

What are the materials used in high-temperature resistant fiber optic sensors

Article Overview

High-temperature fiber optic sensors typically use silica or crystal fibers with specialized coatings to withstand temperatures from 150 °C up to 1000 °C or more.

Core Fiber Materials

Silica Fibers: Standard fused silica fibers are widely used for high-temperature sensing due to their thermal stability and optical transparency. With appropriate heat-resistant coatings, they can operate reliably up to 385 °C, and in some cases higher when combined with protective sheaths or metal coatings . **Crystal Fibers:** For extreme temperatures exceeding 1000 °C, crystal fibers such as sapphire fibers are preferred. These fibers maintain structural integrity and optical performance in harsh environments like combustion chambers, turbines, and metallurgical processes . Crystal fibers are particularly suitable for distributed temperature sensing and interferometric applications.

Coatings and Protective Layers

High-temperature performance is often enhanced by specialized coatings:

- o High-temperature acrylate coatings provide thermal protection and mechanical strength for fibers operating up to 270 °C .
- o Hermetic carbon layers can be applied to prevent hydrogen permeation and improve fatigue resistance .
- o Metal sheaths such as aluminum or stainless steel extend operational limits to 290-315 °C for industrial applications .
- o Custom high-temperature coatings allow PM (polarization-maintaining) fibers to survive solder reflow processes in silicon photonics up to 270 °C, and collimators can operate up to 700-1000 °C .

Sensor Types and Applications

High-temperature fiber optic sensors include:

- o Fiber Bragg Grating (FBG) sensors for precise point measurements.
- o Distributed temperature sensors (DTS) for long-range monitoring.
- o Interferometric and fluorescence-based sensors for extreme environments . These sensors are used in aerospace, metallurgy, power generation, and harsh industrial environments, where traditional electronic sensors fail due to electromagnetic interference or extreme heat.

What are the materials used in high-temperature resistant fiber optic sensors

Commercial Solutions

Companies like Corning, MEISU, and WEINERT Industries offer high-temperature fibers with single-mode or multimode cores, PM fiber arrays, and specialized coatings for applications ranging from 150 °C to 1000 °C . These solutions include high-temperature connectors, jumpers, and collimators designed for reliable optical performance in harsh conditions.

Summary

For high-temperature fiber optic sensing, silica fibers with heat-resistant coatings are suitable for moderate high temperatures, while crystal fibers are required for extreme temperatures above 1000 °C. Protective coatings, metal sheaths, and hermetic layers enhance durability, and commercial solutions are available for both industrial and photonic integration applications. These materials enable accurate, reliable sensing in environments where conventional sensors cannot operate.

Generally, optical fiber sensors are operated by collecting and analyzing modulated optical signals, which

High-temperature measurements are of significant importance in various harsh-environment engineering fields, such

500°C-Rated Optical Fiber for High Temperature Applications Specialty optical fibers can be

Use of materials composed of 2-fluoroacrylates and fluorinated aromatic groups in plastic optical fibres was shown to

Fiber-optic sensors are optical sensors based on fiber devices. They are often used for sensing

Optical Fiber (Transmission Medium, Sensing Element) Light modulated due to interaction with parameter of interest (Measurand)

Abstract High-temperature measurements above 1000 °C are critical in harsh environments such as aerospace, metallurgy, fossil

Optical fiber sensors present several advantages in relation to other types of sensors. These advantages are

This paper conducts a systematic analysis of the sensing mechanisms in fiber-optic pressure sensors, with a particular focus on the

What are the materials used in high-temperature resistant fiber optic sensors

Fiber-optic high-temperature sensors are gradually replacing traditional electronic sensors due to their small size, resistance to

Standard telecom fibers are typically coated with acrylate that allow their use in temperatures up to 85°C. Specialty

Fiber-optic sensing (FOS) technology has emerged as a cutting-edge research focus in the

High-temperature fiber optic cables utilize advanced coatings and fiber designs that protect them from heat damage

Optical fiber sensing refers to the use of optical fibers to measure various parameters such as temperature, strain, and pressure by

For use in higher temperature ranges, all optical fibers based on Fused Silica can be optionally equipped with heat-resistant coating

Fiber-optic sensors detect objects and conditions by directing light to a test object and evaluating the intensity change of the

Web: <https://kremgroup.co.za>

