SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

MICROWAVE ENGINEERING

IV YEAR/ VII SEMESTER

UNIT 4 – OPTICAL COMMUNCATION

TOPIC – OPTICAL FIBERS AND DEVICES-OPTICAL WINDOWS, ATTENUATION

Optical Window

- In astronomy, the **optical window** is the optical portion of the electromagnetic spectrum that passes through the atmosphere all the way to the ground.
- Most EM wavelengths are blocked by the atmosphere, so this is like a window that lets through only a narrow selection of what is out there, though the sun is particularly active in the passed wavelengths.
- It is called "optical" because the wavelengths we can see are all in this range.
- The window runs from around 300 nanometers (ultraviolet-B) at the short end up into the range the eye can use, roughly 400–700 nm and continues up through the visual infrared to around 1100 nm, which is in the near-infrared range.
- There are also infrared and "radio windows" that transmit some infrared and radio waves.
- The radio window runs from about one centimeter to about eleven-meter waves.

FEATURES

- In medical physics, the optical window is the portion of the visible and infrared spectrum where living tissue absorbs relatively little light.
- This window runs approximately from 650 to 1200 nm. At shorter wavelengths, light is strongly absorbed by hemoglobin in blood, while at longer wavelengths water strongly absorbs infrared light.
- In optics, it means a (usually at least mechanically flat, sometimes optically flat, depending on resolution requirements) piece of transparent (for a wavelength range of interest, not necessarily for visible light) optical material that allows light into an optical instrument.

FEATURES

- A window is usually parallel and is likely to be anti-reflection coated, at least if it is designed for visible light.
- An optical window may be built into a piece of equipment (such as a vacuum chamber) to allow optical instruments to view inside that equipment.
- For UV/VIS spectroscopy, these types of windows are usually made from glass or fused silica.
- In IR spectroscopy, there is a wide range of materials from Barium Fluoride (BaF2), Germanium (Ge), Zinc Selenide (ZnSe) and Sapphire that transmit light into the far infrared.
- These windows are either built into circular or rectangular configurations.

ATTENUATION&DISPERSION

$$\alpha = \frac{10}{L} \log\left(\frac{P_{in}}{P_{out}}\right)$$

Expressed as α dB/Km.

L = fiber length.

Caused by

- Absorption
- Scattering
- Bending

ATTENUATION&DISPERSION

- Intrinsic absorption by glass materials itself.
- Due to absorption bands in ultraviolet region (Energy level transition).
- Tail of the curves enter the operation region.
- Small as compared to IR absorption.
- E and loss inversely proportional to wavelength.
- Typically 0.1dB/Km at 1200nm.
- Follows empirical relation as: Urbach's rule (E-Photon Energy)

$$\alpha_{uv} = Ce^{E/E_0}$$

C and E_0 are empirical constants

ATTENUATION&DISPERSION

- SIGNAL DEGRADATION - ABSORPTION
- Intrinsic absorption by glass materials itself.
- Crystal lattice vibration in Infra red region
- If frequency lies within resonant frequency of vibration.
- Tail of the curves enter the operation region.
- Typically 0.1dB/Km at 1500nm.

ATTENUATION&DISPERSION

SCATTERNG

- Microscopic variations in material density.
- Glass is randomly connected network of molecules having higher or lower than average density.
- Compositional fluctuations of SiO_2, GeO_2, and P_2O_5.
- Give refractive index fluctuations.
- If fluctuation distance very small w.r.t wavelength, cause Rayleigh-type scattering of light.
- i.e. photons moving in all directions.
- Effective signal strength gradually reduces.
- Proportional to λ^{-4}.
- Reduces with increase in wavelength.

ATTENUATION&DISPERSION

MIE scattering

- When RI fluctuation distance comparable to wavelength.

Can be reduced by-

- Reducing imperfections during manufacturing.
- Carefully controlled extrusion and coating.
- Increasing fiber guidance by increasing Δ.

THANK YOU