

LOSSES IN OPTICAL FIBRES

1. Absorption loss:

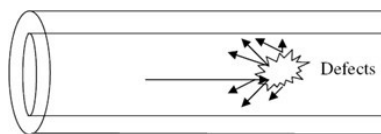
There are two types of absorption;

- (a) Absorption by impurities.
- (b) Intrinsic absorption.

In the case absorption by impurities, the type of impurities is generally transition metal ions such as iron, chromium, cobalt and copper. During signal propagation when photons interact with these impurities, the electron absorbs the photons and gets excited to a higher energy level. Later these electrons give up their absorbed energy either as heat energy or light energy. The re-emission of light energy is of no use since it will usually be in a different wavelength or at least in a different phase with respect to the signal. The other impurity which would cause significant absorption loss is the OH⁻ (Hydroxyl) ion, which enters into the fibre constitution at the time of fibre fabrication. **In Intrinsic absorption** it is the absorption by the fibre itself, or it is the absorption that takes place in the material assuming that there are no impurities and the material is free of all inhomogeneities and this sets the lowest limit on absorption for a given material.

2. Scattering loss:

The signal power loss occurs due to the scattering of light energy due to the obstructions caused by imperfections and defects, which are of molecular size, present in the body of the fibre itself. The scattering of light by the obstructions is inversely proportional to the fourth power of the wavelength of the light transmitted through the fibre. Such a scattering is called Rayleigh scattering. The loss due to the scattering can be minimized by using the optical source of large wavelength.



3 Bending losses (radiation losses):

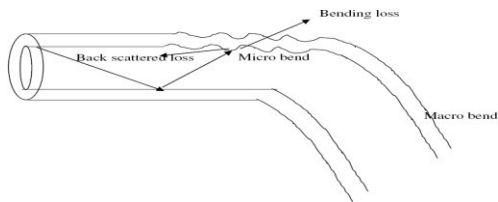
There are two types of bending losses in optical fibre a) macroscopic and b) microscopic bending loss.

- a) *Macroscopic bends:*

Macroscopic bends occur due to the wrapping of fibre on a spool or turning it around a corner. The loss will be negligible for small bends but increases rapidly until the bending reaches a certain critical radius of curvature. If the fibre is too bent, then there is a possibility of escaping the light ray through cladding material without undergoing any total internal reflection at core-cladding interface.

b) Microscopic bends:

This type of bends occurs due to repetitive small-scale fluctuations in the linearity of the fibre axis. Due to non-uniformities in the manufacturing of the fibre or by non-uniform lateral pressures created during the cabling of the fibre. The microscopic bends cause irregular reflections at core-cladding interface and some of them reflect back or leak through the fibre. This loss could be minimized by extruding a compressible sheath over the fibre which can withstand the stresses while keeping the fibre relatively straight.



4 Coupling losses:

Coupling losses occur when the ends of the fibres are connected. At the junction of coupling, air film may exist or joint may be inclined or may be mismatched and they can be minimized by following the technique called splicing.

Applications of Optical Fibres:

Point-to-point Communication

The use of optical fibres in the field of communication has revolutionized the modern world. An optical fibre acts as the channel of communication (like electrical wires), but transmits the information in the form of optical waves. A simple p to p communication system using optical fibres is illustrated in the figure.

The main components of p to p communication is

- 1) An optical transmitter, i.e., the light source to transmit the signals/pulses
- 2) The communication medium (channel) i.e., optical fibre
- 3) An optical receiver, usually a photocell or light detector, to convert light pulses back into electrical signal.

