Fabrication of Fiber Optic Multimode Glass Rods



Overview

The first step in manufacturing glass optical fibers is to make a solid glass rod, known as a preform.

Key Takeaways

Multimode fiber optic glass rods are fabricated by depositing ultra-pure silica and doped silica layers onto a preform using processes like MCVD, OVD, or VAD, followed by consolidation and fiber drawing.

Raw Materials

The primary materials for multimode fiber fabrication are silicon tetrachloride ($SiCl_4$) for the silica base and germanium tetrachloride ($GeCl_4$) as a dopant to increase the refractive index of the core. Additional dopants such as boron, fluorine, phosphorus, or titania may be used to modify the cladding or core properties. These chemicals are highly purified to minimize optical loss and ensure uniformity in the final fiber.

Preform Fabrication Methods

Modified Chemical Vapor Deposition (MCVD)In MCVD, a high-purity quartz tube is mounted on a rotating lathe. A mixture of $SiCl_4$, $GeCl_4$, and oxygen is introduced into the tube. A methane/oxygen torch heats the tube externally, causing the gases to react and form submicron silica and germania particles, known as "soot," which deposit on the inner wall.

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The torch traverses the tube repeatedly, and the deposited soot is vitrified into transparent glass layers. By controlling the dopant concentration and deposition parameters, a graded-index or step-index core can be formed for multimode fibers. Outside Vapor Deposition (OVD)OVD involves depositing silica and doped silica soot on the outer surface of a rotating bait rod.

The soot is generated in a flame via hydrolysis reactions of $SiCl_4$ and $GeCl_4$. Multiple layers are deposited to form the core and cladding. After deposition, the bait rod is removed, and the porous preform is sintered into a solid glass rod.

OV

D allows high doping levels and precise control of the core-to-cladding ratio. Vapor Axial Deposition (VAD)VAD deposits silica and doped silica axially along a target rod. Gases are injected into a high-temperature furnace, where pyrolysis reactions form soot that accumulates along the rod.

This method is suitable for large-scale production and allows uniform deposition of thick preforms for multimode fibers. Direct Nanoparticle Deposition (DND)DND is a specialized OVD variant where nano-sized particles of silica and dopants are deposited simultaneously. This method achieves high doping levels with minimal clustering, improving optical performance and damage thresholds.

Consolidation and Sintering

After deposition, the preform is heated in a furnace to remove residual porosity and consolidate the glass into a solid, transparent rod. This step ensures mechanical strength and optical clarity. The preform now has the desired core and cladding structure with precise refractive index profiles.

Fiber Drawing

The solid preform is then drawn into thin fibers in a vertical draw tower. The preform tip is softened in a high-purity graphite furnace at temperatures around 1900–2200°C. Gravity and controlled tension pull the molten glass into a continuous fiber.

The fiber is immediately coated with UV-curable acrylate layers to protect against mechanical damage and environmental contamination. Draw speeds typically range from 10 to 20 meters per second, and the core-to-cladding ratio is preserved from the preform.

Quality Control

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Throughout the process, mass flow controllers and precise temperature regulation ensure uniform deposition and doping. Optical properties such as attenuation, numerical aperture, and modal dispersion are monitored to meet multimode fiber specifications. In summary, the fabrication of multimode fiber optic glass rods involves chemical vapor deposition of doped silica layers, consolidation into a solid preform, and precise fiber drawing, with careful control of dopants and thermal conditions to achieve the desired optical performance.

Article Content

FOA Tech Topics: Manufacturing optical fiber

The first step in manufacturing glass optical fibers is to make a solid glass rod, known as a preform. Ultra-pure chemicals -- primarily silicon tetrachloride (SiCl4) and germanium tetrachloride (GeCl4) --

Fabrication of Optical Fibers

Fabrication of Optical Fibers Basically, fiber manufacturers use two methods to fabricate multimode and single mode glass fibers. One method is vapor phase oxidation, and the other method is direct-melt

Fiber Preforms – fabrication, modified chemical vapor deposition,

Here, we cover only the fabrication of glass preforms, and mostly on those for silica fibers. In this section, the fabrication of standard fiber preforms is explained, while special preforms for various

Optical Fiber Manufacturing Process And Methods

Manufacturing Optical Fiber Cable The manufacturing process consists of major steps, including glass deposition, preform fabrication, and fiber drawing, shown schematically below: ...

Optical Fiber Fabrication

A general description of optical fiber fabrication methods is presented, where the fabrication methods are described for silica and polymer optical fibers, since there are some differences in the fabrication,

Materials and Fabrication Technologies in Optical Fiber Manufacturing

Optical fiber drawing technology and each of the processes associated with preform fabrication—OVD, VAD, MCVD, and PCVD—have been developed to the point at which they can easily yield both

Fiber Fabrication

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How are optical glass fibers typically fabricated? Most fibers are made by pulling them from a heated glass rod, called a preform, in a tall apparatus known as a fiber-drawing tower.

Optical Fiber Manufacturing: From Preform to Final Fiber Process

Explore the optical fiber manufacturing steps: preform production (MCVD, OVD) and fiber drawing. Learn how high-purity materials and precision techniques create low-loss fibers for telecom

Optical Fiber Fabrication Techniques | PDF | Optical Fiber

The direct-melt process combines multicomponent glass rods in a molten state within concentric crucibles to form a preform, which is then drawn into an optical fiber through a similar process.

Low-loss multi-mode anti-resonant hollow-core fibers

Abstract: In this work, multi-mode anti-resonant hollow-core fiber (AR-HCF) with 18 fan-shaped resonators is fabricated and characterized. The ratio of core diameter over transmitted wavelengths ...

The FOA Reference For Fiber Optics

Designers of fiber optic cable plants and networks depend on these specifications to determine if networks will work for the planned applications. For the purposes of

Fiber-optic cable

A fiber-optic cable, also known as an optical-fiber cable, is an assembly similar to an electrical cable but containing one or more optical fibers that are used to carry light. The optical fiber elements are

Fiber Preforms – fabrication, modified chemical vapor deposition,

This article explains what a fiber preform is: the piece of optical glass from which an optical fiber is manufactured in a fiber drawing tower, and how its structure determines the fiber''s properties. The

High-power ultra-broadband supercontinuum generation in tapered ...

In this work, we demonstrate the significant potential of short tapered multimode rods for high-power ultrabroadband SC generation on distinct glass platforms by means of a high-repetition-rate

Materials and Fabrication Technologies in Optical Fiber

The quantity of silica glass necessary to make up the core and primary cladding of any conventional single-mode or multimode optical fibers is small, totaling less

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Stack and draw: how plain glass rods turn into the fibre optics of the ...

Furnaces in each drawing tower of the fibre fabrication facility heat glass rods to over 2050 degrees Celcius, softening the glass so it can be pulled into a fine strand. Tucked away in the Centre for

FIBER OPTICAL COMMUNICATIONS (R17A0418)

UNIT I general Optical Fiber communication system, advantages of optical fiber communications. Optical fiber wave guides- Introduction, Ray theory t ansmission, Total Interna Fiber materials, Fiber

FABRICATION OF OPTICAL FIBERS Thomson CSF

INTRODUCTION Optical fibers which are used for high bit rate transmission over long distances must meet two requirements: low transmission loss and low signal distortion. To o"btain such high quality

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