Optoelectronics Easy Notes

Notes

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typeset with LaTeX

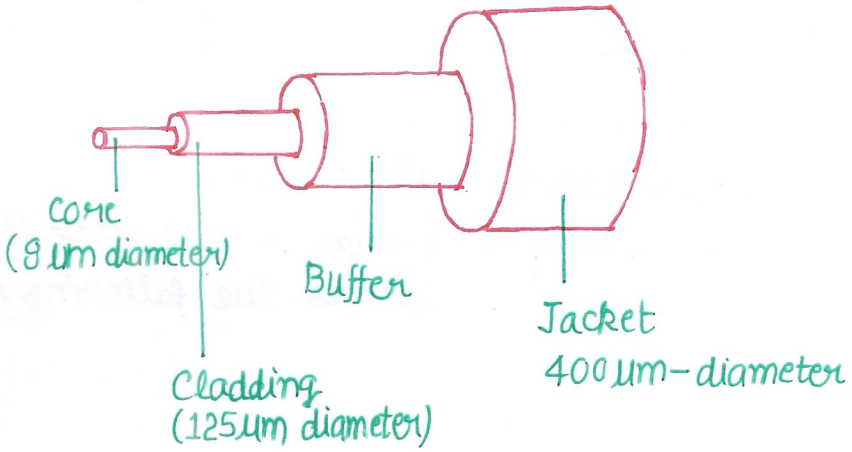
- Photodiode
- Step Index and Graded Index Fibre
- LED
- Optical Fibre
- Avalanche Photodiode

- Optical Fibre –

A thin flexible and transparent wire prepared for light propagation is called optical Fibre. The optical fibre has been constructed for the following reasons;

- The light wave cannot transerve long distance in air without any losses.
- To make loss less light wave communication, the optical fibre wave can be guided through optical fibre
- Additional advantage of high bandwidth.

physically optical fibre is very thin and flexible. The optical fibre can be used for many of Industrial application and medical application as well. The Optical Fibre consists of two media kept one inside the other. The center transparent medium of Optical Fibre is called core and the outer is cladding. The refractive index of core will be always higher than the refractive index of cladding.



Having cylindrical shape with three sections.

1. Core
2. Cladding
3. Buffer
4. Jacket

The core of a conventional Optical Fibre is a cylinder of glass or Plastic that runs along the fibre length. The core is surrounded by a medium with a lower refrective index known as cladding of a different glass or plastic. Light travelling in the core reflects from the core cladding boundary due to the total internal reflection. The core is characterised by the diameter or cross section area.

Cladding in optical fibre is one or more layers of materials of lower refrective index with the core material of high referective index.

Buffer is a component use to incapsulate one or more optical fibres for the purpose of providing such function such as mechanical isolation protection from physical damage and other.

The Jacket is the outer most portion of a Optical Fibre. Jacket is made from Polymer(PVC, plastic etc.) to protect the core and cladding from mechanical lose or damage. Fibre Optical Jacket are made in different colours for colour coating Identification.

- Importance of Optical Fibre-
  (i) Attanuation is lower than the coaxial cable.
  (ii) Smaller size and light weight.
  (iii) No physical, electric connection is required between sender and receiver.
  (iv) Realiblity is high.
  (v) Higher data rate
  (vi) Cost effective

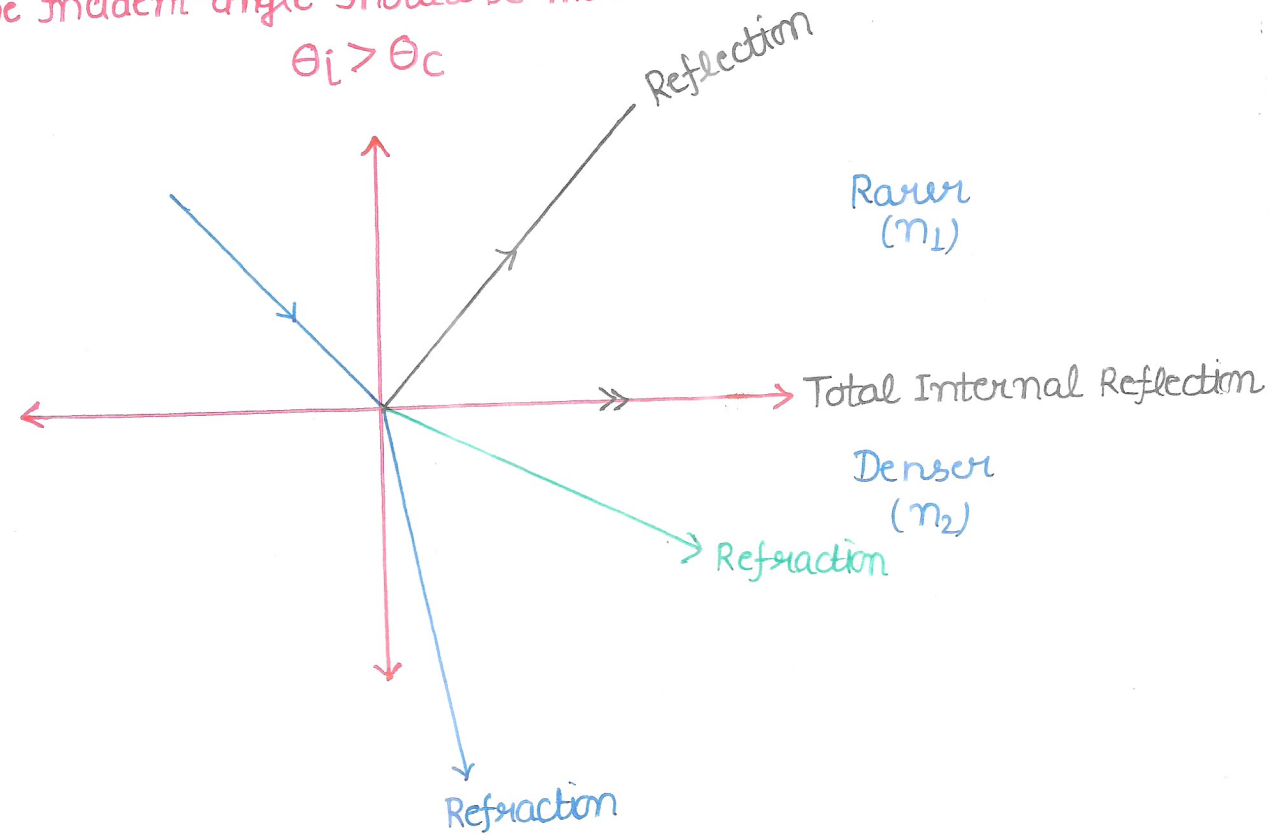
- The Propagation of Light in optical fibre-
  The light propagates through optical fibre through "Total Internal reflection". The TIR reflection appears due following reasons.

- When light travers from optically rarer medium (like air) to denser medium (glass) the refracted ray moves towards the normal drawn on the interface of media as in snell's law. Conversly, if light traverse from denser to optically rarer medium, the refracted ray moves away from the normal drawn on the interface of the medium.

Conditions for Total Internal Reflection:

1. The ray of Light should be transerve from denser to rarer medium.
2. The incident angle should be more than the critical angle

$\theta_i > \theta_c$



Parameters –

(i) Radius of core

(ii) Numerical Aparture

$$n_0 \sin\theta_i = n_1 \sin\theta_r$$

$$\sin\theta_i = \frac{n_1}{n_0} \sin\theta_r$$

$$\sin\theta_i = \frac{n_1}{n_0}\sqrt{1-\cos\theta_r} \quad \ldots\ldots\ldots (1)$$

Snell's rule

$$n_1 \sin\theta = n_2 \sin 90^\circ$$

$$n_1 \sin(90-\theta) = n_2 \sin 90^\circ$$

$$n_1 \cos\theta = n_2$$

$$\cos\theta_r = \frac{n_2}{n_1} \quad \ldots\ldots (2)$$

From eqn (1) & (2)

$$\sin\theta_i = \frac{n_1}{n_0}\sqrt{1-\left(\frac{n_2}{n_1}\right)^2}$$

$$\checkmark \left(NA = \sin\theta_i = \frac{1}{n_0}\sqrt{n_1^2 - n_2^2} \right)$$

(iii) Acceptance Angle

$$NA = \sin\theta_i = \frac{1}{n_0}\sqrt{n_1^2 - n_2^2}$$

$$\sin\theta_i = \frac{1}{n_0}\sqrt{n_{01}^2 - n_2^2}$$

$$\theta_i = \sin^{-1}\left(\frac{1}{n_0}\sqrt{n_1^2 - n_2^2}\right)$$

$$\boxed{\theta_i = \sin^{-1}(NA)}$$

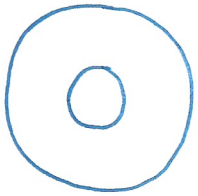
(iv) Attenuation

$$\boxed{\alpha = -\log\left(\frac{I_{out}}{I_{in}}\right)}$$

#Classification

- Material based
  - Plastic made OFC
  - Glass made OFC
- Refractive Index
  - Step / Single Index OFC
    - Single mode
    - Multimode
  - Graded Index OFC
    - Single mode
    - Multi mode

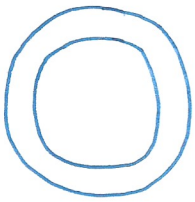
Single Index + Step Index -



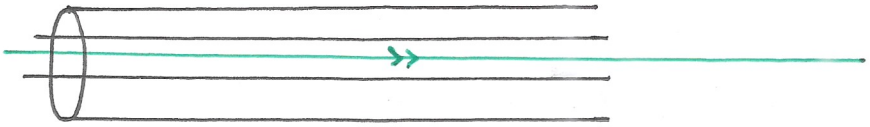
core << cladding

If the refractive index of core remains the same from the center of the core to the core cladding Interface.

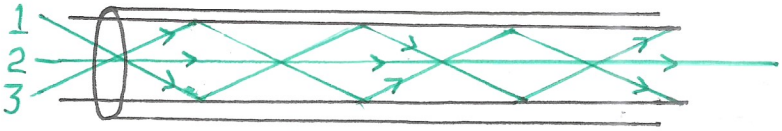
Graded Index -



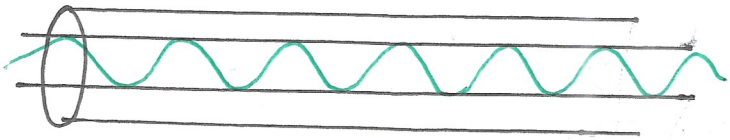
core < cladding



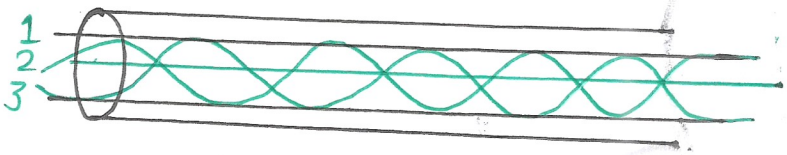
Step Index single Index mode



Step
Index Multimode



Graded
Index Single Mode



Graded Index Multimode

Communication -

