

Article Overview

Optical fiber chromatography is a technique that uses light delivered through optical fibers to separate particles in a fluid based on size, refractive index, and shape.

Principle of Optical Fiber Chromatography

Optical fiber chromatography combines optical forces with microfluidic flow to achieve particle separation. When a particle in a fluid encounters a laser beam propagating in the opposite direction of the flow, it experiences a radiation pressure that opposes the fluid drag force. The particle reaches a rest point, called the retention distance, where the optical force balances the Stokes drag force. This distance depends on the particle's size, refractive index, and shape, allowing selective separation of different particles without pre-tagging them (Imasaka et al., 1995; Hart et al., 2003).

Role of Optical Fibers

Optical fibers, particularly photonic crystal fibers (PCFs), are used to deliver laser light precisely into microfluidic channels. PCFs offer endlessly single-mode guiding, enabling stable and aligned beam delivery for optical sorting and fluorescence excitation simultaneously. This integration allows on-chip optical chromatography, improving separation efficiency and enabling the study of biological particles, such as human kidney embryonic cells tagged with fluorescent microspheres.

Mechanism of Separation

- o Fluid Flow: Particles are carried by a microfluidic stream.
- o Optical Force: A laser beam exerts a counter-propagating force on the particles.
- o Equilibrium Position: Particles stop at a point where optical and drag forces balance.
- o Retention Distance: Varies with particle properties, enabling size-driven or refractive index-driven separation.
- o Detection: Fluorescence or optical imaging can monitor separation purity.

Applications

- o Colloidal particle separation: Differentiating particles by size or refractive index.
- o Biological particle sorting: Separating cells with or without fluorescent tags.
- o Immunoassays: Studying reaction rates in situ by observing particle retention changes.
- o Nanoparticle manipulation: Extending the technique to smaller scales using PCFs and waveguides.

Advantages and Limitations

Advantages:

- o Passive sorting without pre-labeling.
- o High selectivity based on intrinsic particle properties.
- o Integration with microfluidic chips allows compact, on-chip analysis.
- o Requires highly stable fluid flow.
- o Precise laser alignment is critical.
- o Sensitive to particle concentration and optical power variations . Optical fiber chromatography represents a maturing field in optofluidics, combining microfluidics, optical manipulation, and fiber optics to enable precise, non-contact particle separation for research and analytical applications.

Optical attenuation in an optical fiber is one of the most important issues affecting all applications that use optical fibers. A number of

What are Optical Fibers? Optical Fibers are hair-thin strands of glass or plastic that transmit light over distances just like wires carry

Firstly we review the current stage of optical chromatography. We present a new advance in optical chromatography

Rare-earth-doped optical fibers can be used to provide signal amplification by splicing a short section of doped fiber into a regular

Basic Elements of a Fiber Optic Communication System For gigabits and beyond gigabits transmission of

We present a new advance in optical chromatography potentially enabling the unique beam delivery properties of photonic crystal

What Is an Optical Fibre? Optical fibre is the technology associated with data transmission using light pulses travelling along with a

We are aware that optical fiber has completely revolutionised the communications industry. A core, cladding, and

Example 8.1.1: Critical angle for optical fiber Typical values of n_f and n_c for an optical fiber are 1.52 and 1.49,

Use our fiber 101 tutorials and videos and get the fiber optic basics to learn why optical fiber has

Optical Fiber Chromatography Concept

Here, this review provides a comprehensive overview of recent advances in optical chromatography (OC) and explores emerging

Optical Fiber Communications 101: Key Concepts and Technologies Optical Fiber Communications 101: Key Concepts and

Fiber Optic Basics Optical fibers are circular dielectric wave-guides that can transport optical energy and information. They have a

Optical chromatography is a powerful technique, capable of separating micron-sized particles within a fluid flow,

Abstract: We describe the realization of integrated optical chromatography, in conjunction with on-chip fluorescence excitation, in a

Here we show a novel fiber optical in-line sensor, based on localized surface plasmon resonance (LSPR), for specific

Web: <https://www.morwarreconst.co.za>

