

Principle of Mirror-Type Fiber Optic Sensor



Overview

The choice of fiber type depends on the sensor's physical operating principle, as well as the requirements for resolution, range, sensitivity, and the installation environment.

Key Takeaways

Mirror-type fiber optic sensors operate by reflecting light within a fiber loop or grating structure, where changes in physical parameters modulate the reflected light, enabling precise sensing.

Basic Concept

A mirror-type fiber optic sensor uses a reflective element within the optical fiber system to detect changes in environmental or structural conditions. The sensor typically consists of a light source, optical fiber, reflective mirror or grating, and a detector. Light from the source travels through the fiber, reflects off the mirror or grating, and returns to the detector.

Any modulation in intensity, phase, wavelength, or polarization of the reflected light corresponds to the physical quantity being measured, such as strain, temperature, or pressure.

Fiber Loop Mirror Principle

One common implementation is the fiber loop mirror, which forms a loop by connecting two ports of a fiber coupler. In a linear regime with a 50: 50 coupler, the loop acts as a perfect reflector. When the fiber experiences strain, temperature changes, or birefringence, the optical path length or polarization state changes, altering the interference of counter-propagating light waves.

This modulation is detected and converted into an electrical signal, allowing precise measurement of the physical parameter. Fiber Bragg Grating (FBG) as a Mirror Another approach uses fiber Bragg gratings, which are periodic variations in the refractive index of the fiber core. These gratings act as wavelength-specific mirrors, reflecting light at the Bragg wavelength while transmitting other wavelengths.

When the fiber is subjected to strain or temperature changes, the grating period and effective refractive index change, shifting the reflected wavelength. This shift is measured at the detector to quantify the physical change. Advantages Mirror-type fiber optic sensors are highly sensitive, immune to electromagnetic interference, and suitable for remote or distributed sensing.

They can be configured as intrinsic sensors, where the fiber itself is the sensing element, or as extrinsic sensors, where the fiber transmits light to an external reflective transducer.

Summary

In essence, the principle of mirror-type fiber optic sensors relies on reflection-based modulation of light. The reflected light carries information about the measurand, which is extracted by analyzing changes in intensity, phase, or wavelength. Configurations like fiber loop mirrors and fiber Bragg gratings provide versatile and precise sensing solutions for structural, environmental, and biomedical applications.

Article Content

Fiber Optic Sensors: Types, Working Principle

What is a Fiber Optic Sensor? A fiber optic sensor measures a physical quantity by modulating the intensity, spectrum, phase, or polarization of light traveling

Review of Optical Fiber Sensors: Principles, Classifications and

The choice of fiber type depends on the sensor's physical operating principle, as well as the requirements for resolution, range, sensitivity, and the installation environment.

Recent Advances in High-Birefringence Fiber Loop Mirror Sensors

Recent advances in devices and applications of high-birefringence fiber loop mirror sensors are addressed. In optical sensing, these devices may be used as strain and temperature

Fiber Sensors

These Sensors operate on the principle that an object interrupts or reflects light, so they are not limited like Proximity Sensors to detecting metal objects. This means they can be used to detect virtually

Optical Fiber Sensors: Working Principle, Applications, and Limitations ...

Brief theory of sensing principle, fabrication method, applications, advantages and disadvantages of the different fiber-optic sensors, are addressed. Recent progress in numerous

(PDF) Optical Fiber Sensors: Working Principle

Brief theory of sensing principle, fabrication method, applications, advantages and disadvantages of the different fiber-optic sensors, are addressed.

A fiber-optic sensor based on no-core fiber and Faraday rotator mirror ...

An optical fiber sensor based on the single-mode/no-core/single-mode (SNS) core-offset technology along with a Faraday rotator mirror structure has been proposed and experimentally

Fiber Loop Mirror Based on Optical Fiber Circulator for Sensing Applic ...

This paper presents and characterizes a novel Fiber Loop Mirror (FLM) configuration utilizing two circulators for strain and torsion discrimination in sensing applications, achieving a balanced system

Fiber Optic Sensors: Fundamentals, Principles & Applications

Radiation absorption creates electronic excited states that are trapped by localized defects for extended periods of time. Heating the material enables the trapped states to interact with phonons and decay

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Fiber optic sensors have been widely used and studied in recent times. This paper presents operating principles and applications of fiber optic sensors namely reflectometric and interferometric ...

Fibre-optic temperature and pressure sensor based on a deformable ...

Abstract This article presents a fibre-optic sensor that measures temperature and pressure. Its operating principle is based on the amplitude modulation caused by the variation in the

Multi-tapered polarization-maintaining fiber-optic sensor for ...

Abstract In this paper, a fiber-optic refractive index and temperature sensor based on Mach-Zehnder interferometer (MZI) is designed and fabricated. The sensor structure consists of a

Fiber Optic Sensors: Fundamentals, Principles & Applications

Extrinsic Fiber Optic Sensors Fiber is Only an Information Carrier To and From a Black Box Light Signal Generation in Black Box Depending on the Arriving Information

A fiber-optic sensor based on no-core fiber and Faraday rotator mirror ...

All such problems have hindered the development of fiber-optic based temperature and concentration sensors. Based on these findings, this paper proposes the use of a section of no-core

FOE-18024-NM 215..226

Abstract Fiber optic sensors have been widely used and studied in recent times. This paper presents operating principles and applications of fiber optic sensors namely reflectometric and interferometric

Fiber Optic Sensors: Types, Working Principle

Explore fiber optic sensors: their working principles, types (intrinsic, extrinsic, hybrid), and diverse applications in mechanical, chemical, and structural health

Fiber Optic Sensor : Types, Working, Interfacing & Its Applications

The fiber optic sensor working principle is that transducer changes some optical fiber system parameters like wavelength, intensity, phase, polarization, etc. This gives an increase in

Optical Fiber Sensors Guide

An optical fiber sensing system is basically composed of a light source, optical fiber; a sensing element or transducer and a detector (see Fig. 2.2). The principle of operation of a fiber sensor is that the

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