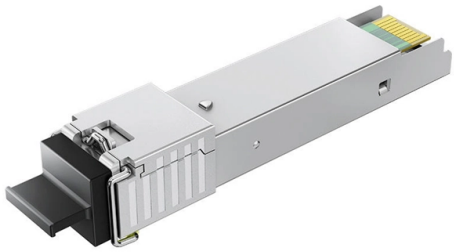
Fiber Optic Cable Diaphragm



Overview

Design and simulation of a novel multi-diaphragm cable for. This paper introduces the first of its kind, an optical fiber cable design exclusively tailo.

Key Takeaways

A fiber optic cable diaphragm is a thin, flexible membrane integrated with an optical fiber sensor to detect pressure, strain, or displacement by modulating light signals.

Overview and Function

A fiber optic diaphragm serves as the primary sensing element in fiber optic pressure or strain sensors. When external pressure or force is applied, the diaphragm deflects, causing measurable changes in the optical signal transmitted through the fiber. This deflection can be detected using various optical techniques, such as Fabry-Perot interferometry, fiber Bragg gratings (FBG), or intensity modulation, allowing precise measurement of pressure, strain, or vibration.

Materials and Construction

Diaphragms can be made from diamond, sapphire, silicon, or polymer materials, depending on the application requirements: Diamond diaphragms offer ultra-high Young's modulus (~1143 GPa), high thermal conductivity (~2200 W/cm·K), low thermal expansion, and chemical inertness, making them ideal for high-temperature or harsh environments. Sapphire diaphragms are suitable for high-temperature sensing due to their melting point (~2040°C), though fabrication is more complex and costly. Silicon diaphragms are commonly used in scalable sensor designs and can be integrated with optical fibers using adhesives or direct deposition.

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The diaphragm is typically mounted across a cavity in a sensor housing, forming an extrinsic Fabry-Perot cavity with the fiber tip. Deflection of the diaphragm changes the cavity length, producing interference patterns that are transmitted along the fiber for measurement. Sensing MechanismsFabry-Perot Interferometer (FPI): The diaphragm forms one mirror of the cavity.

Pressure-induced deflection alters the optical path length, modulating the interference signal. This method provides high sensitivity, point sensing, and polarization independence. Fiber Bragg Grating (FBG): Strain in the diaphragm induces a shift in the Bragg wavelength of the grating inscribed in the fiber, enabling distributed or discrete sensing of deformation.

Intensity Modulation: Small bends or displacements in the diaphragm modulate light intensity in the fiber, though this method is more sensitive to environmental factors like temperature.

Applications

Fiber optic diaphragms are used in: High-precision pressure sensors for gases, liquids, and solids. Structural health monitoring, such as diaphragm wall deformation in underground construction, using distributed FBG or ultra-weak FBG sensors. High-temperature or chemically harsh environments, leveraging diamond or sapphire diaphragms.

Dynamic pressure and vibration sensing, where diaphragm deflection produces strain in the fiber proportional to acoustic or hydro-acoustic signals.

Advantages

Electromagnetic interference (EMI) immunity due to optical signal transmission. High sensitivity and bandwidth, suitable for dynamic measurements. Compact and robust design, allowing deployment in harsh or confined environments.

Scalability in fabrication using batch processes and automated fiber mounting. In summary, a fiber optic cable diaphragm is a versatile sensing element that converts mechanical deflection into optical signals, enabling precise, high-resolution measurement of pressure, strain, or vibration across a wide range of applications and environmental conditions.

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The fiber-optic pressure sensor actually measures displacement caused by the pressure, such as devices utilize diaphragms or bellows as their pressure sensing elements.

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Page 7 • Connect fiber optic cable to sensor (NOTE: Minimize bends in fiber optic cable to 2” radius minimum to help ensure optimum signal strength.). Fiber optic

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