

Hollow-core optical fiber production process



Overview

As we have been told, splicing needs to be done quickly before too much outside air gets into the fiber.

Key Takeaways

Hollow-core optical fibers are manufactured through precision preform fabrication, controlled fiber drawing with internal gas pressure, and rigorous proof testing to maintain the hollow structure and optical performance.

Preform Fabrication

Hollow-core fibers begin with a preform, a macroscopic structure that defines the fiber geometry. Unlike conventional solid-core fibers, HCF preforms include annular support structures and capillaries that form the hollow core and cladding elements . The preform may contain sealed tubes to maintain internal cavities and prevent collapse during drawing. Materials are typically high-purity silica, sometimes doped to adjust refractive indices, and the hollow core is often filled with an inert gas to reduce attenuation . Preform fabrication requires precise alignment of nested tubes or capillaries, as the number and arrangement of tubes directly affect optical guidance and loss characteristics .

Fiber Drawing

The preform is then drawn into fiber using a fiber draw tower. Key parameters include:



- Furnace temperature: carefully controlled to soften the silica without collapsing the hollow structure .
- Capstan tension: regulates the fiber diameter and uniformity.
- Internal gas pressure: maintained in the hollow core to prevent collapse, typically ranging from slightly below to slightly above atmospheric pressure (e.g., 1.0–3.0 psig) during drawing . The drawing process transforms the preform into kilometers of thin fiber while preserving the hollow core geometry. Advanced designs, such as nested anti-resonant nodeless fibers (NANF), use multiple concentric tubes to optimize light guidance and reduce attenuation .

Post-Processing and Proof Testing

After drawing, fibers undergo proof testing to ensure mechanical strength and long-term reliability. This includes:

- Tensile testing to verify fiber can withstand handling and installation stresses.
- Sealing the fiber ends to maintain the inert gas environment and prevent moisture ingress, which is critical for long-term performance .
- Splicing and adapter fibers may be used to connect HCF to conventional single-mode fibers, compensating for differences in mode field diameters and minimizing insertion loss .

Quality Control and Automation

Modern HCF manufacturing relies on process automation and advanced control systems to improve yield, reduce defects, and ensure consistent optical performance . Monitoring includes real-time diameter measurement, pressure regulation, and spectral attenuation testing.

Summary

The manufacturing of hollow-core optical fiber involves:

- Preform fabrication with hollow structures and capillaries.
- Precision fiber drawing with controlled furnace temperature, tension, and internal gas pressure.
- Post-processing and proof testing to ensure mechanical and optical reliability.
- Integration with conventional fibers using splicing techniques and adapter fibers for practical deployment. These processes enable HCF to achieve ultralow latency, high-speed transmission, and reduced attenuation, making them suitable for applications in data centers, quantum communications, and high-power laser delivery .

Article Content

Method of manufacturing hollow core optical fibers

A method for manufacturing hollow core optical fibers is disclosed comprising continuously feeding a glass rod of the desired

Hollow core optical fibers and methods of making

The present disclosure is generally directed to hollow core optical fibers, and more specifically to anti-resonant hollow core optical

Cost-effective Production Testing of Hollow-core Optical Fibers

Realizing the full promise of hollow-core fiber technology requires the adaptation of proven production test solutions so that product

Hollow Core Fiber

Hollow core fiber is a type of optical fiber that guides light through a hollow central core, as opposed to the solid glass

Hollow-Core Optical Fibers: Recent Advances and Applications

This Special Issue aims to provide a comprehensive overview of the state-of-the-art developments, understanding, and diverse

Hollow-core optical fibers: current state and development prospects

Such success of optical fibers is largely due to the properties of fused silica, which is the basic material used to fabricate both the

Hollow Core Antiresonant Fibers: Novel Designs, Materials and ...

The development of hollow core optical fibers (HCs) based on the antiresonant optical principle is gaining a significant interest within

The FOA Reference For Fiber Optics

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