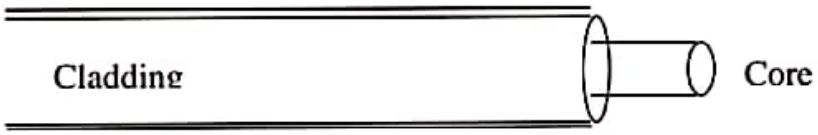
Optical fibres

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 traverse long distance in air without any losses.
- To make loss less light wave communication, the optical waves can be guided through optical fibre.

The optical fibre can be used for the many of industrial application and medical applications as well. The optical fibre consists of two media kept one inside the other. The centre 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.



Outer protective

1. The propagation of light in optical fibre.

The light propagates through optical fibre through "Total internal reflection". The total internal reflection appears due following reasons.

- When light traverse 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. Conversely, if light traverse from denser to optically rarer medium, the refracted ray moves away from the normal drawn on the interface of the medium fig.(1a)
- If the angle of incidence increases (fig.1b), to certain value for which the refracted ray happen to be on the interface of medium. The angle of incidence s known as critical angle (θ_c)(fig.1c).
- If the incident angle (fig.1d) increases more than critical angle, then the refracted ray falls on the same denser medium with no refraction. "This reflection of light is called total internal reflection".

Thus, following are the conditions for total internal reflection:

1. The ray of light should be traverse from denser to rare medium.
2. The incident angle should be more than the Critical angle ($\theta_i > \theta_c$).

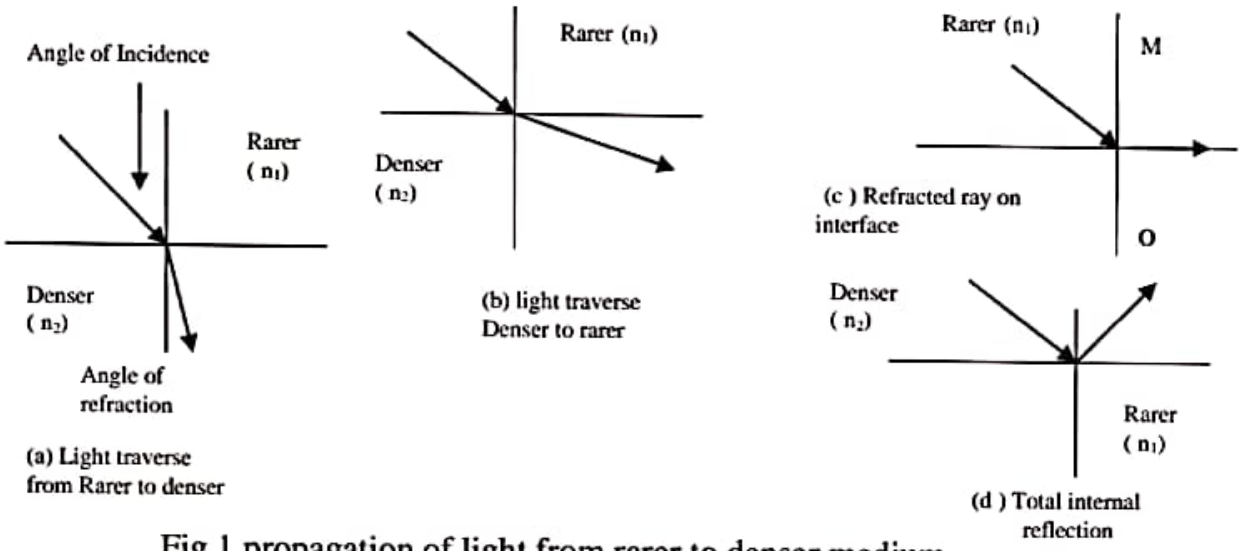


Fig.1 propagation of light from rarer to denser medium

Total internal reflection

If the incident ray exceeds the critical angle, the refraction would be turned in to reflection called total internal reflection. The critical angle is used for the mathematical expression to the occurrence of total internal reflection (fig.1c)

$$n_1 \sin\theta_i = n_2 \sin 90^0 \quad \text{(from Snell's law)}$$

$$\sin\theta_i = \frac{n_2}{n_1} \qquad \text{Since, } \sin 90^\circ = 1$$

$$\sin\theta_c = \frac{n_2}{n_1} \qquad \text{Since, } \theta_i = \theta_c$$

$$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

Therefore, to propagate the light through optical fibre, the incident angle should be made higher than the critical angle at various points on the core, so that the light can be traversed by the total internal reflection at those points.

To achieve the above, the size of core should be adjusted suitably which causes different types of optical fibre based on size, (no. of modes) refractive index and modes of propagation.

1.2 Classification

In the optical fibres the materials used, refractive index and mode of propagation of light are used for classification as follows: