Can fiber optic sensors measure thickness



Overview

A NOVACAM thickness measurement system has been used in the production of optical fibers for several years.

Key Takeaways

Fiber optic sensors can measure film or coating thickness with sub-nanometer precision using interferometric techniques such as Fabry–Perot cavities and hollow-core fiber structures.Principles of Thickness Detection

Fiber optic thickness sensors operate by detecting changes in light properties—such as phase, intensity, or wavelength—caused by the presence of a thin film or coating on the fiber or substrate. Interferometric methods, particularly Fabry–Perot interferometers (FPIs), are widely used. In FPIs, a thin film forms a cavity between reflective surfaces, and as the film thickness changes, the interference pattern of reflected light shifts. By analyzing these shifts, the film thickness can be calculated with high precision .

Sensor Configurations
• Fabry–Perot Interferometer on Fiber Tip: A single-mode fiber (SMF) can be cleaved and placed in a deposition chamber, allowing the thin film to grow directly on the fiber tip. The cavity length of the FPI corresponds to the film thickness, and interferograms are analyzed using techniques like the Hilbert Transform to achieve nanometer-scale accuracy .

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• Y-Shaped Optical Fiber: This configuration splits the light path, directing coherent light to the film surface and collecting reflected signals. The thickness is determined by measuring the wavelength difference between interference peaks and considering the film's refractive index .

• SMF–Hollow Core Fiber–SMF (SMF–HCF–SMF): A hollow-core fiber section is spliced between two single-mode fibers, and a thin layer is coated on the HCF surface. The anti-resonant reflecting guidance mechanism and transverse Fabry–Perot interference allow detection of sub-nanometer thickness changes, with high repeatability and low fabrication cost .

Advantages of Fiber Optic Thickness Sensors

• High Sensitivity and Resolution: Capable of detecting thickness changes down to sub-nanometer levels .

• Compact and Lightweight: Fiber probes are small, allowing integration into confined or harsh environments .

• Electromagnetic Immunity: Optical signals are unaffected by EM interference, making them suitable for industrial and laboratory applications .

• Real-Time Monitoring: Fiber sensors can track film growth dynamically, providing immediate feedback for deposition processes .

Applications

Fiber optic thickness sensors are used in semiconductor fabrication, optical coatings, functional material deposition, and surface roughness monitoring. They are particularly valuable where high precision, compact size, and resistance to harsh conditions are required .

Summary

By leveraging interferometric principles and specialized fiber structures, fiber optic sensors provide a highly accurate, compact, and versatile solution for thickness detection. Configurations such as FPIs on fiber tips, Y-shaped fibers, and SMF–HCF–SMF structures enable sub-nanometer resolution, real-time monitoring, and robust performance in challenging environments, making them ideal for both research and industrial applications .

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Article Content

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The general structure of an optical fiber sensor system is shown in Figs. 1 and 2. It consists of an optical source

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Thickness Measurements with High-Precision & Non-contact

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Topic Editorial on Fiber-Optic Sensors

Fiber-optic sensors are highly significant in modern technology due to their unique abilities and versatility [1, 2, 3].

Measurement of Film Thickness on a Curved Surface by Fiber Optic

A fiber optic sensor is developed in order to measure film thickness along a curved surface. The technique is non-inva-sive, which

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A new ray-tracing–based calibration method for an Optical fiber–based Reflective Probe (ORP) was developed. This

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Thickness / Width When selecting sensors to measure thickness or width, the first step is to choose a

Fiber Sensors

Polarization of Light Light can be represented as a wave that oscillates horizontally and vertically. Fiber Sensors almost always use

What are Fiber Optic Sensors?

Fiber optic sensors are advanced sensing tools that use light - rather than electricity - to measure environmental

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Fibre-optic sensor for simultaneous measurement of thickness and ...

We examined how the refractive index of a liquid film and its thickness affect spectrum at the output of a fibre-optic

Ultrahigh Resolution Thickness Measurement Technique Based on a

The experimental results show that the fiber sensor structure can detect a thin layer with a thickness down to 0.21

Thickness Measurements with High-Precision & Non-contact

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Several fiber-based probes can be multiplexed to a single detector (MICROCAM interferometer) for simultaneous thickness

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