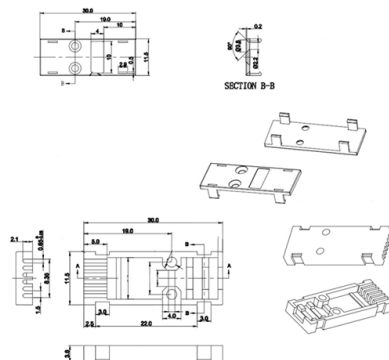


Old and New Types of Optical Fiber Chromatography



Overview

Types of optical fiber Optical fibers come in four basic types: step index single mode fibers, step index multimode fibers, graded index multimode fibers, and photonic crystal fibers.

Key Takeaways

Optical fiber chromatography has evolved from traditional silica-based fibers to advanced photonic crystal and waveguide-based fibers, enabling precise particle sorting and enhanced optical manipulation.

Traditional Optical Fiber Chromatography

Early optical fiber chromatography relied on standard silica or doped glass fibers, which guided light through total internal reflection. These fibers were primarily used for telecommunications, sensing, and basic optical manipulation, with single-mode or multimode propagation depending on core size and refractive index differences. Traditional fibers allowed light to interact with particles in a medium, enabling basic optical separation techniques, but were limited in selectivity, tunability, and control over dispersion and nonlinearity.

Modern Optical Fiber Chromatography

Recent advancements have introduced photonic crystal fibers (PCFs) and waveguide-based optical chromatography: Photonic Crystal Fibers (PCFs): These fibers feature microstructured air holes running along the length of the fiber, creating either index-guiding solid cores or hollow-core photonic bandgap fibers.

PC

Fs allow single-mode operation across a wide wavelength range, high nonlinearity, and tunable dispersion.

Hollow-core PC

Fs are particularly useful for optical chromatography because they can propel and sort particles within a liquid-filled core, offering precise control over particle movement and selectivity based on size and refractive index.

Waveguide-

Based Optical Chromatography: This approach uses hollow-core waveguides to manipulate particles with optical forces. By adjusting beam power, wavelength, polarization, and waveguide modes, particles can be sorted with high precision. The axial and radial optical forces scale differently with particle size, allowing selective separation of Rayleigh and Mie particles, including aerosols and virus-laden droplets.

This method represents a non-contact, highly tunable alternative to traditional fiber-based chromatography. Key Differences Between Old and New

Types	Feature	Traditional Fibers	Modern PCFs / Waveguides
Core structure		Solid silica or doped glass	Microstructured air holes, hollow or solid cores
Light guidance		Total internal reflection	Index-guiding or photonic bandgap effects
Particle manipulation		Limited, basic optical forces	Tunable optical forces, selective sorting
Wavelength range		Narrow, limited by material	Broad, from UV to IR
Applications		Telecommunication, basic sensing	Advanced spectroscopy, biomedical sorting, optical chromatography, nonlinear optics

Modern optical fiber chromatography is applied in biomedicine, spectroscopy, metrology, and environmental monitoring, where precise particle sorting and manipulation are critical.

Hollow-core PC

Fs and waveguide-based systems enable highly selective, non-contact separation, which is particularly valuable for microscale and nanoscale particles. In summary, optical fiber chromatography has transitioned from simple light-guiding fibers to sophisticated photonic crystal and waveguide systems, offering enhanced control, selectivity, and versatility for modern scientific and industrial applications.

Article Content

Toward Waveguide-Based Optical Chromatography

The further development of fiber-based optical chromatography techniques requires a better understanding of the optical forces exerted on the particles by the waveguide modes, whose

Types of Optical Fiber Chromatography

Types of optical fiber Optical fibers come in four basic types: step index single mode fibers, step index multimode fibers, graded index multimode fibers, and photonic crystal fibers.

High-Resolution Optical Chromatography: Principles, Innovations, and ...

Here, this review provides a comprehensive overview of recent advances in optical chromatography (OC) and explores emerging applications, from label-free exosome sorting for

(PDF) Toward Waveguide-Based Optical Chromatography

We report analytical expressions for optical forces acting on particles inside waveguides. The analysis builds on our previously reported Fourier Transform method to obtain Beam Shape...

Chromatographic techniques: types, principles, and applications

In this chapter, a brief discussion was made on the different chromatographic techniques based on their bed shape, different phases, separation mechanism, principle, procedure, and application. Emphasis

History of chromatography

New forms of chromatography developed in the 1930s and 1940s made the technique useful for a wide range of separation processes and chemical analysis tasks, especially in biochemistry.

High-Resolution Optical Chromatography: Principles, Innovations, and ...

In this review, we provide a comprehensive overview of the fundamental principles of OC, followed by recent progress in particle separation strategies and integrated optofluidic system

14 Types of Chromatography (Definition, Principle, Steps, Uses)

Chromatography is a very useful technique as it allows the separation of components of a mixture on the basis of their nature, structure, size, and other properties.

LC vs. HPLC vs. UHPLC: Tracing the Evolution of Chromatographic ...

Discover the evolution of chromatography from LC to HPLC and UHPLC. Learn how these techniques differ in terms of performance, applications, and advancements in analytical chemistry.

Optical fiber chemo and biosensors operating in the electrochemical ...

This review comprehensively outlines the latest developments in dual-domain biosensing solutions that integrate optical and electrochemical approaches, explicitly focusing on optical fiber

The Development and Milestones of Optical Fibers—A Brief History

The evolution of fiber optic technology, from the initial explorations in the 1840s to its current maturity, is marked by numerous significant milestones that demonstrate both technological

Recent advances in various chromatographic techniques used for

The new chromatographic approach enhances productivity, resolution speed, time consumption, and sensitivity. In the future, three-dimensional chromatographic separation will be possible, which will be

Towards Integrated Optical Chromatography Using Photonic Crystal Fiber

We present a new advance in optical chromatography potentially enabling the unique beam delivery properties of photonic crystal fiber (PCF) to be employed and integrated into microfluidic chips.

Review of Optical Fiber Sensors: Principles, Classifications and

Optical fiber sensors (OFSs) have emerged as essential tools in the monitoring of physical, chemical, and bio-medical parameters in harsh situations due to their high sensitivity,

Microsoft Word

We present a new advance in optical chromatography potentially enabling the unique beam delivery properties of photonic crystal fiber (PCF) to be employed and integrated into microfluidic chips.

Recent Advances in Chromatography: Unraveling the Spectrum of ...

Chromatography, as a powerful analytical tool, plays a pivotal role in diverse fields such as chemistry, biology, pharmaceuticals, and environmental sciences. The current chapter provides a

Optical chromatography using a photonic crystal fiber with on-chip ...

Abstract: We describe the realization of integrated optical chromatography, in conjunction with on-chip fluorescence excitation, in a monolithically fabricated polydimethylsiloxane (PDMS) microfluidic chip.

Design and Fabrication of 3D-Printed Lab-On-A-Chip Devices for Fiber ...

In this work, 3D-printed microfluidic devices are designed and fabricated for optical chromatography and sorting. Optical chromatography is performed by inserting a single-mode optical

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