FO-WAVE : Construction and Study of Mode Properties of Planar Waveguide

FEATURES

- The lab allows construction of single mode and multi mode planner waveguides using ion exchange technique and also to study the optical characteristics of these waveguides.
- Opto-Mechanical components allow easy installation of optical components and alignment of experimental setup to study the optical characteristics of these waveguides
- Waveguide preparation tools such as furnace, crucible, chemicals, glassware, IR lamp, etc. provide complete solution for waveguide construction in lab.
- Specially designed waveguide-prism coupler holder allows easy mounting of prism waveguide assembly and efficient coupling of light.

SPECIFICATIONS

LASER
- Source Type : He-Ne Laser
- Wavelength : 632.8nm
- Light : Red Visible
- O/P Power : 1 mW
- Complete system with power supply

Waveguide
- Single mode, multi mode waveguide
- Substrate - Soda lime glass
- Ion exchange using Potassium Nitrate ion (KnO_3) bath

Prism
- Right Angle Prism : 10 X 10 X 10mm. +0/-0.2mm
- Surface Quality : 60/40
- Refractive Index : >1.7
- Polished Surface : Diagonal, bone and back side.
- Unpolished Surface : Two side surfaces.

Collimator
- Galilean Construction
- Magnification by 10X

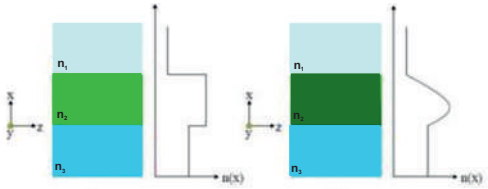
Furnace
- Top Loading
- Temp : 0 - 1200 ^{0}C
- Active Space : 9” height - 4” width - 4” depth

Crucible
- Thickness : 1 mm
- Shape : Cylindrical
- Height : 4”
- Diameter : 2”

OPTICAL PLANAR WAVEGUIDE

- In the ray model of wave guiding ,we consider that the light propagates along the guide by a series of total internal reflections
- Planar waveguide is simply a thin layer of high index material bound on both sides by material of lower index

Following are two types of planar waveguides based on Their RIP:

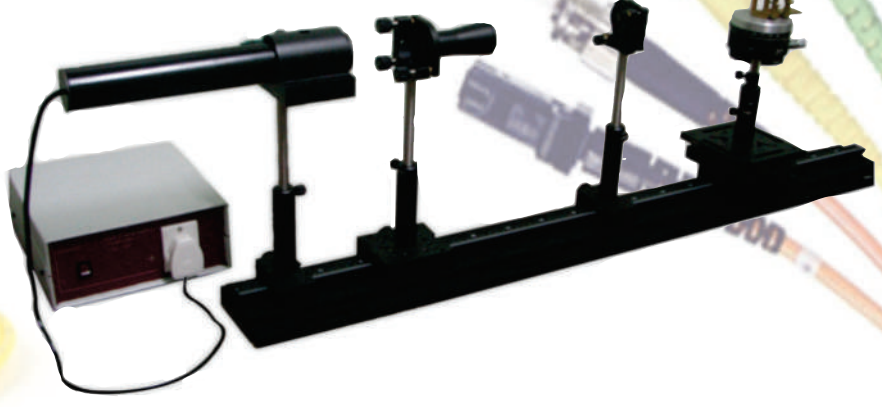


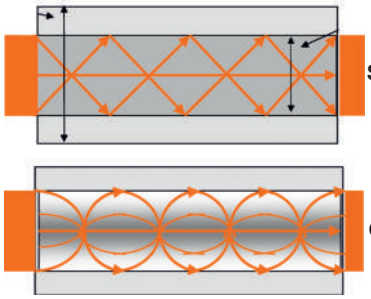
Step Index **Graded Index**

- For a planar waveguide of thickness d and refractive index n_2 ,the allowed angles, θ_m, are given by the following eigen value equation:

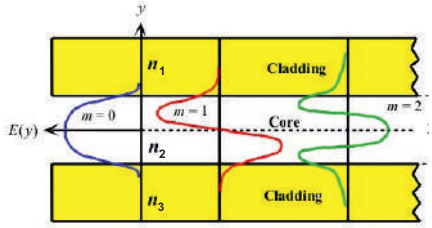
$$(2\pi d n_2 \cos\theta_m)/\lambda_0 = m\pi + \Phi_1 + \Phi_3$$

Where,
λ_0 is the wavelength of the input light in free space,
m is an integer (m=0,1,2……) called the mode number
Φ_1 and Φ_3 are the evanescent field phase shifts at the waveguide boundaries with the surrounding material





- Light travels in curved path in Graded index where as travels straight path in step index optical planar waveguide.
- Mode is the angle of incidence which is allowed to propagate through optical planar waveguide.

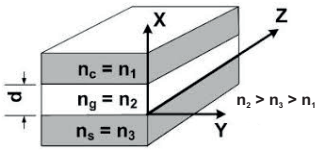


- Above diagram shows the electric field patterns of first three modes (m=0, 1, 2) travelling along optical waveguide:

PREPARATION OF OPTICAL PLANAR WAVEGUIDE

Methods of waveguide preparation:

- Film Deposition
- Diffusion
- Ion Exchange



- Film deposition is primary approach for preparation of Step Index profile Waveguide
- Diffusion and Ion Exchange techniques are used for Graded Index profile Waveguide.
- The ion exchange technique involves use of soda lime glass substrate, KnO_3 bath, temperature controlled ceramic furnace
- Waveguide thickness(d) are determined by the Temperature (T), of ithe melt, and Immersion time (t)
- Relation between T,t and d

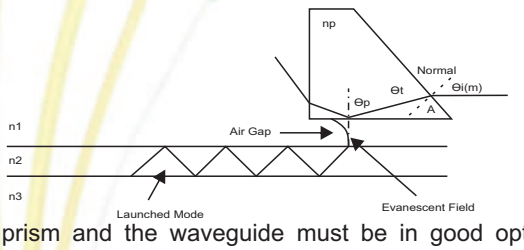
$d=\sqrt{Dt}$

D: Temperature dependent effective diffusion constant.

Prism Coupling:

The conditions for coupling to take place are as follow:

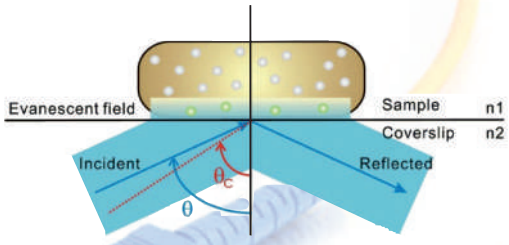
- The prism refractive index,np must be greater than that of the waveguide material.



- The prism and the waveguide must be in good optical contact such that the evanescent field generated by total internal reflection at the bottom surface of the prism penetrates into the waveguide.

EVANESCENT WAVE

- An evanescent wave is a near field standing wave with an intensity that exhibits exponential decay with distance from the boundary at which the wave was formed.



- They are formed at the boundary between two media with different wave motion properties, and are most intense within one third of a wavelength from the surface of formation.

COMPONENT FOR WAVEGUIDE PREPARATION

- Furnace : 1 No
- Beakers : 2 No
- Crucible : 2 No
- Long Nose Twiser : 1 No
- Twiser : 1 No
- Soap Powder : 2 Pouch
- Distilled Water Bottle : 1 No
- Petri Dish : 1 No
- Tea Spoon : 1 No
- KNO3 : 500GMS
- Soft Tissues : 1 BOX
- Prisms : 4 No
- Slides : 1 BOX
- Steel Bowl : 1 No
- Cleaning Brush : 1 No
- IR Lamp : 1 No

COMPONENTS FOR WAVEGUIDE STUDY

- Prepared Wave Slides : 2 No
- Rail Base : 1 No
- 88mm Carrier. : 1 No
- 42mm Carrier : 1 No
- 12mm Post. : 3 No
- Laser Beam Expander. : 1 No
- Polarizer Holder. : 1 No
- Laser Source with power supply unit : 1 No
- Laser Tube Holders. : 1 No
- Laser Bean Expander Holder : 1 No
- Translation Stage. : 1 No
- Base Plate (BP-1) : 1 No
- Helicoidally Post Holder. : 1 No
- Base Plate (BP-18) : 1 No
- Rotational Stage : 1 No
- Specially designed prism assembly holder : 1 No
- Post (length 200mm)-M6 hole on one side, screw on other. : 1 No
- Post (length 200mm)-M6 hole on one side, M4 hole on other. : 3 No
- Post (50mm)-M6 hole on one side screw on other : 1 No.