Fiber Optic Suppressed Total Internal Reflection Sensor



Overview

In this work the design and construction of a simple fiber-optic pressure sensor based on the principle of frustrated-total-internal-reflection in a fiber cut beyond the critical angle are described.

Key Takeaways

A Fiber Optic STIR Sensor detects displacement, pressure, or strain by modulating light through frustrated total internal reflection in an optical fiber.

Working Principle

A suppressed total internal reflection sensor operates on the principle of frustrated total internal reflection (FTIR). In a standard optical fiber, light is confined to the core by total internal reflection, which occurs when light strikes the core-cladding interface at angles above the critical angle determined by Snell's Law. In an STIR sensor, the fiber end is positioned near a reflective or deformable surface but not in direct contact.

When the surface moves closer, a portion of the light escapes the fiber core and is absorbed or transmitted across the gap, modulating the reflected light intensity. This change in light intensity is proportional to the displacement, pressure, or strain applied to the sensor element. Sensor DesignSingle-fiber configuration: The fiber is often cut at an angle to enhance the sensitivity of the reflection modulation.

© 2026 CGWEB NETWORK INFRASTRUCTURE - All rights reserved

All-fiber sensors: Entirely made of optical fibers, these sensors can be fabricated with silica or sapphire fibers for high-temperature applications. Output signal: The ratio of reflected to input light is converted into an electrical signal, which can be analog or digital, representing the measured physical quantity.

Applications

Hazardous environments: Since STIR sensors are purely optical, they do not generate electrical sparks, making them ideal for explosive or flammable atmospheres. High-temperature industrial settings: Sapphire fibers allow operation where conventional silica fibers fail. Precision displacement and pressure sensing: Used in aerospace, industrial automation, and optical logic interfacing.

Non-contact sensing: The sensor can detect objects or surface changes without physical contact, reducing wear and damage.

Advantages

High sensitivity: Small displacements produce measurable changes in reflected light. Lightweight and flexible: Optical fibers allow long-distance signal transmission with minimal weight, suitable for aircraft or remote installations. Fast response: Light-based detection ensures rapid measurement without mechanical lag.

Environmental robustness: Resistant to vibration, shock, and electromagnetic interference. In summary, a Fiber Optic STIR Sensor leverages the modulation of light via frustrated total internal reflection to provide precise, non-contact measurements of displacement, pressure, or strain, with applications in hazardous, high-temperature, and weight-sensitive environments. Its design flexibility and optical nature make it a versatile tool in modern sensing technologies.

Article Content

Frustrated-total-internal-reflection fiber-optic pressure sensor

In this work the design and construction of a simple fiber-optic pressure sensor based on the principle of frustrated-total-internal-reflection in a fiber cut beyond the critical angle are described.

The FOA Reference For Fiber Optics

Using Snell''s Law, we can calculate the angle at which an optical fiber begins total internal reflection, which happens like this drawing below, when the refracted ray lays along the boundary between the

Total Internal Reflection and Optical Fibers Explained

© 2026 CGWEB NETWORK INFRASTRUCTURE - All rights reserved

Optical fibers use total internal reflection to guide light for communication, medical imaging, inspection, laser delivery, sensing, and illumination. This infographic shows major

Ultrasensitive total internal reflection sensor with rotatory biased ...

A modified weak measurement scheme, rotatory biased weak measurement, is proposed to significantly improve the sensitivity and resolution of the total internal reflection sensor.

Total internal reflection in optical fibres

Explore total internal reflection in optical fibres, its significance, factors affecting efficiency, and a sample calculation.

Investigation And Application Of The Frustrated-Total-Internal ...

A detailed investigation of the frustrated-total-internal-reflection (FTIR) phenomenon in silica-glass-based optical fibers and its application to simple intensity-modulated strain and pressure

Total Internal Reflection

Total internal reflection takes place at the interface between the high-index core and lower-index cladding. Snell''s law applied to these different refractive indices yields the result that no transmission

Frustrated-total-internal-reflection in optical fibers: investigation ...

In this paper we present an investigation of the frustrated-total-internal-reflection (FTIR) phenomenon and its application to intensity-modulated fiber sensors. The sensor design offers simple potential

Fiber Sensors

These Fiber Units offer better detection of small objects at close distances (of 2 mm or less) than Standard Reflective Fiber Units. They also detect glossy surfaces

Total internal reflection

The efficiency of the total internal reflection is exploited by optical fibers (used in telecommunications cables and in image-forming fiberscopes), and by reflective

Analysis and Comparison of Daylighting Technologies: Light Pipe

The optical fiber is the core of the dielectric material, and its refractive index is greater than that of the surrounding cladding material, resulting in the total internal reflection (TIR) of light

PDF document

© 2026 CGWEB NETWORK INFRASTRUCTURE - All rights reserved

PDF document PDF document Read this PDF document online, download the original file, and browse related details on device.report. Additional coding instructions can be found in the Article File chapter

Ultrasensitive total internal reflection sensor with rotatory biased ...

Optical refractive index (RI) sensors are widely used in chemical, biomedical, and food applications due to their high resolution, fast response and label-free detection , . Various

BOLOMETER-OPTICAL MICRORESONATOR INFRARED SENSOR

A bolometer-optical microresonator infrared sensor is designed to detect changes in infrared light intensity. It has a frame with two legs that support a small island, which contains

D-type fiber optic sensor used as a refractometer based on total ...

A new type of fiber optic sensor (FOS) based on total-internal reflection heterodyne interferometry (TIRHI) is proposed. It can be used as a liquid refractometer. The phase shift

U-shaped optical fiber sensor based on multiple total internal ...

Abstract In this paper, an optical fiber sensor based on multiple total internal reflections (MTIRs) in heterodyne interferometry is proposed. With the optical fiber sensor the phase shift

Fiber Optic Fire Alarm Systems: Advanced Detection and Superior

For fiber optic systems, relevant UL standards might cover general fire alarm control units, signaling devices, and specific sensor technologies. Manufacturers of fiber optic fire alarm systems

A Novel Fiber-Optic Ice Sensor to Identify Ice Types Based on Total ...

To address the issues of not accurately identifying ice types and thickness in current fiber-optic ice sensors, in this paper, we design a novel fiber-optic ice sensor based on the reflected

© 2026 CGWEB NETWORK INFRASTRUCTURE - All rights reserved

Contact Us

Continue your research online:

Website: https://cgweb.co.za
Technical inquiry: https://cgweb.co.za/project-enquiry.html

This document is for preliminary research. Verify specifications against current standards, product documentation and project requirements.

© 2026 CGWEB NETWORK INFRASTRUCTURE - All rights reserved