
- Easily align Fibre
- High forward radiance and high current density due to using low contact resistance of n-GaN

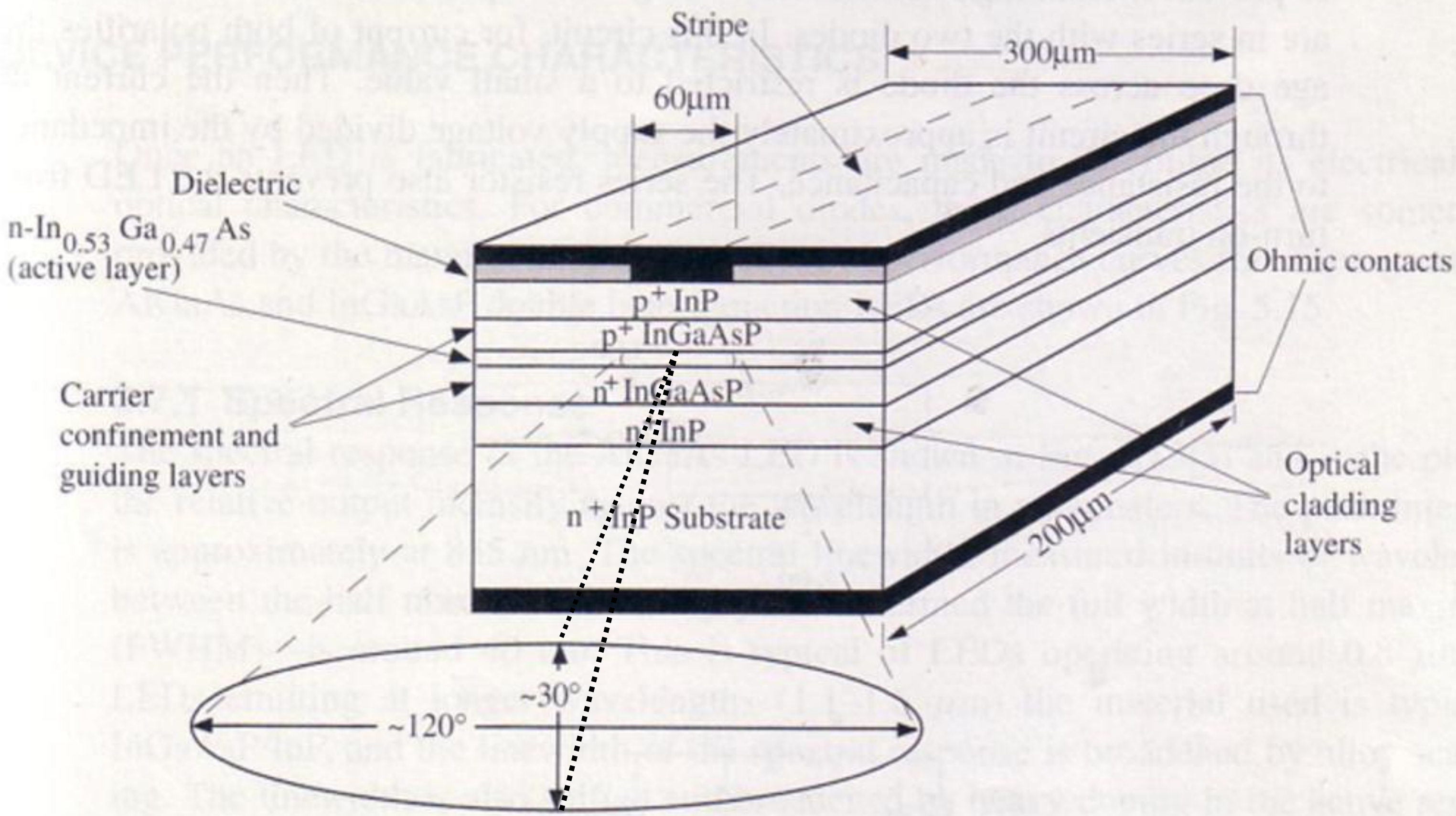
Coupling Loss



$$\textit{coupling}\ \text{efficiency} = \frac{\text{power coupled into the fibre}}{\text{power emitted from the sourse}}$$

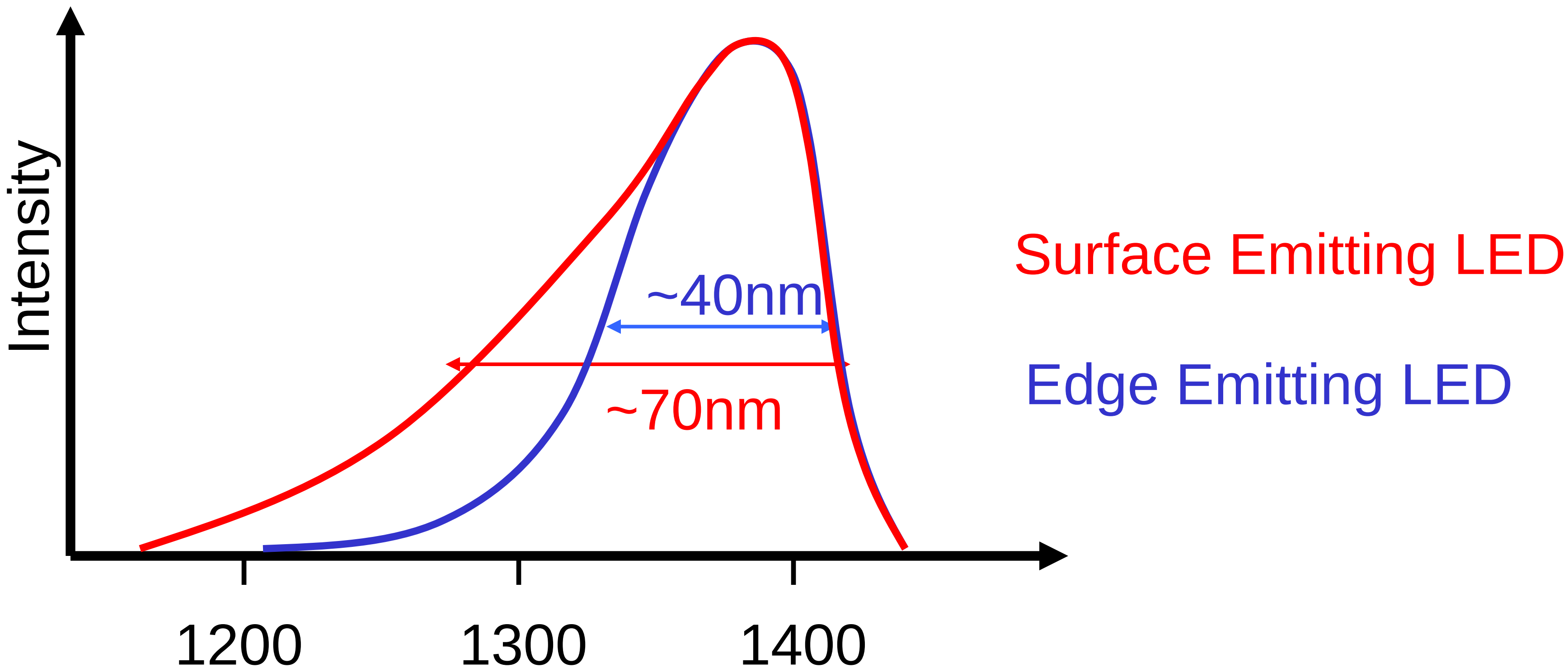
Burrus Type Surface Emitting LED: typically 1-2%
Lens coupling: improving coupling efficiency to 5-15%

Edge Emitting LED



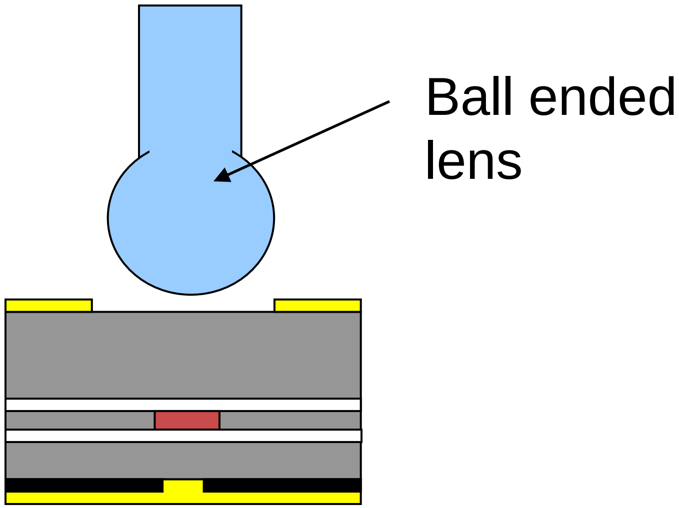
- Similar to laser structure but without a feedback cavity
- Cladding layer: photons generated in a thin active layer spread into the guiding layer and cladding layer without causing reabsorption.
- Waveguide: reduce the divergence of the emitted radiation vertically, allowing more efficient coupling of the radiated beam into fibres

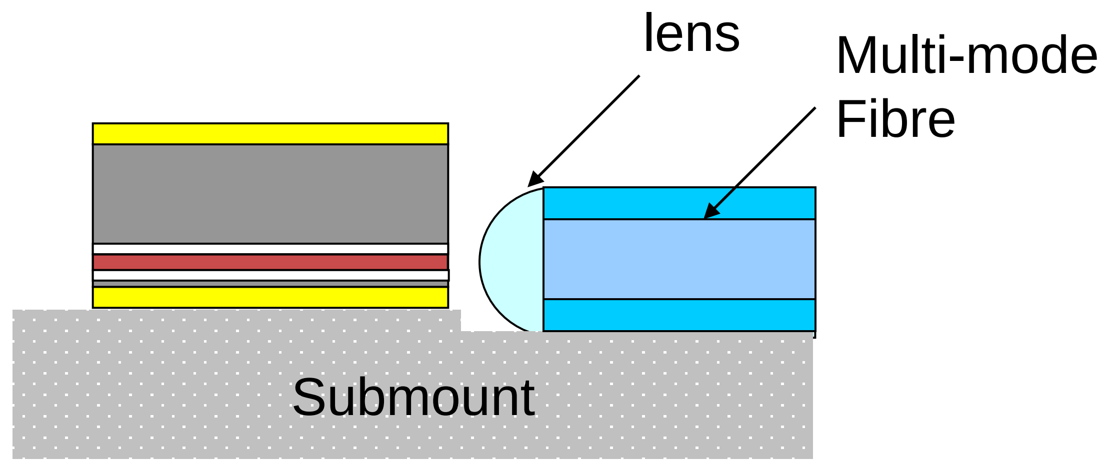
Output Spectrum

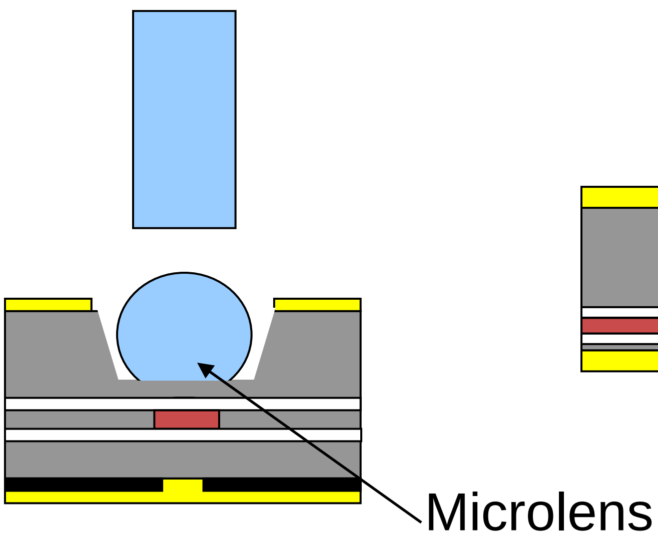


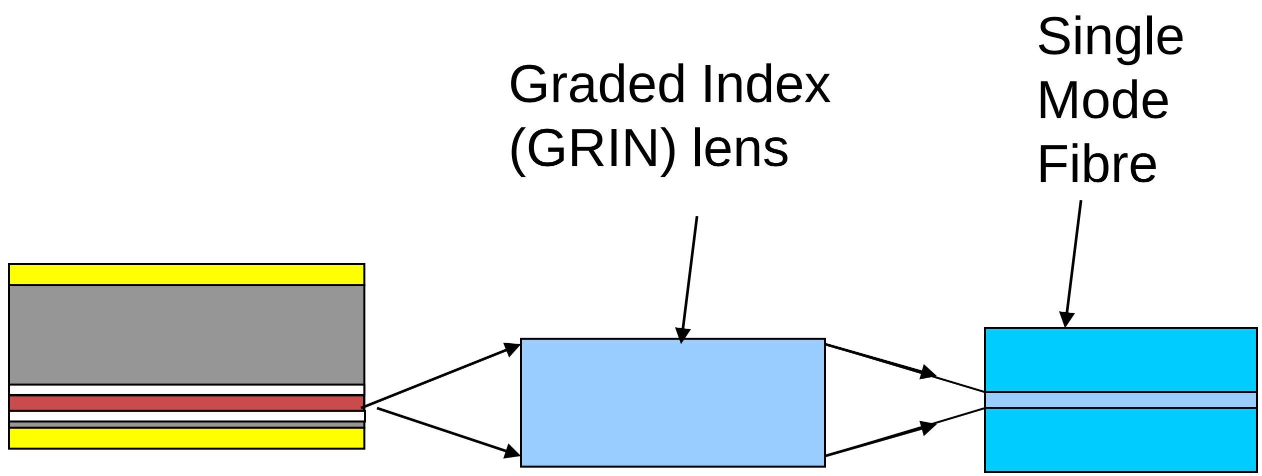
Edge emitter – high energy (low wavelength) light tends to be re-absorbed – emission is convolution of emission

Fibre – LED Coupling

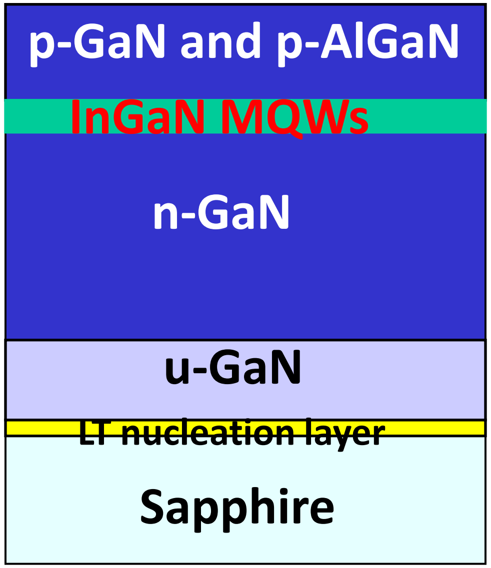


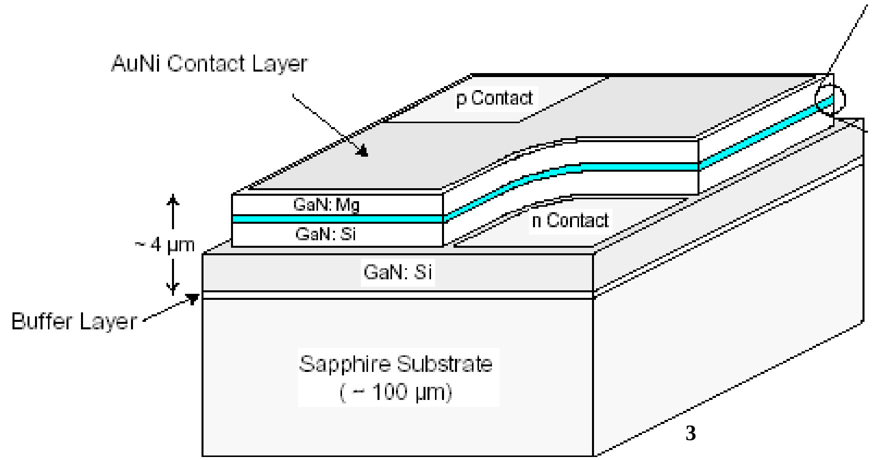


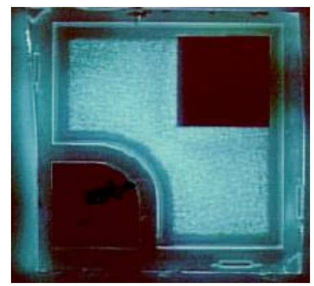


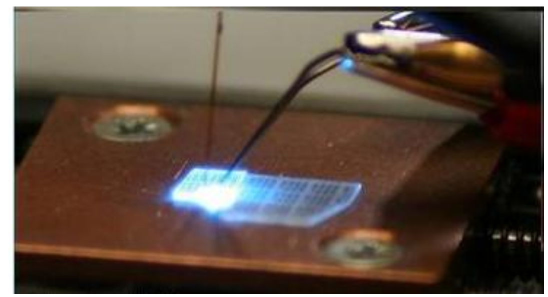


LED Design Growth and Fabrication







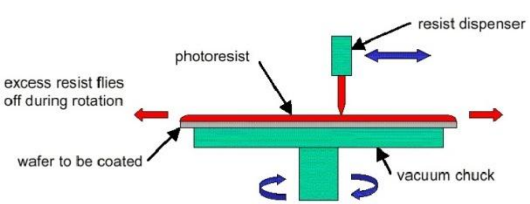


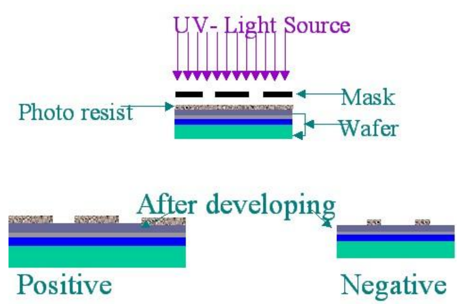
Industry:

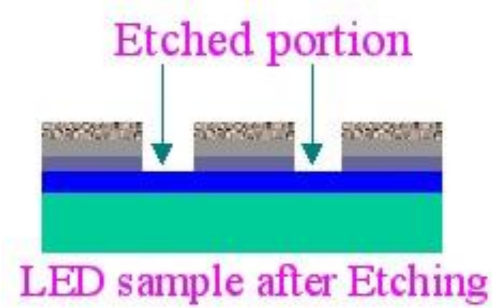
Growth: multiple-wafer MOCVD or MBE

Fabrication: lithograph and dry-etching technology (350x350 μm^2)

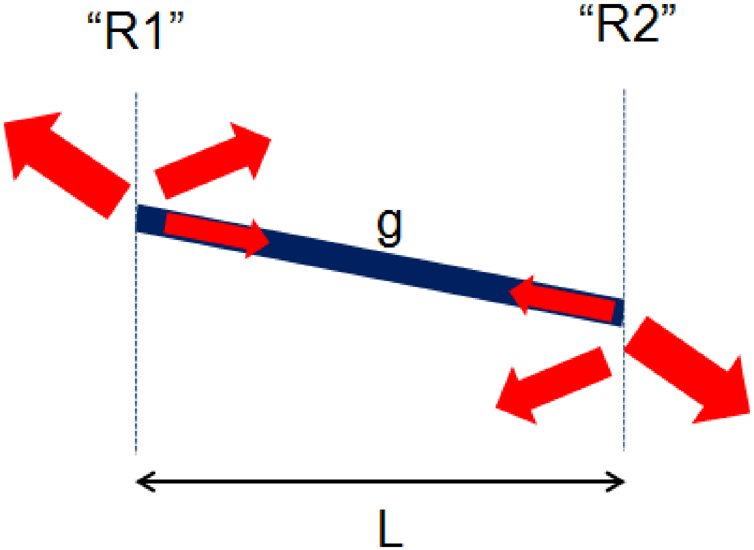
Package: Epoxy dome lens

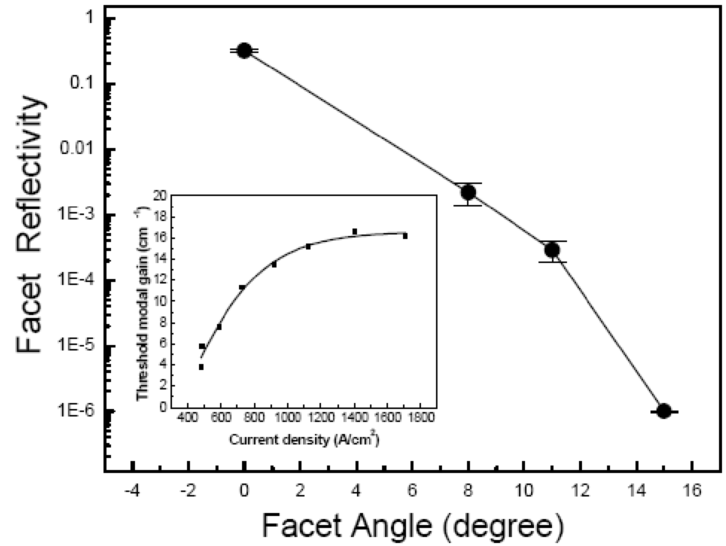






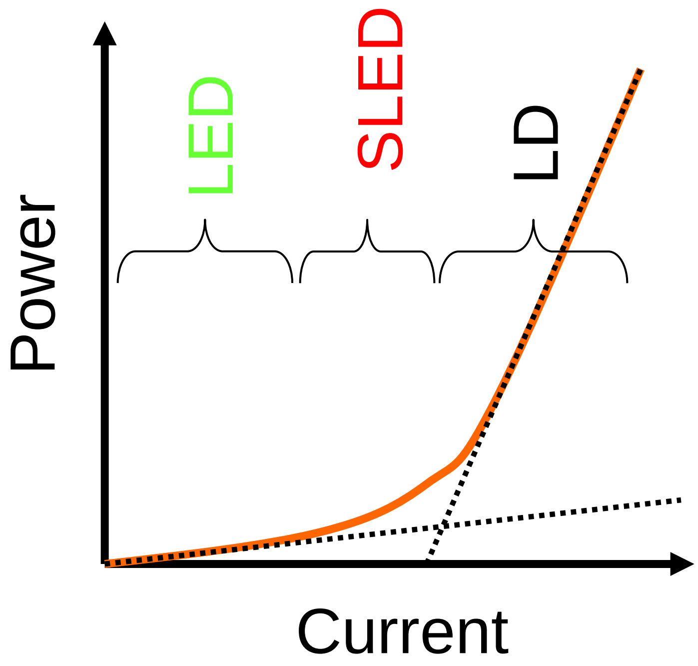
Superluminescent Diodes (i)

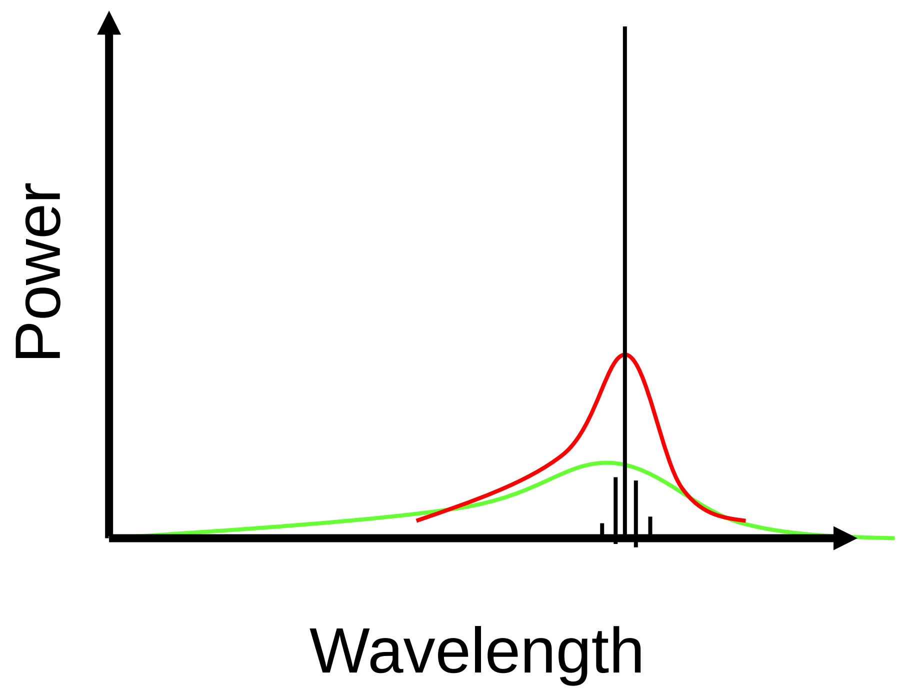




- **Actual reflectivity can be high – as cleaved, 0.1% from facet coating**
- **Low effective reflectivity – back-reflected light is not guided back into waveguide**
- **Low <u>effective</u> facet reflectivity**
- **Used for optical amplifiers and superluminescent diodes**

Superluminescent Diodes (ii)





Combine power of laser with the wide spectral bandwidth of the LED

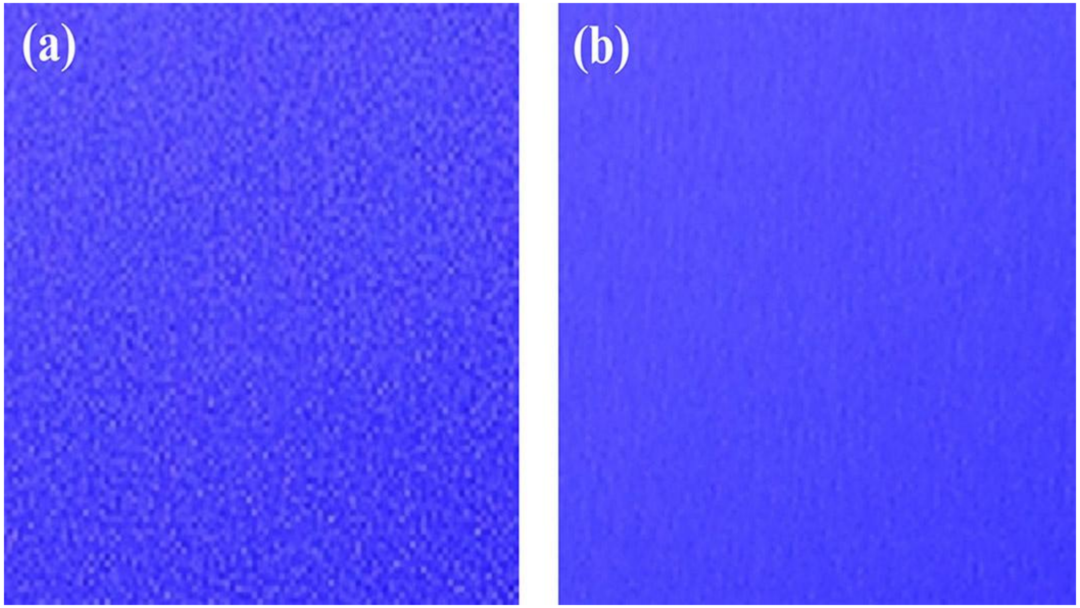
Uses:

- Testing DWDM systems
- Fibre sensors (fibre optic gyroscopes)
- Biomedical imaging
- High definition display which can minimise **speckle issue** due to laser

Pico-projectors

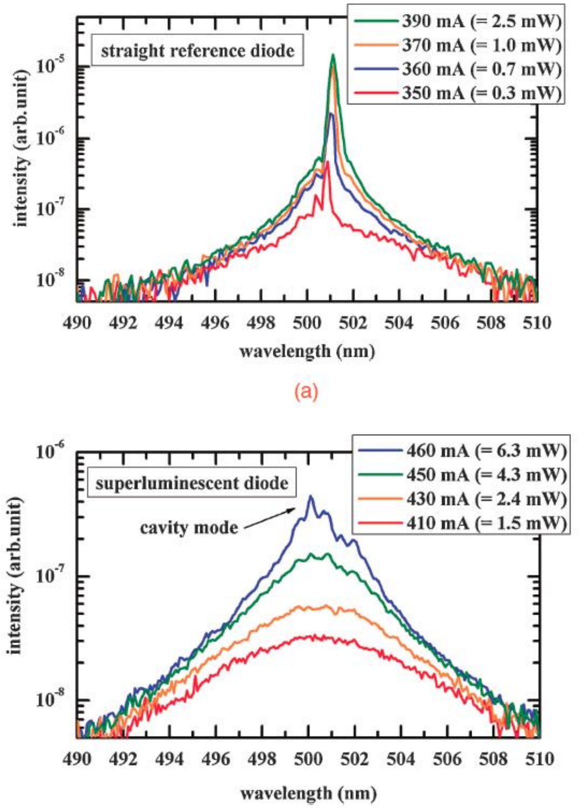
- **Pico-projectors: using so-called flying-spot technology, in which full-color images are created by high-intensity mixing of red, green, and blue beams.**
- **Compact lasers with RGB are required**
- **High degree of spatial coherence: speckle issues**

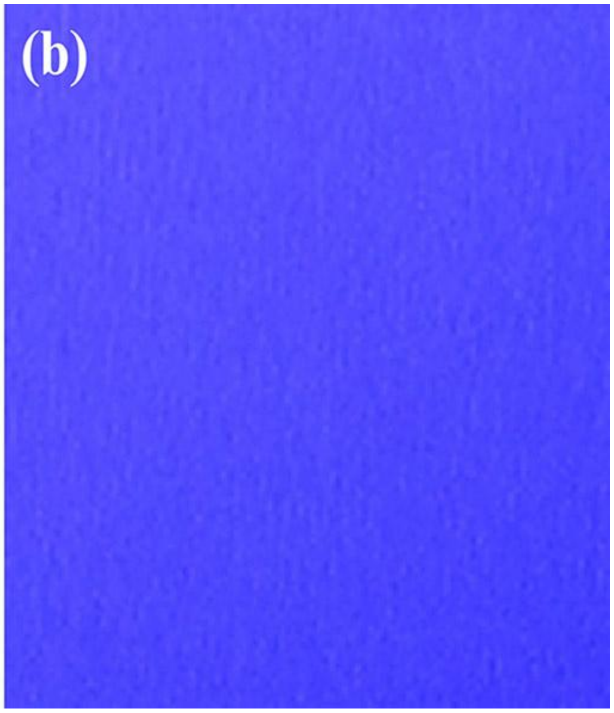
Other Applications of SLED



- Incident laser on a screen or wall with a slightly rough surface: constructive and destructive interference, causing the image to be superimposed with brightness fluctuations (speckle).
- Visibility of speckle has an inverse correlation with spectral line-width
- Image quality can be greatly improved by using light sources with a broad line-width.

SLED for focus-free handheld projection





- **Blue SLEDs with over 100 mW:**

promising for focus-free pico-projection due to reduced interference and improved image quality as a result of broad line-width

- **Great Challenge: green SLEDs with high power**

Summary - LED

- LED-optical fibre coupling
- Burrus Type Surface Emitting LED
- Fabrication of LEDs
- Various examples of devices
- Edge emitters have narrower emission spectrum due to absorption at high energies
- SLED
- Similarity and difference between laser diode/LED and super luminescence LED
- Speckle issue: definition and formation mechanism