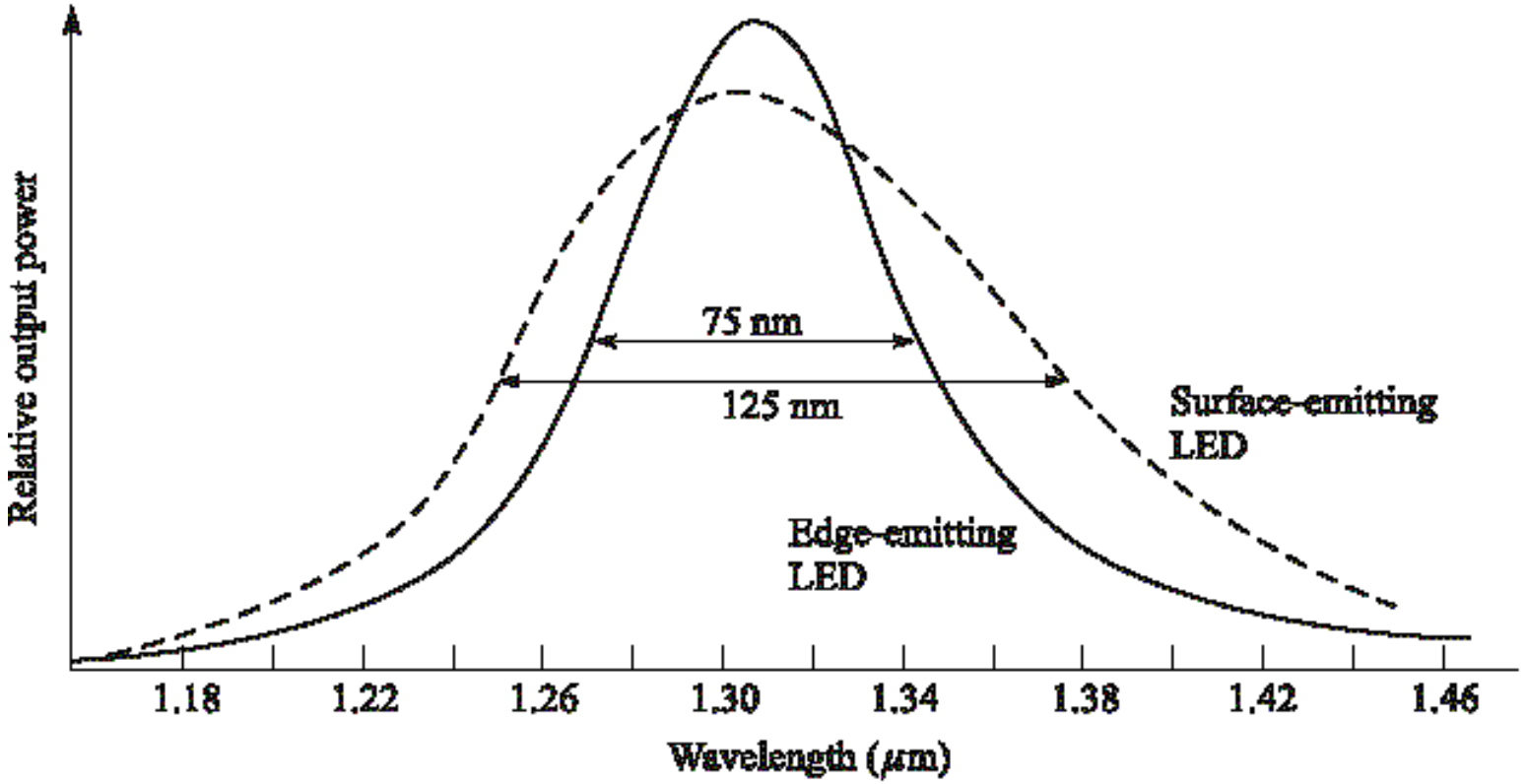
Unit-3

Lecture -5

LED Spectrum, Quantum Efficiency, Internal Efficiency, External Efficiency, Power Bandwidth

LED Spectral Width



Edge emitting LED's have slightly narrow line width

Quantum Efficiency

- Internal quantum efficiency is the ratio between the radiative recombination rate and the sum of radiative and nonradiative recombination rates

- $$\eta_{\text{int}} = R_r /(R_r + R_{nr})$$

- For exponential decay of excess carriers, the radiative recombination lifetime is n/R_r and the nonradiative recombination lifetime is n/R_{nr}

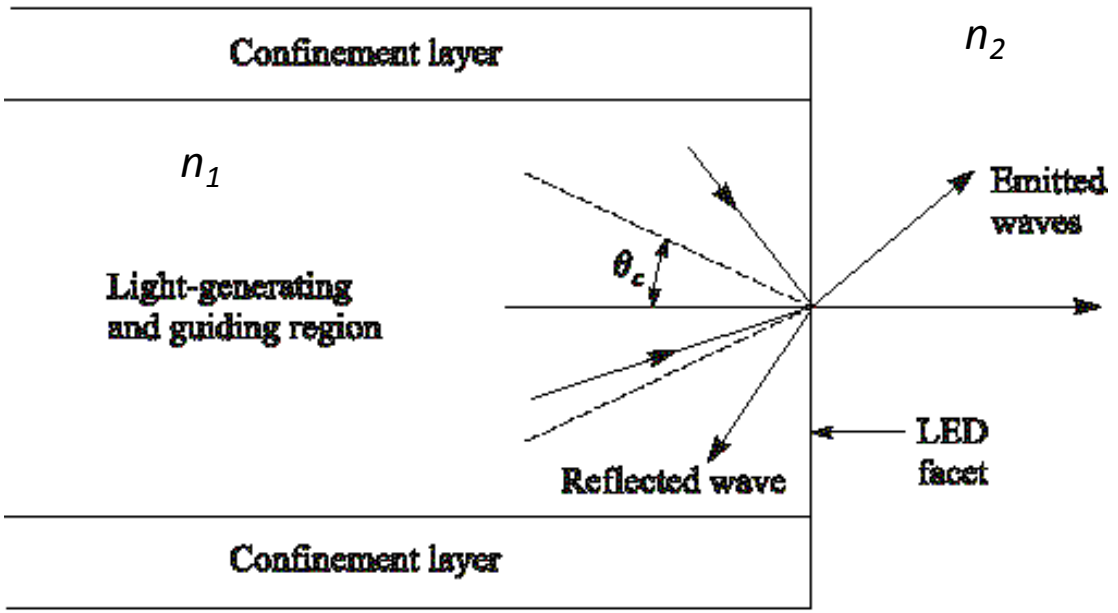
Internal Efficiency

If the current injected into the LED is I, then the total number of recombination per second is, $R_r + R_{nr} = I/q$ where, q is the charge of an electron.

That is, $R_r = \eta_{int} I/q$.

Since R_r is the total number of photons generated per second, the optical power generated internal to the LED depends on the internal quantum efficiency

External Efficiency



Fresnel Transmission Coefficient

$$T(0) = 4n_1n_2 / (n_1 + n_2)^2$$

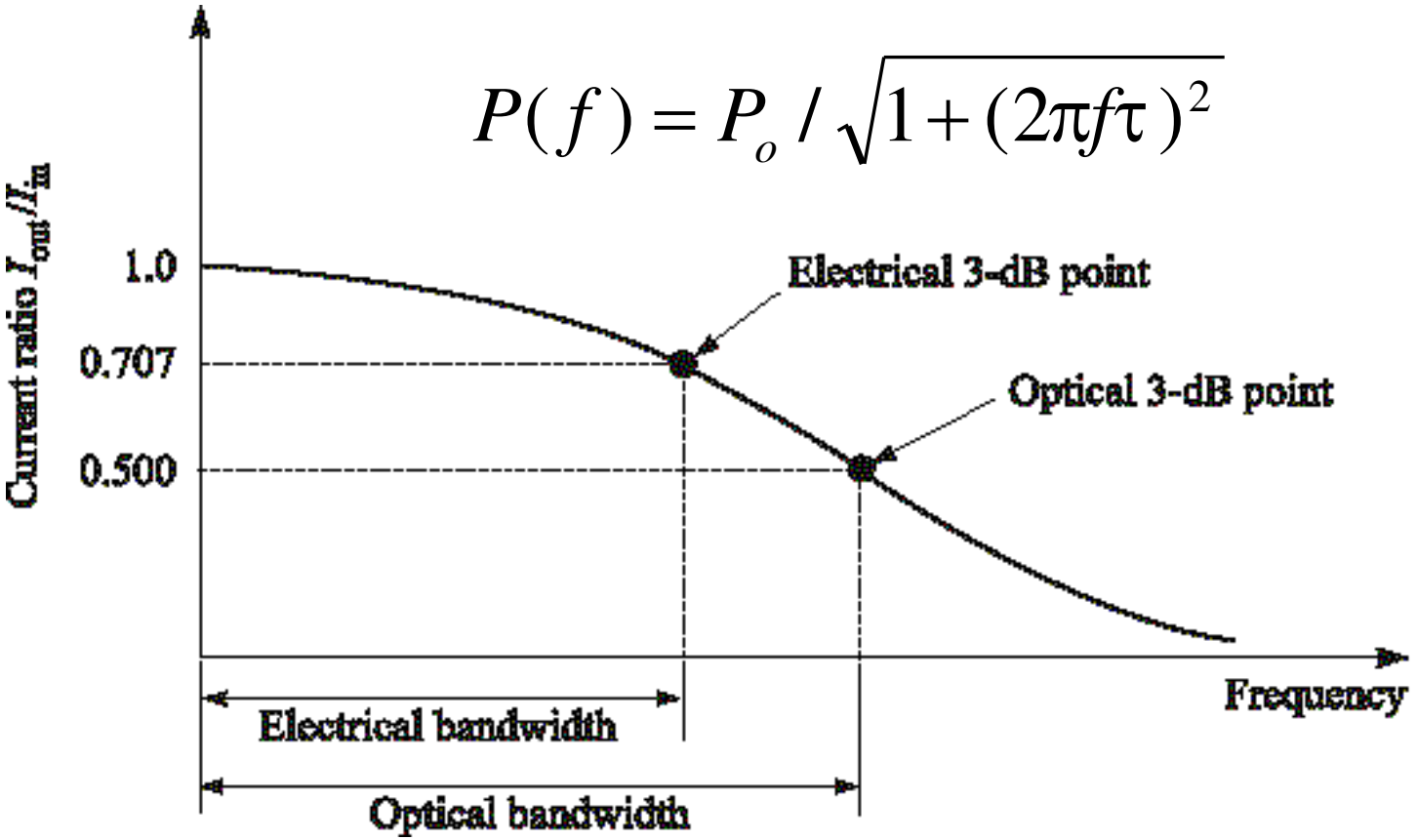
External Efficiency for air

$n_2=1$, $n_1 = n$

$$\eta_{ext} = 1 / n(n+1)^2$$

3-dB bandwidths

$$P(f) = P_o / \sqrt{1 + (2\pi f\tau)^2}$$



Optical Power ∝ I(f); Electrical Power ∝ I^2(f)

Electrical Loss = 2 x Optical Loss

Drawbacks of LED

- Large line width (30-40 nm)
- Large beam width (Low coupling to the fiber)
- Low output power
- Low E/O conversion efficiency

Advantages

- Robust
- Linear