Classification of Fiber Bragg Grating Pressure Sensors



Overview

Figure 3 illustrates the classification of FBGs based on grating types and optical fiber types, providing an overview of their structural and functional categories.

Key Takeaways

An FBG pressure sensor typically consists of a fiber Bragg grating attached to a diaphragm or lever structure that converts applied pressure into strain, which shifts the Bragg wavelength for measurement.

Core Components

Fiber Bragg Grating (FBG): The FBG is a short segment of optical fiber with a periodic modulation of the refractive index in the core, forming a wavelength-specific reflector. When broadband light passes through, the FBG reflects a narrow wavelength (Bragg wavelength) that shifts in response to strain or temperature changes. Diaphragm or Sensing Element: The pressure sensor usually incorporates a metallic diaphragm that deforms under applied pressure.

The diaphragm converts pressure into mechanical strain, which is then transferred to the FBG. Diaphragm-type designs are preferred for high sensitivity because they produce larger strain for a given pressure. Amplification Mechanisms: Advanced designs often include multi-hinges or lever structures to amplify the strain experienced by the FBG.

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For example, a three-lever mechanism can significantly increase the strain transferred from the diaphragm to the FBG, enhancing sensitivity and allowing precise pressure measurement in the range of 0–1. 5 MPa. Temperature Compensation: To eliminate cross-sensitivity between temperature and pressure, a second FBG is often integrated.

This FB

G measures temperature independently, allowing the system to correct the Bragg wavelength shift caused by thermal effects. Packaging and Mounting: The FBG and diaphragm assembly are typically housed in a protective casing to ensure durability and stability in harsh environments, such as oil and gas pipelines or industrial settings. The fiber is carefully bonded to the diaphragm or lever structure to ensure efficient strain transfer.

Working Principle

Pressure Application: External pressure deforms the diaphragm. Strain Transfer: The deformation is mechanically amplified via levers or hinges and transferred to the FBG. Optical Response: The FBG experiences axial strain, causing a shift in the Bragg wavelength.

Signal Detection: The wavelength shift is measured using an optical interrogation system, which correlates the shift to the applied pressure. Temperature Correction: If a dual-FBG configuration is used, the temperature-induced wavelength shift is subtracted to isolate the pressure effect.

Advantages of This Structure

High sensitivity due to strain amplification mechanisms. Immunity to electromagnetic interference. Capability for simultaneous pressure and temperature measurement.

Robustness in corrosive or harsh environments. This combination of FBG, diaphragm, and lever amplification forms the fundamental structure of modern high-precision FBG pressure sensors, making them suitable for industrial, aerospace, and structural health monitoring applications.

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Article Content

Fiber Bragg grating pressure sensors: a review

The extrinsically sensitized FBG pressure sensors are classified into metal-mechanical structure-based FBG pressure sensors and polymer-mechanical structure-based FBG pressure sensors, i.e., from

Fibre Bragg Grating Sensor

According to the wave vector direction, the spatial period distribution and the period length, fibre gratings are classified into four basic types: fibre Bragg grating, blazed fibre grating, chirped fibre grating and

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Figure 3 illustrates the classification of FBGs based on grating types and optical fiber types, providing an overview of their structural and functional categories.

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Compared to conventional piezoelectric sensors, fiber Bragg grating (FBG) sensors have many advantages. This paper reviews the development of FBG pressure sensor.

A Guide to Fiber Bragg Grating Sensors

Fiber Bragg Grating (FBG) technology is one of the most popular choices for optical fiber sensors for strain or temperature measurements due to their simple manufacture, as we will see later on, and

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This paper discusses mathematical modelling and experimental validation of a highly sensitive optical fibre Bragg grating (FBG) contact pressure sensor developed for healthcare

Fiber Bragg grating pressure sensors: a review

Our work examines two types of sensitized FBG pressure sensors, namely FBG pressure sensors with innately improved sensi-tivity and FBG pressure sensors with extrinsically increased sensitivity.

Research on High-Sensitivity Fiber Bragg Grating Pressure Sensor

To meet the demand for high-sensitivity pressure detection, this article proposes a design method for a fiber Bragg grating (FBG) pressure sensor based on a diaphragm–lever composite

A Comparative Investigation on Performance of Fiber Bragg Grating

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Long-term and accurate measurement of soil pressure is crucial for safety monitoring in geotechnical engineering. The diaphragm-type fiber Bragg grating (FBG) soil pressure sensor is currently the most

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Abstract Fiber Bragg Grating (FBG) sensors have emerged as versatile tools for various sensing applications due to their unique properties such as small size, immunity to electromagnetic

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Due to attractive application in the medical field, fiber Bragg grating sensor has become increasing attractive from past few decades for various strain sensing applications. FBG sensor has

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Abstract. Fiber Bragg grating (FBG) pressure sensors have the potential to replace conventional voltage sensors due to their compact size, resistance to electromagnetic interference,

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Abstract In recent years, fiber optic sensors, primarily based on fiber Bragg gratings (FBGs), have been gradually applied in the monitoring of electrical equipment. This article provides

Control Over the Pressure Sensitivity of Bragg Grating-Based Sensors

We present fiber Bragg grating (FBG)-based hydrostatic pressure sensing with highly birefringent microstructured optical fibers. Since small deformations of the microstructure can have a

Design of a Fiber Bragg Grating Pressure Sensor Based on a Metal

In this paper, a pressure sensor based on a metal diaphragm and lever structure is designed, the sensing principle and mechanical structure of this sensor are analyzed and simulated,

Research on pressure tactile sensing technology based on fiber Bragg ...

A pressure tactile sensor based on the fiber Bragg grating (FBG) array is introduced in this paper, and the numerical simulation of its elastic body was implemented by finite element

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Fiber Bragg grating (FBG)-based sensors: a review of technology and recent applications in structural health monitoring (SHM) of civil engineering structures

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Design of a Pressure Sensor Based on Optical Fiber Bragg Grating

This paper describes steps involved in the design and realization of a new type of pressure sensor based on the optical fiber Bragg grating. A traditional pressure sensor has very

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