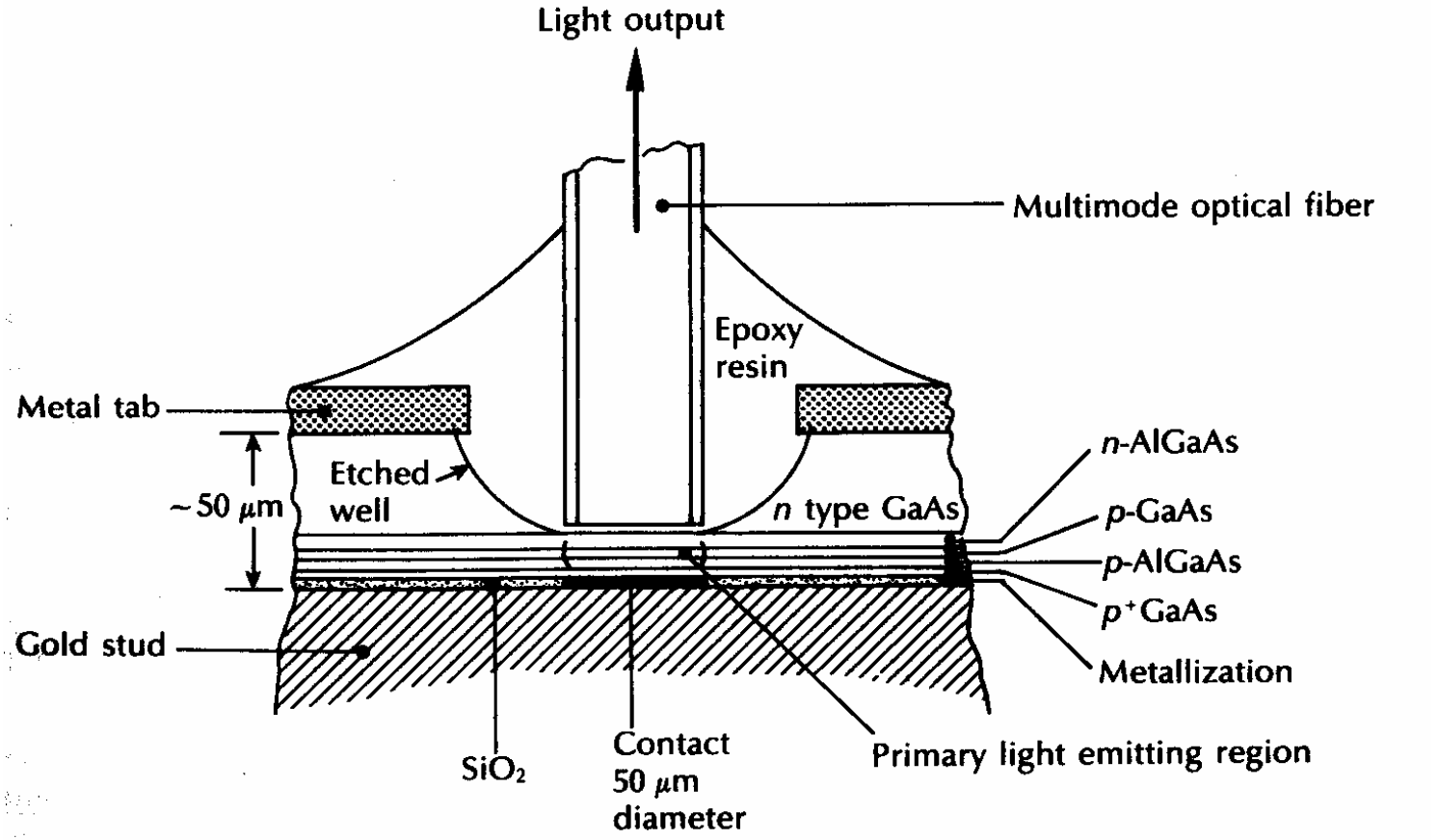
Topic 13

13 Light emitting diodes (LEDs) -2

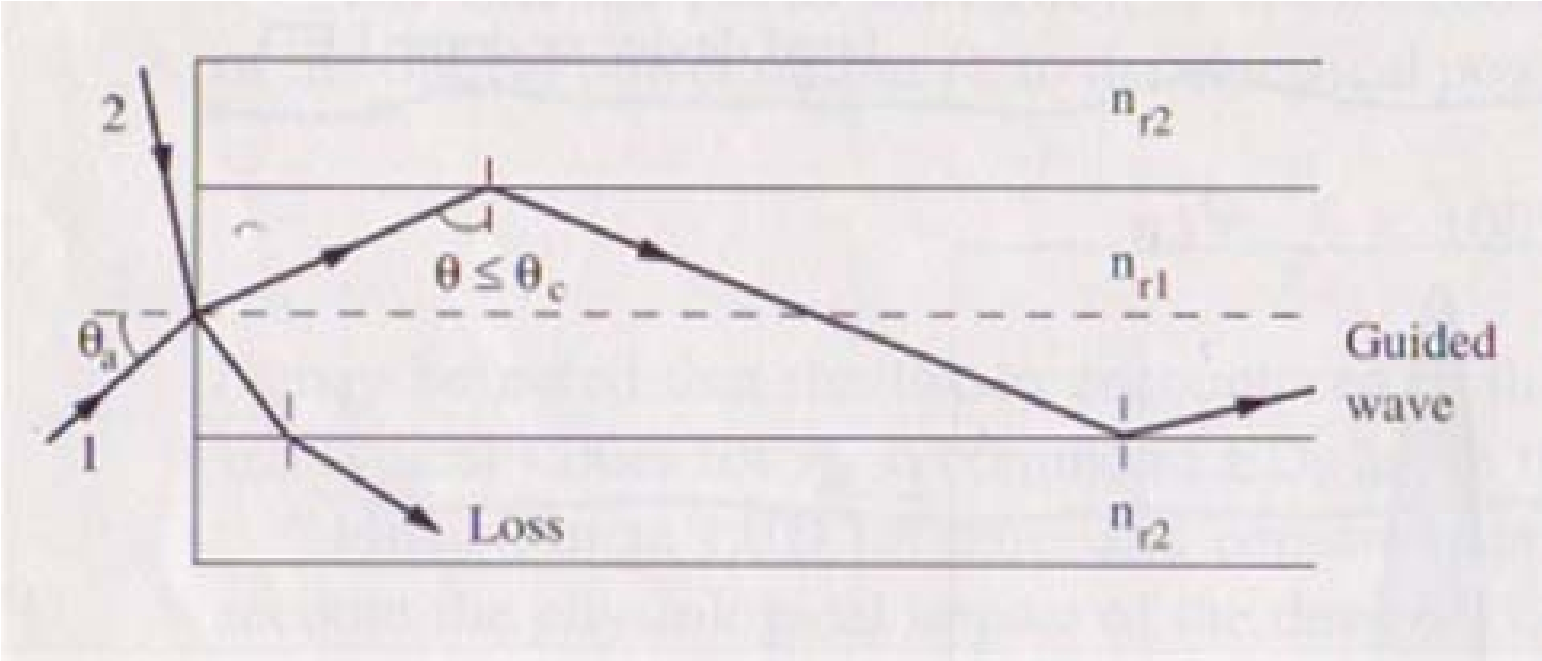
- 13.1 Burrus surface emitter
- 13.2 Edge emitter
- 13.3 Coupling to fibre
- 13.4 Fabrication of LEDs
- 13.5 Special applications using UV LED
- 13.6 Superluminescent Diodes

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

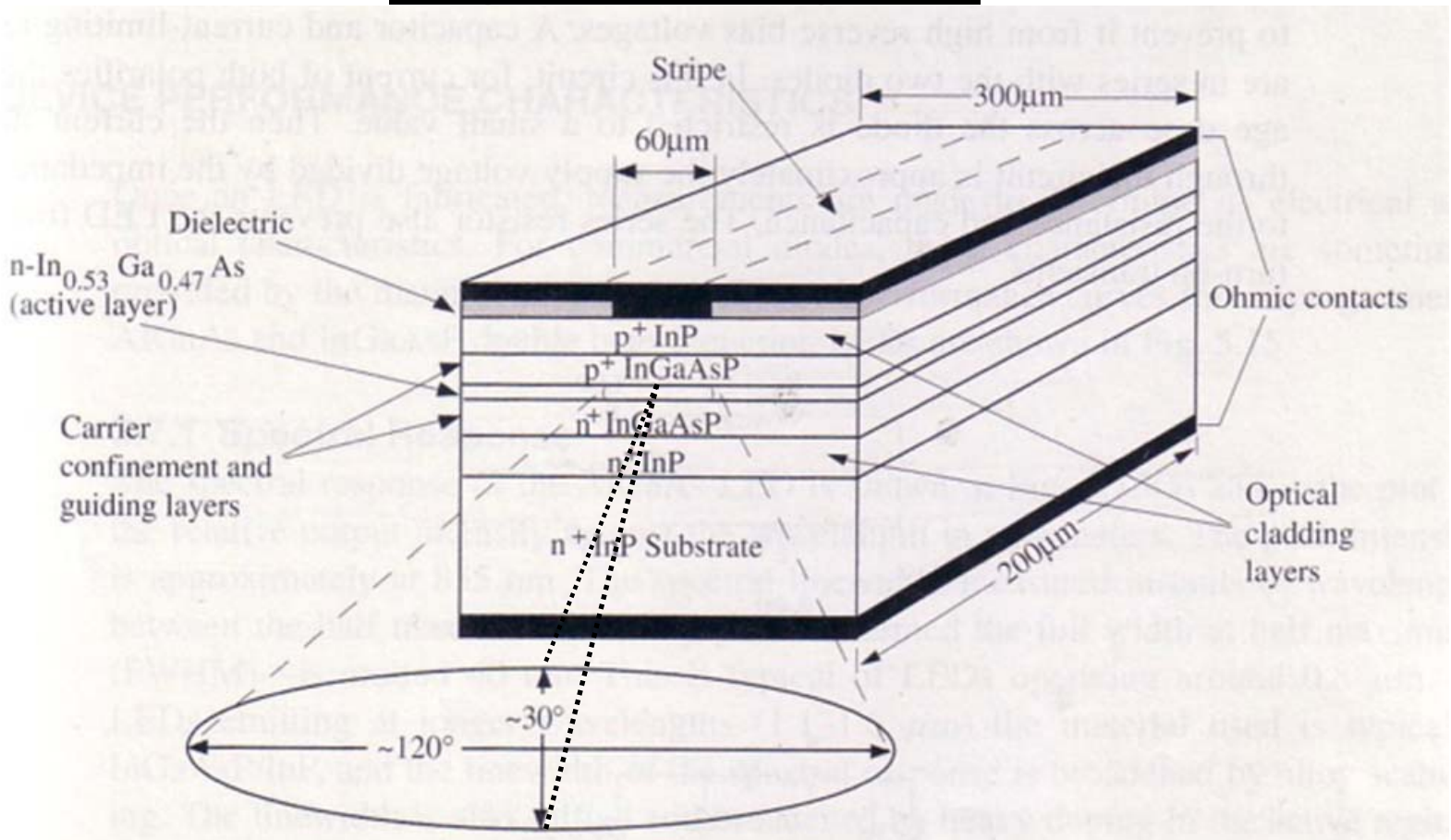
Coupling Loss



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

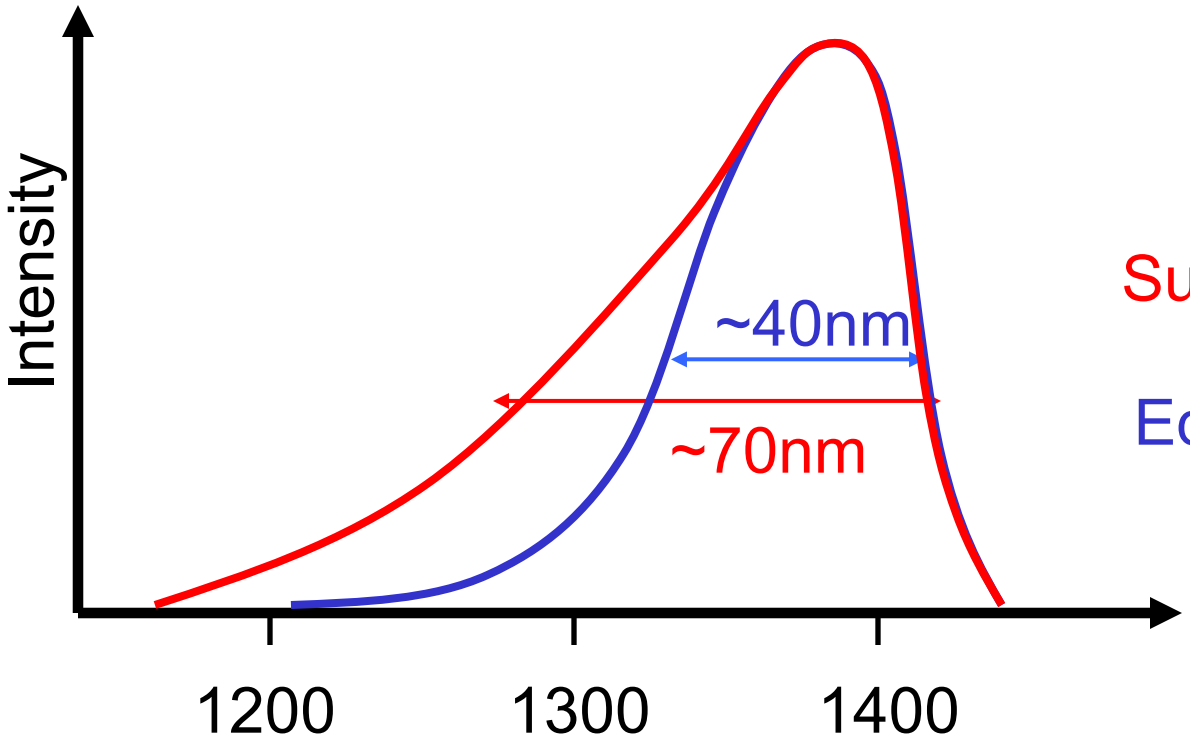
Burrus Type Surface Emitting LED: typically 1-2%
Lens coupling: improving coupling efficiency to 5-15%

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

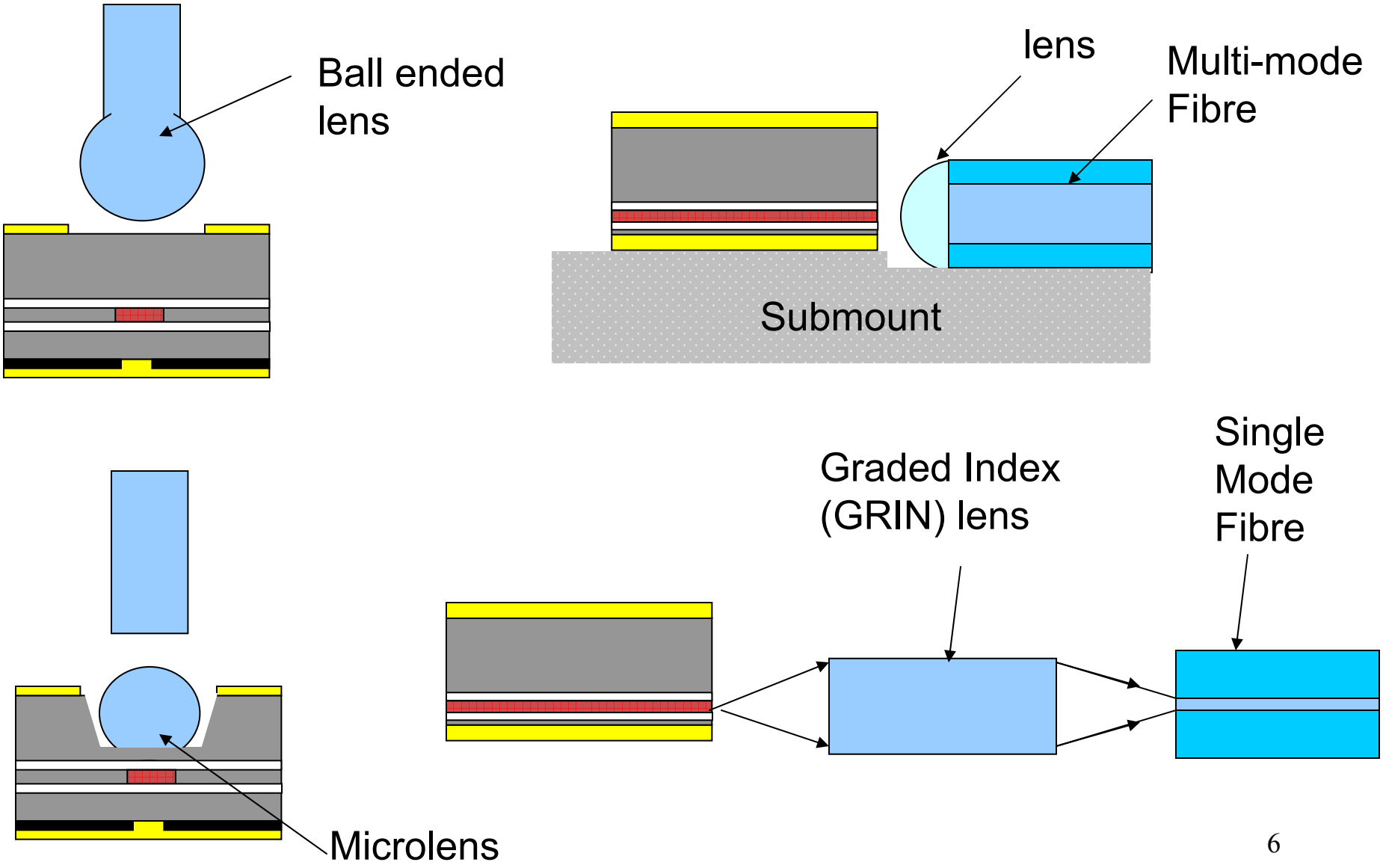


Surface Emitting LED

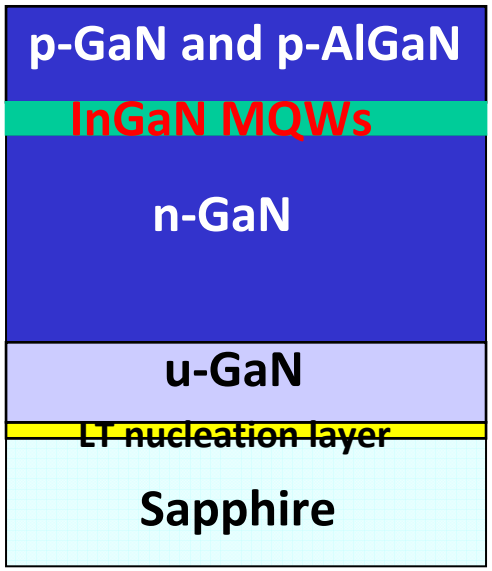
Edge Emitting LED

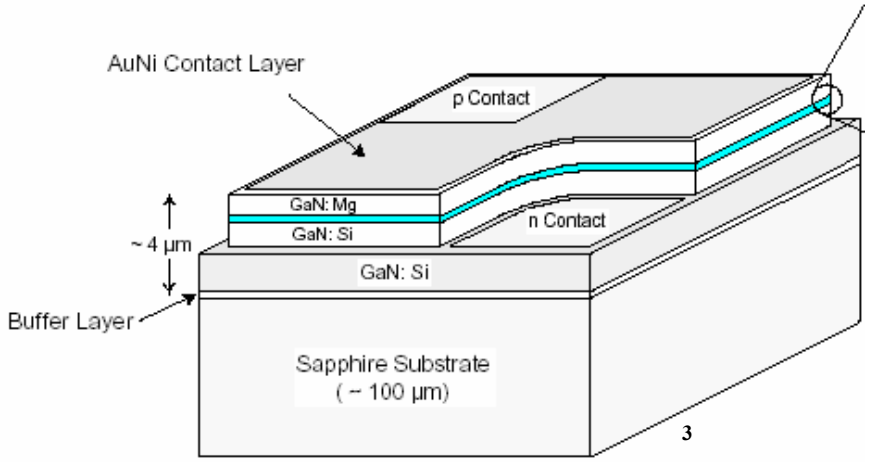
Edge emitter – high energy (low wavelength) light tends to be re-absorbed – emission is convolution of emission

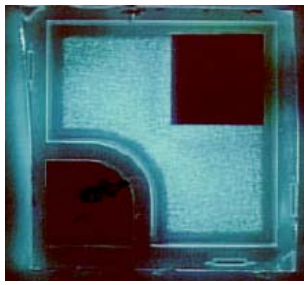
Fibre – LED Coupling

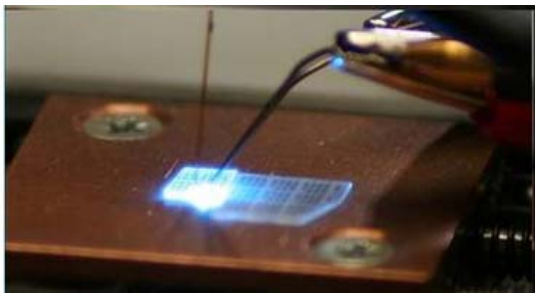


LED Design Growth and Fabrication







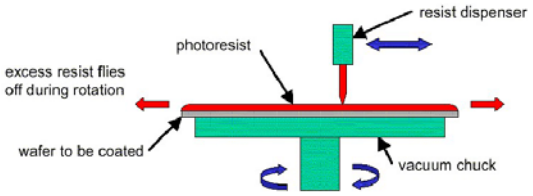


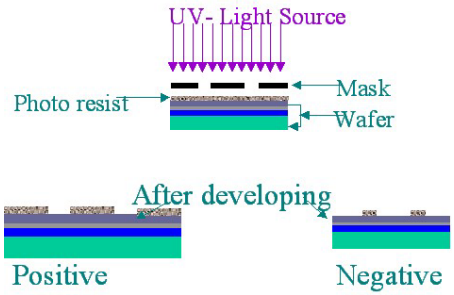
Industry:

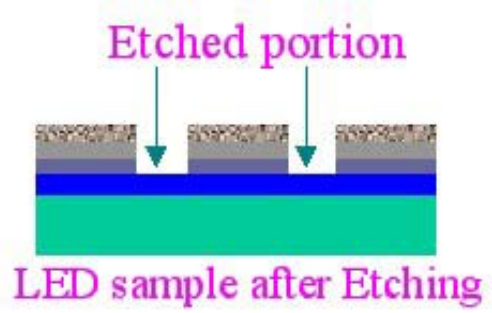
Growth: multiple-wafer MOCVD or MBE

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

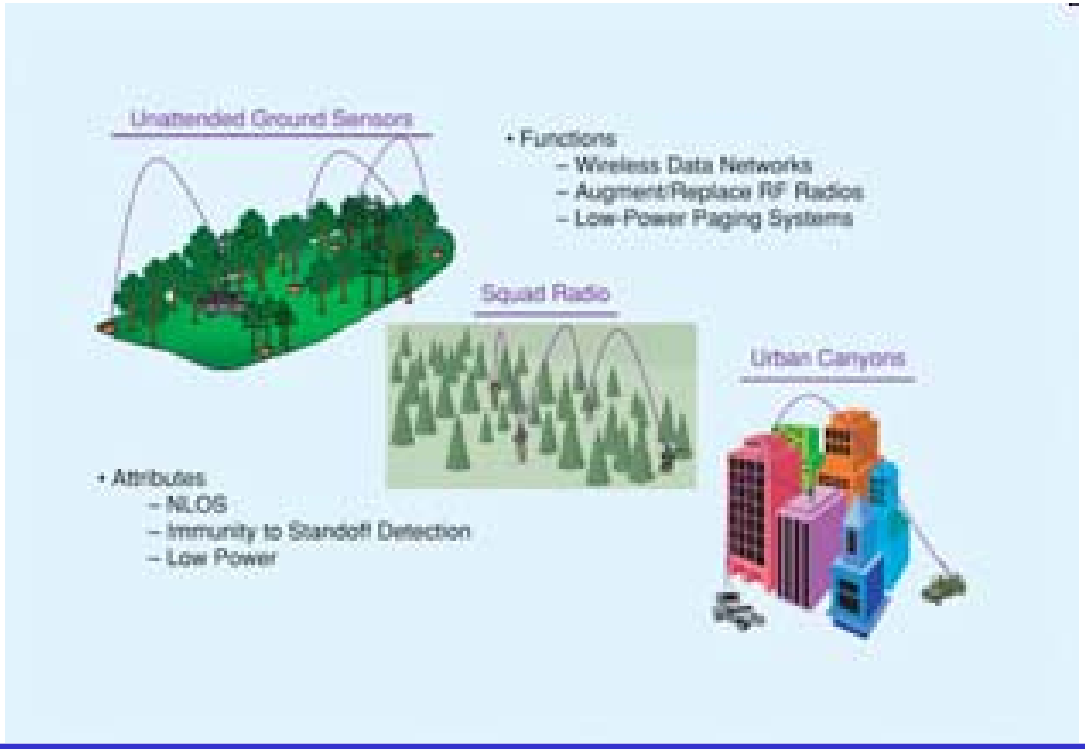
Package: Epoxy dome lens







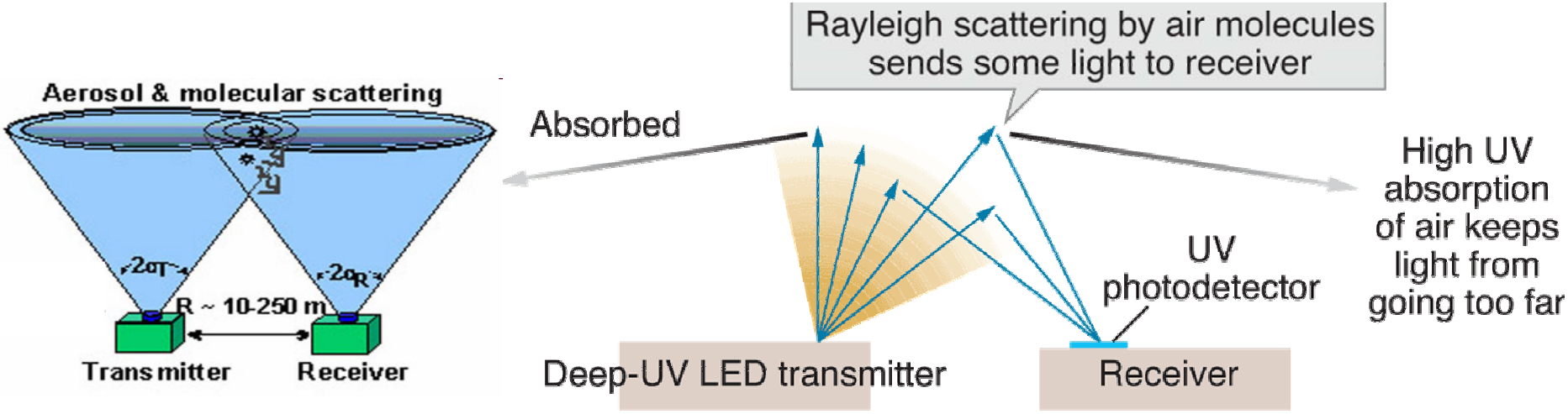
Non-line-of-sight Communication (NLOS)



Short distance wireless communication:

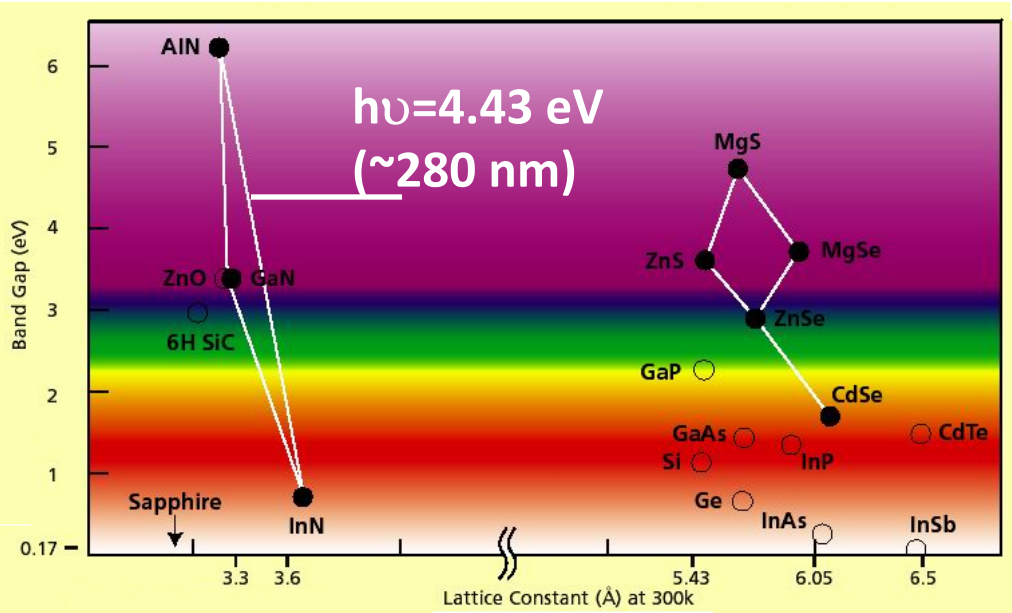
- Transmission across a path that is partially blocked
- NLOS has become more popular in the context of wireless local area networks (WLANs)
- Military applications: require a short distance communication and security

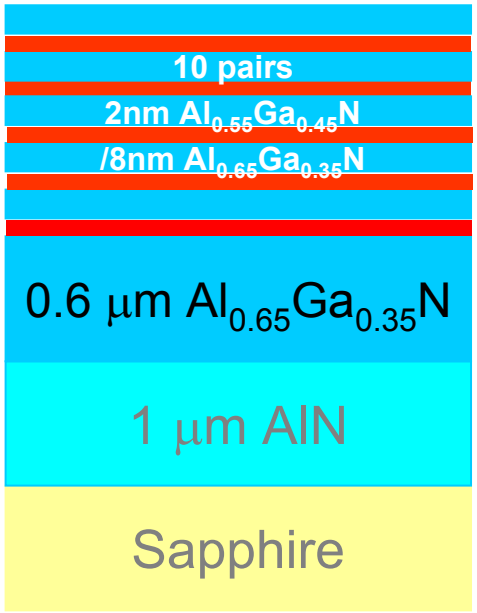
Mechanism for NLSO

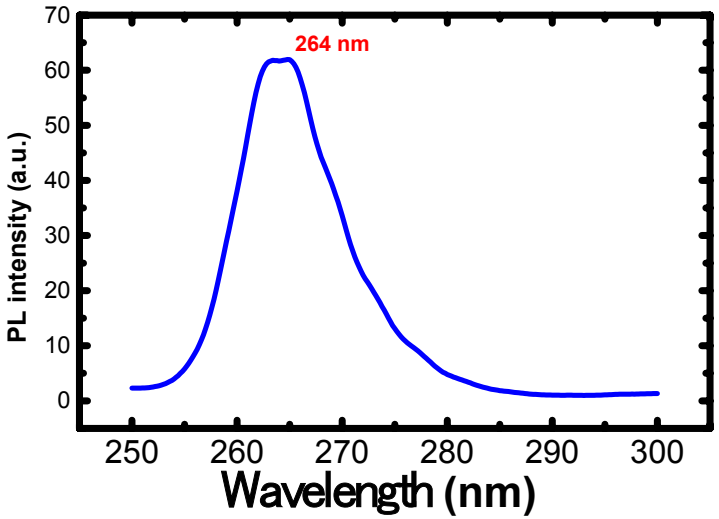


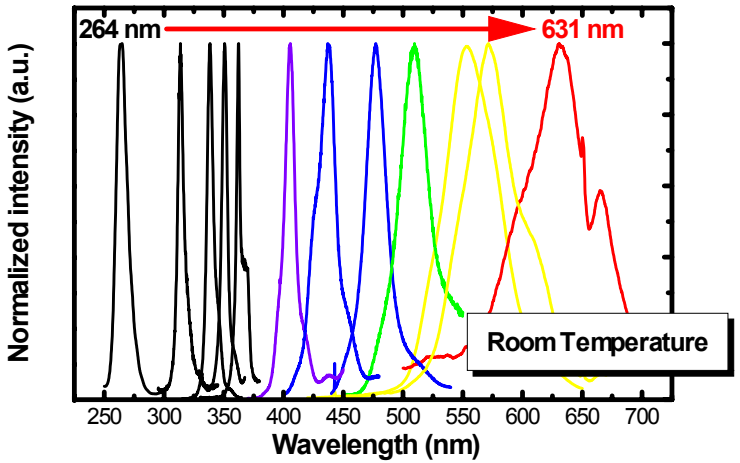
- Basically, it is due to **Rayleigh scattering**: Scattering of light by particles with a size ≤ wavelength of light
- **Rayleigh scattering** requires short wavelength: Scattering $\propto \lambda^{-4}$
- Deep UV: strong absorption
- Visible region: scattering becomes weak, and not secure
- Best wavelength: **λ=280 nm**

III-nitrides devices for NLOS



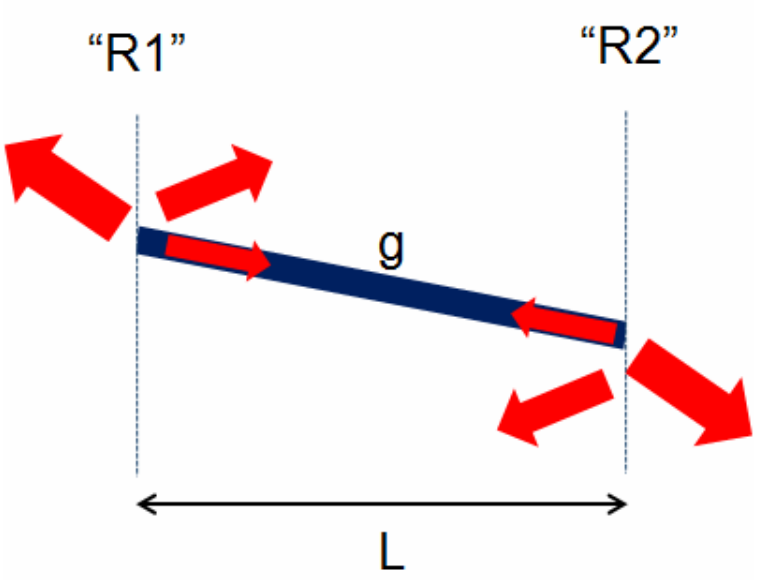


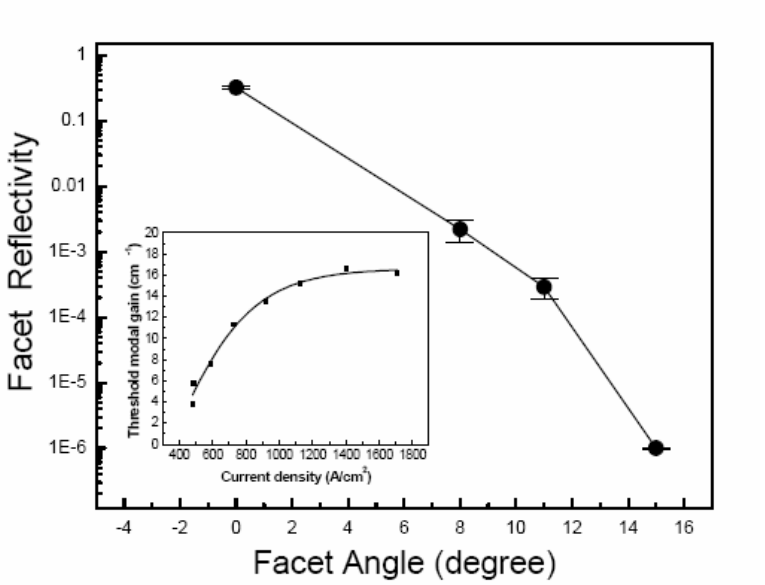




Sheffield is among only a few teams to achieve so short wavelength

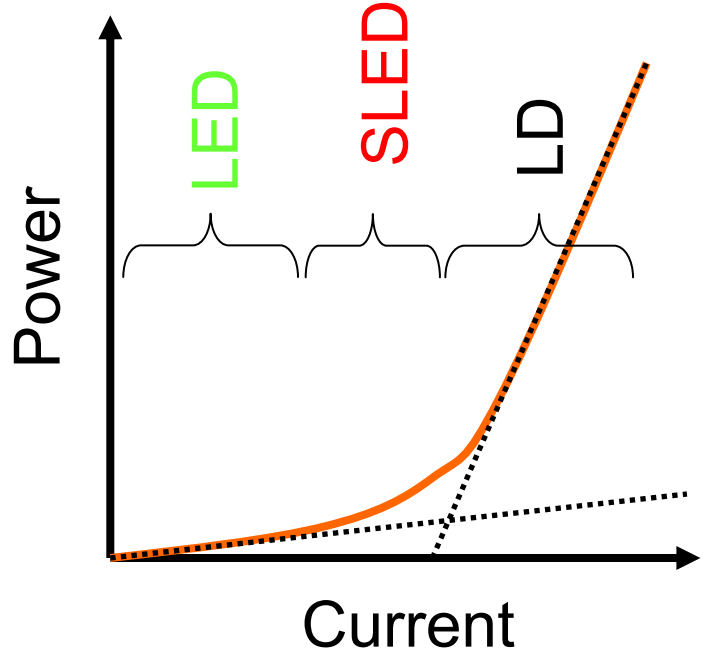
Superluminescent Diodes (i)

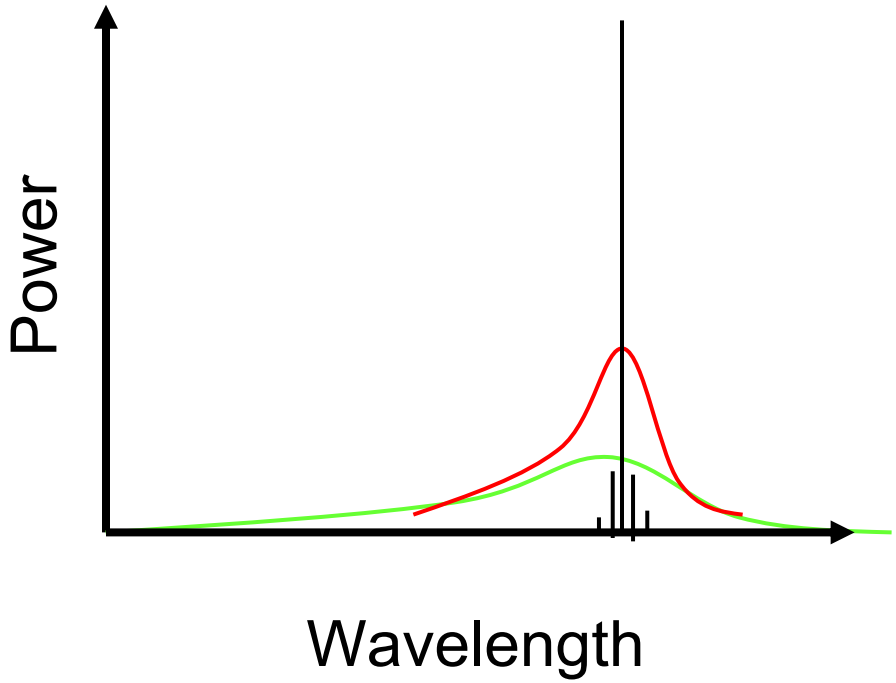




- Actual reflectivity can be high – as cleaved, 0.1% from facet coating
- Low effective reflectivity – back-reflected light is not guided back into waveguide
- Low effective facet reflectivity
- Used for optical amplifiers and superluminescent diodes

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

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