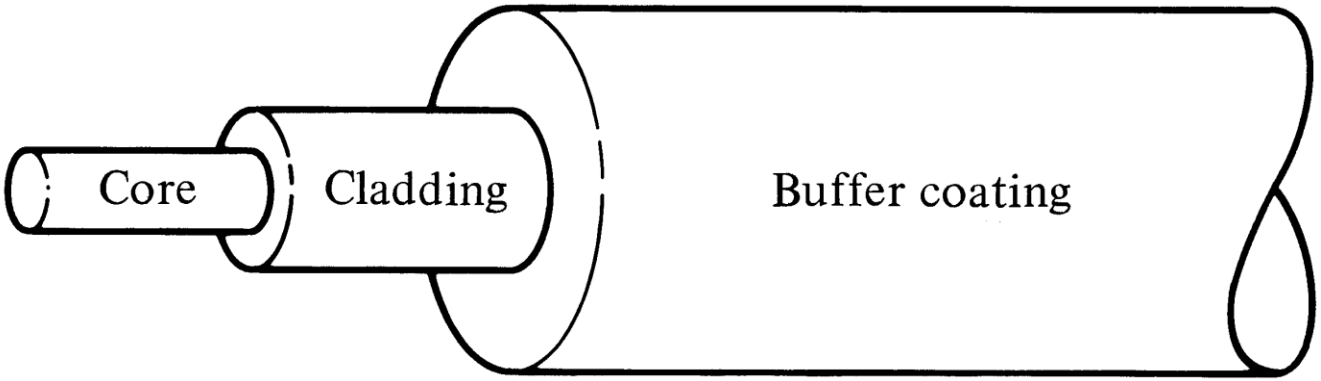
OPTICAL FIBER Materials

Manufacturing-II

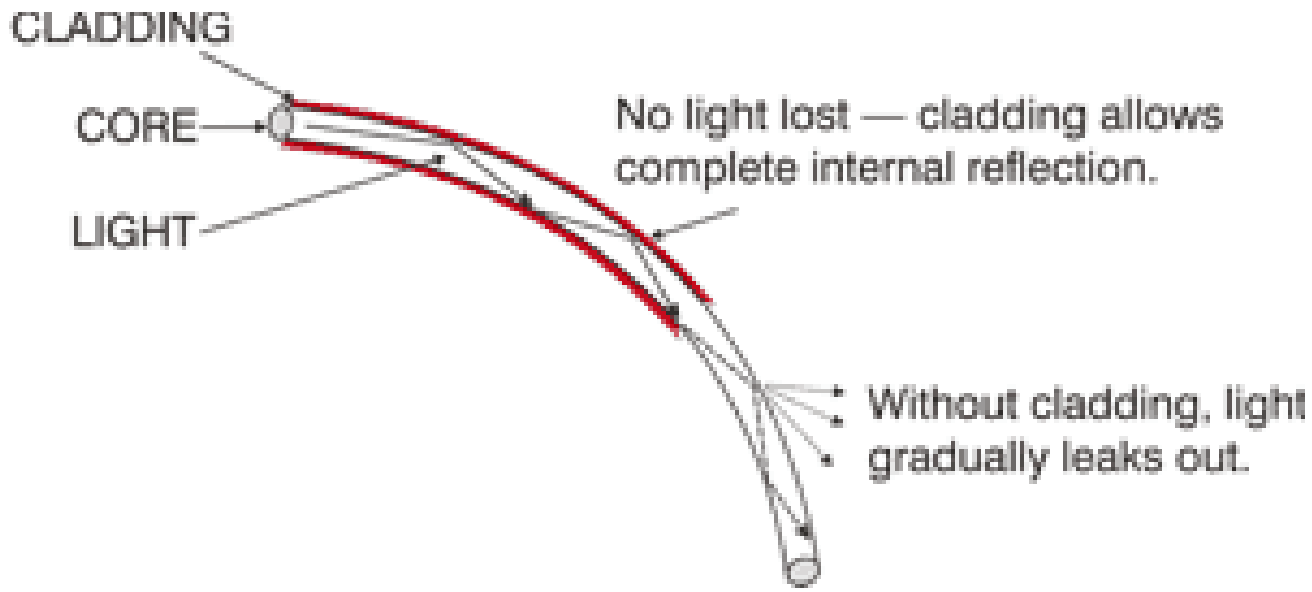
Fiber Structure



- An optical fiber is a long cylindrical dielectric waveguide, usually of circular cross-section, transparent to light over the operating wavelength.
- A single solid dielectric of two concentric layers. The inner layer known as **Core** is of radius **'a'** and refractive index **'n_1'**. The outer layer called **Cladding** has refractive index **'n_2'**.

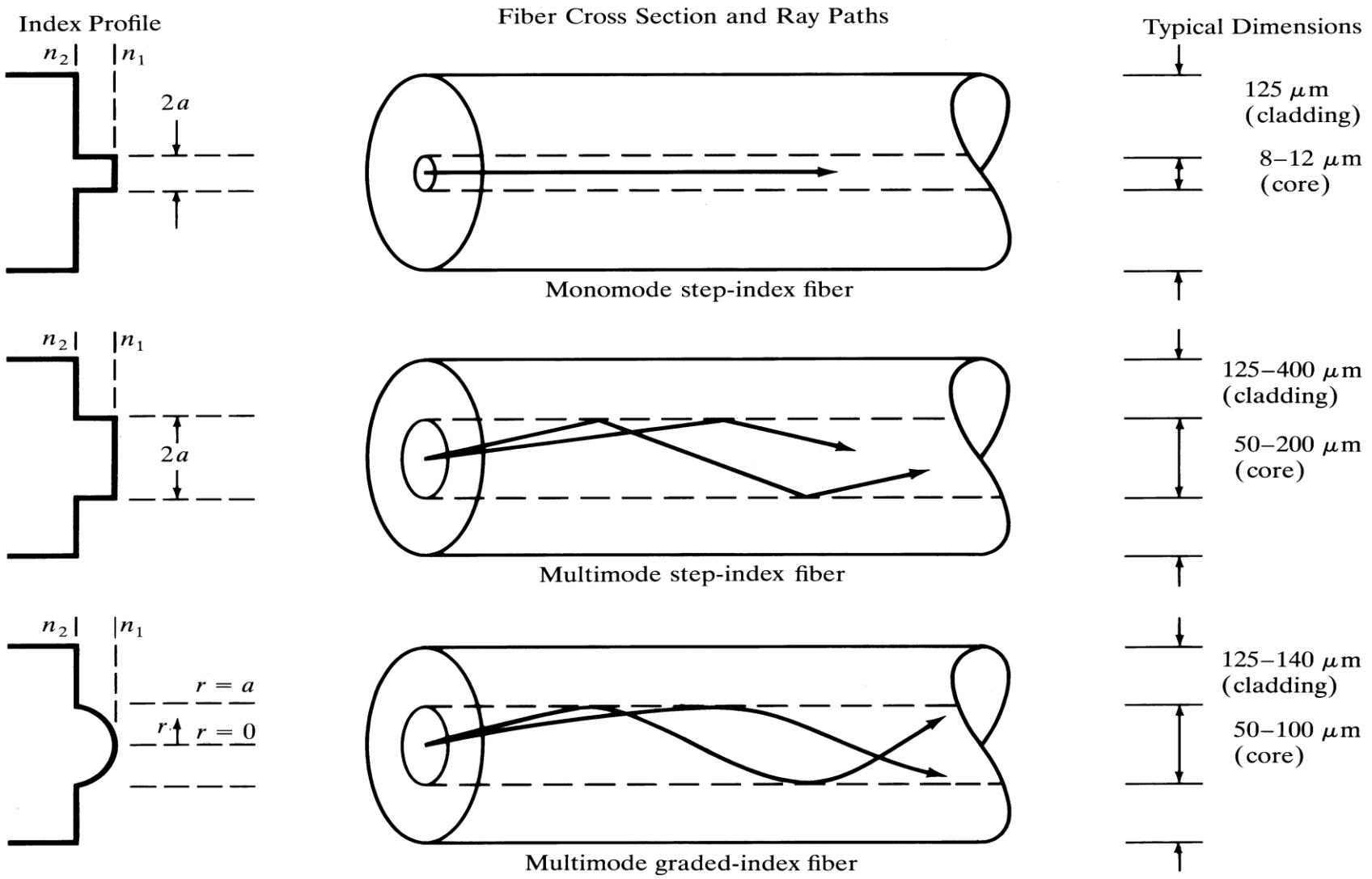
$n_2 < n_1 \rightarrow$ **condition necessary for TIR**

Light Propagation through Optical Fiber



- **Must meet the conditions for Total Internal Reflection (TIR)**

Step Index / Graded Index



DESIGNER'S PARAMETERS

Numerical Aperture (NA) : $NA = \sin\theta_a = [(n_1)^2-(n_2)^2]^{1/2}$

0.12-0.15 for SMF, 0.15-0.25 for MMF

Relative Refractive Index Difference (Δ):

$\Delta = (n_1 - n_2)/n$; n- the average refractive index

< 0.4% for SMF, >1% for MMF

Normalized Frequency or **V-Number:**

$V = [(2\pi a)/\lambda] NA$

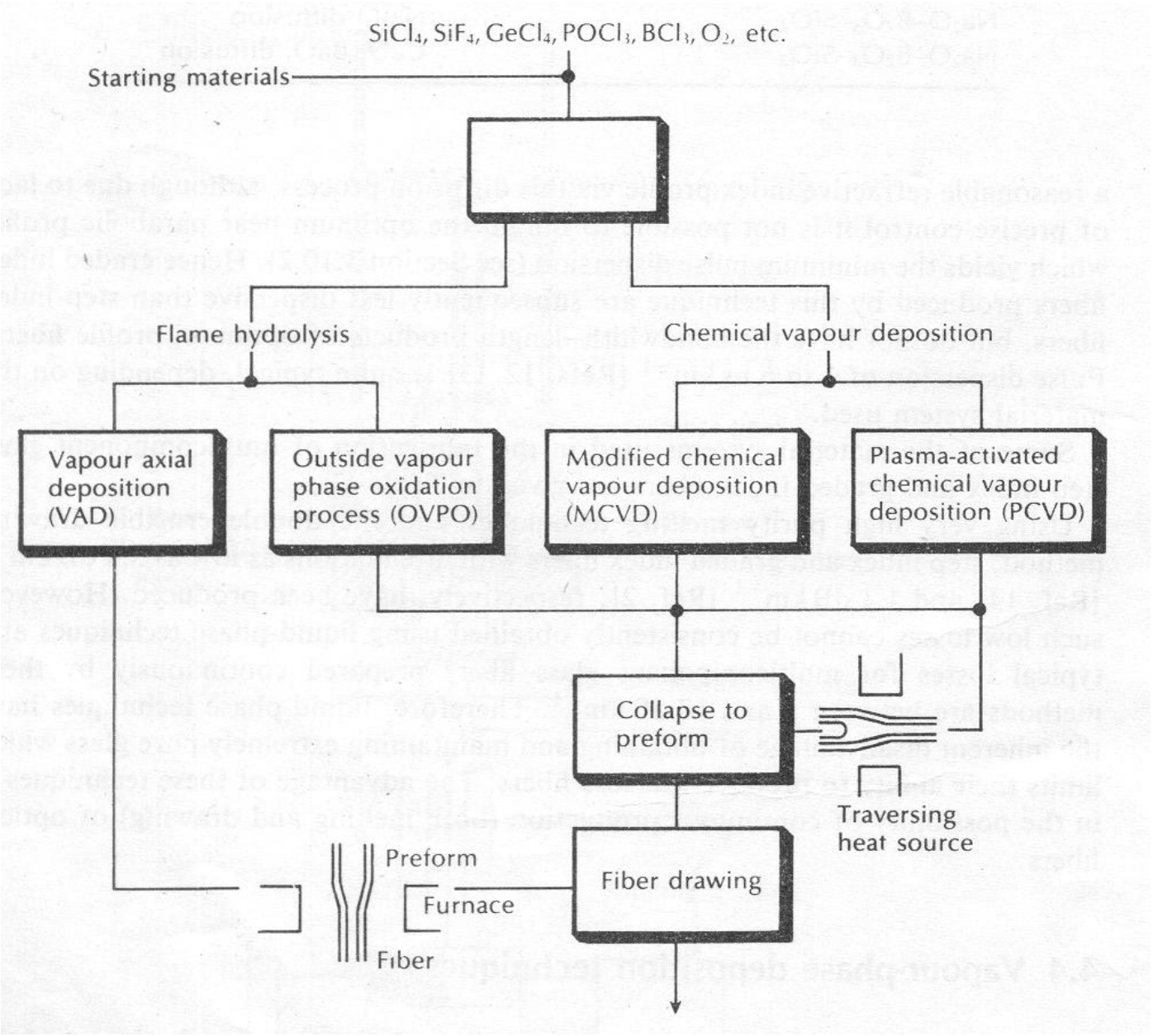
$V \leq 2.405$ for SMF; ≥ 10 for MMF

Schematic of Vapour-Phase Deposition Techniques

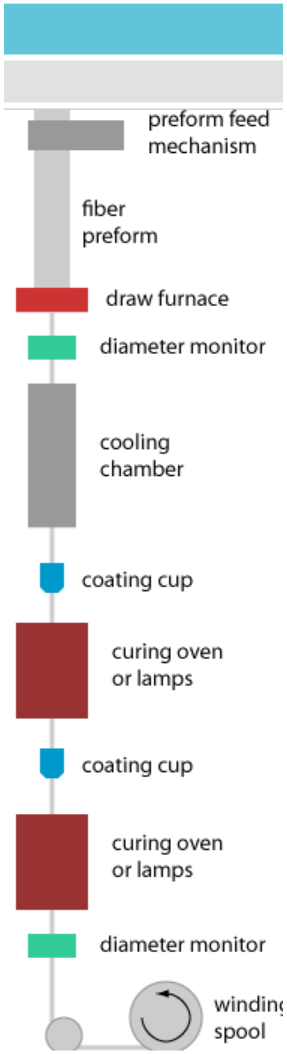
- **For Silica rich glasses**

✓ High transperency

✓ Optimuml optical properities.



Step-II-Fiber Drawing

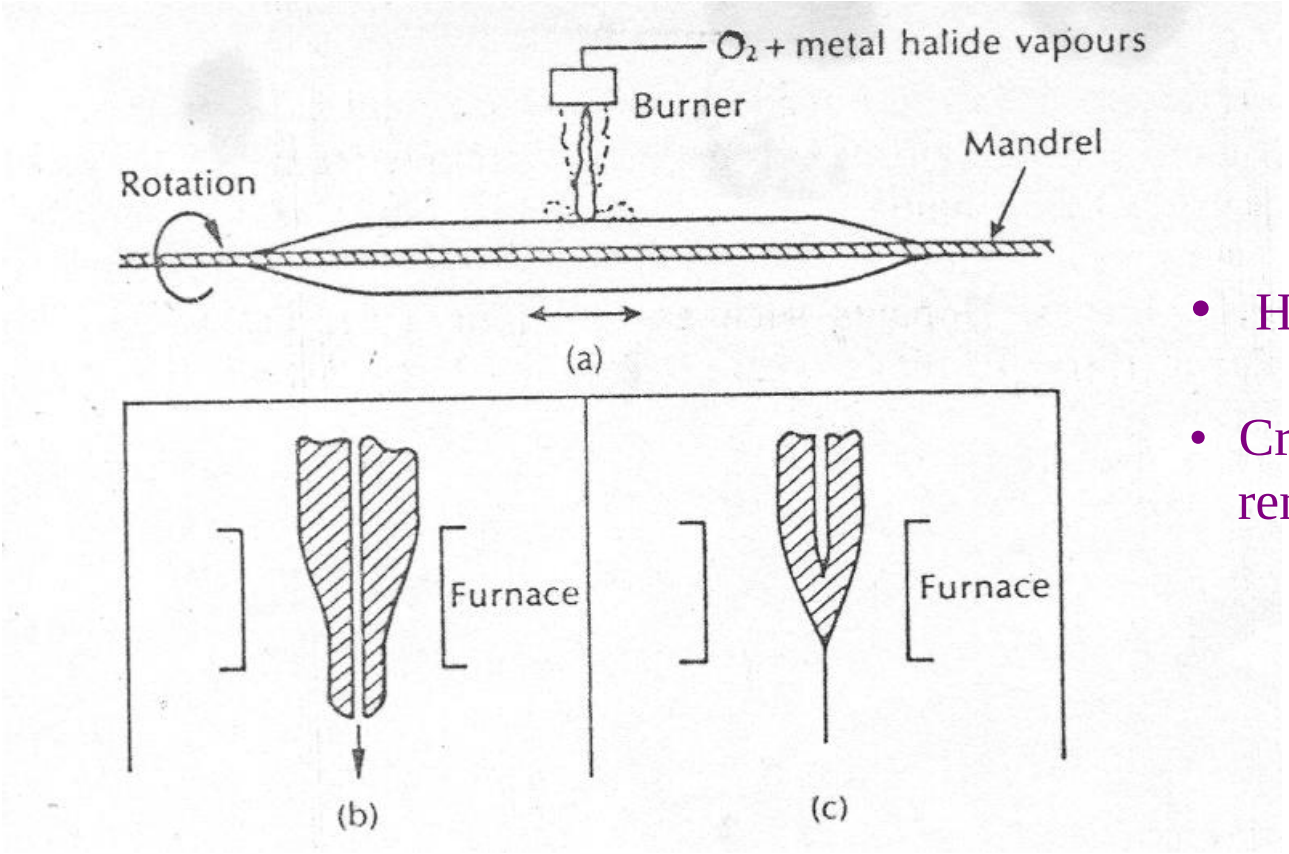


- **Rod in tube** process
- Useful only for Step Index fibers with large core and cladding diameters.
- ***Bubbles & particulates*** at interfaces
- 5-10 dB/km loss

Optical Fiber from a Preform.

Outside Vapour-Phase Oxidation (OVPO) Process

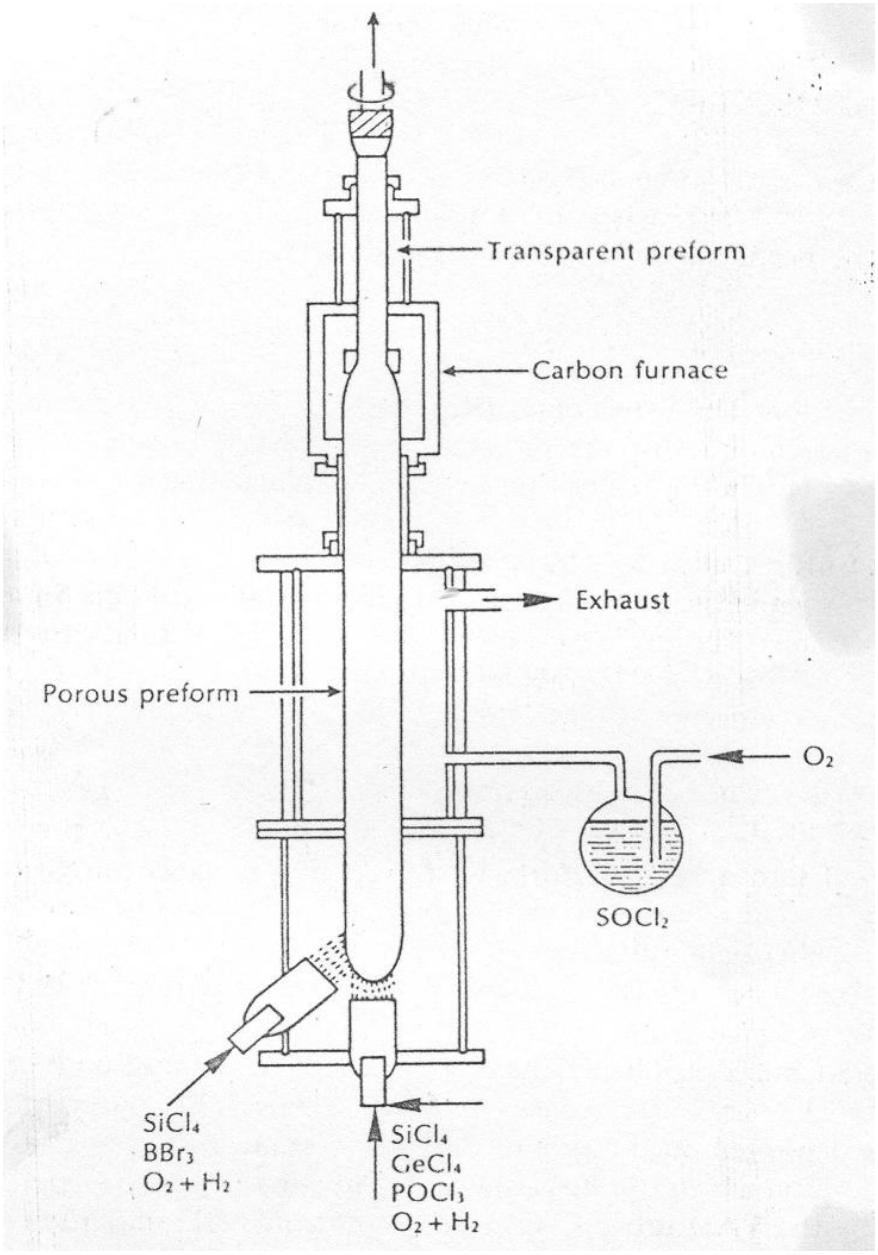
- Uses Flame hydrolysis for **'Soot'** Formation



- High OH impurity content
- Cracks during mandral removal

OVPO Process: (a) Soot deposition, (b) Preform Sintering
(c) Fiber Drawing

VAD Process



The VAD Process

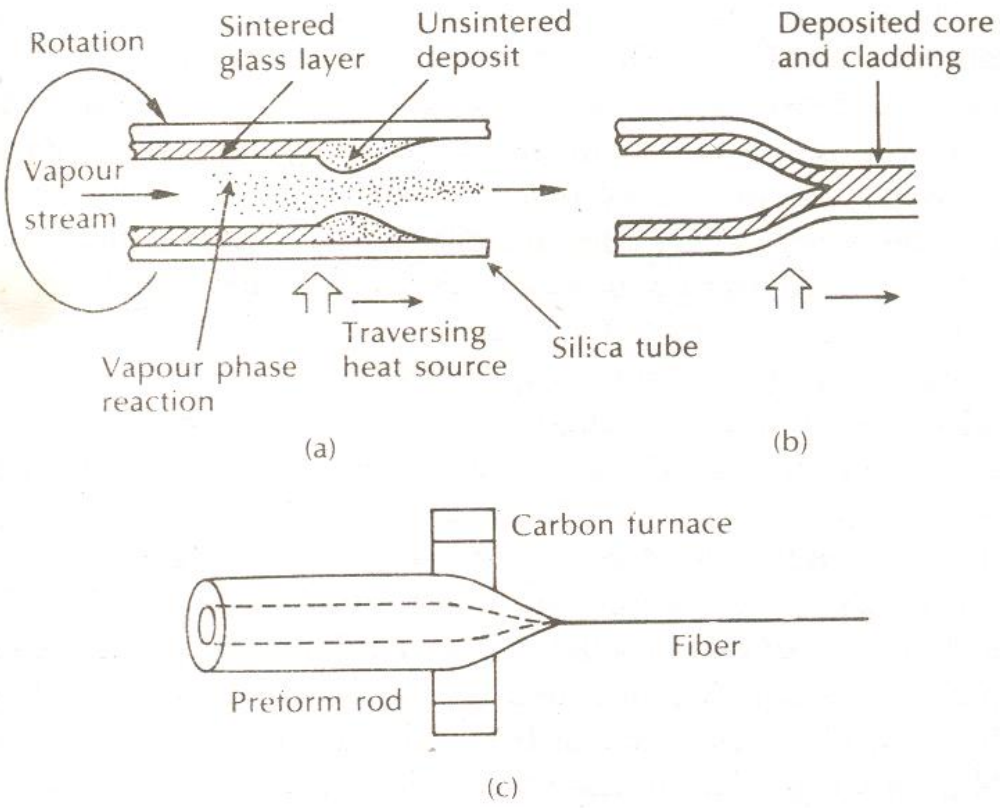
- End-on deposition
- Typical OH content between 50-200 PPM
- Reduced by applying chlorine as drying agent
- Typical Temp. 1500 ^{O}C
- Losses as low as 2 dB/km

Difficulties:

- Cracks while removing mandral
- Depression in RL profile near centre due to collapsed hole.

MCVD Techniques

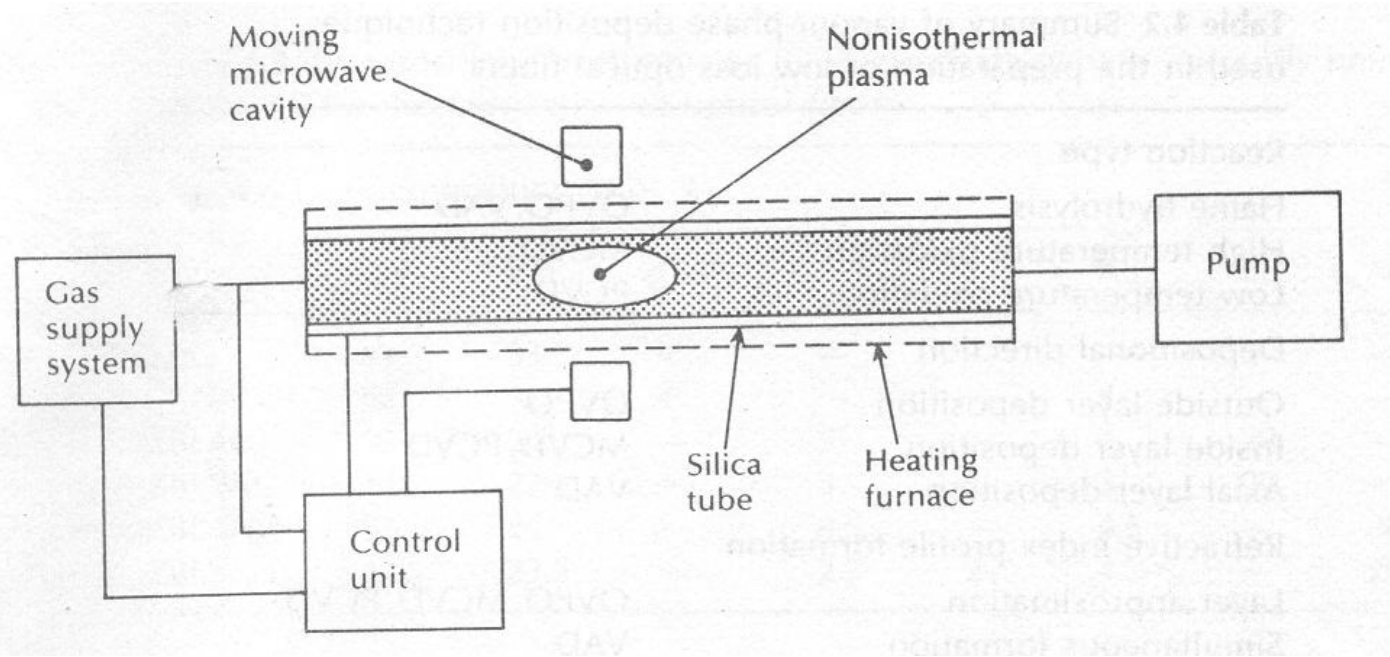
- Modified Chemical Vapor Deposition (MCVD)
  - An inside vapour phase oxidation (IVPO) method
  - vaporized raw materials are deposited into a pre-made silica tube



- Deposition within an enclosed reactor-very clean environment
- Fiber formation 1400-1600 ^{O}C, drawing at 2000 - 2200 ^{O}C
- Reduced OH impurity
- Minimum losses of only 0.2 dB/km at 1550 nm

PCVD Technique

- Plasma Activated Chemical Vapour Deposition
  - A variation on the MCVD technique to use plasma to supply energy for the vapour-phase oxidation of halides.
  - Film deposition at around 1000 ^{O}C



➢ Provide controlled and high uniformity of layers

THANK YOU