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

OPTICAL AND MICROWAVE ENGINEERING

III YEAR/ VI 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