Optical Sensor Monitoring and Analysis Platform

INTELLIGENT SENSOR SYSTEMS LTD
Mission

To provide high quality integrated intelligent sensing solutions to make the energy industry safer, greener and more efficient.

To develop reliable, cost-effective system solutions for our customers in the harsh-environment and industrial applications. We will achieve this by empowering our dedicated team and leveraging strong partnerships with our customers.

To be the preferred source of total solutions for our customers, driven by our passion for new sensor products and technologies while maintaining the highest standards of service and support.

Our Vision:

Today’s creative innovation is the foundation for tomorrow’s better world
Outline

- Optic Fibre Sensor Products
- Optic Fiber Sensor Systems for monitoring hazard sources
- Demonstration Projects
Optic Fibre Sensor Products

- Fibre Optic Temperature Sensors
- Fibre Optic Liquid Level, Pressure Sensors
- Fibre Optic Methane Sensors
- Fibre Optic Strain and Displacement Sensors
- Fibre Optic Seismic Sensors
- Fibre Optic High Temperature and High Pressure Sensors
Fibre Optic Temperature Sensors

Temperature Sensors for High Voltage Switch Temperature Monitoring

General Purpose Temperature Sensors
Liquid level sensor

High Temperature and High Pressure Sensor for Oil Well Down-Hole Logging
Fibre Optic Methane Sensors

- **Measurement Range**: 0-10%, (0-100%)
- **Measurement Error**: ±0.05%, (Below 1%) ± 0.5% (Above 1%)
- **Response Time**: < 20s
- **Calibration Period**: 6 Months

**Features:**
- Not Charged;
- High Sensitivity (±/-0.05%)
- Long Calibration Period: 6 months
- Not Affect by Humid Environmental Impact
- Large Dynamic Range (0-10%; 0-40%; 0-100%)
Fibre Optic Strain and Displacement Sensors

- FBG pressure sensor
- Small draft, online monitoring
- FBG Roof separation monitor
- Measured Depth: 3~4m
- Accuracy: 0.5mm
- Range: 0~200mm

Principle:
To convert the force at the anchor into the FBG internal deformation.

To convert the displacement between the fixed anchor and the sensor into the wavelength change from the FBG.
Fiber Optic Seismic Sensor

- OF Seismic Sensor
- Remote monitoring
- No active electrical components
- Immune from EMI
- High sensitivity

**Specification:**
- Dynamic Range: 90dB;
- Band width: 5~200 Hz
High Temperature/Pressure Sensor

Specification:

Temperature Range: -20 to 350 C. Accuracy: +/- 0.3 C;
Pressure Range: 0 to 40MPa, Accuracy: +/-0.2%
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Why OFS Early Warning Platform?

- Since the sensor head does not have any active electrical components, it is intrinsically safe when used in the hazard environment such as coal mines;
- OFS based monitoring network is capable to monitor the conditions of mine roof, electrical and mechanical equipments and detect rock burst, hazard gas, fire, flood, etc;
- OFS system addresses the constraints of multi-location and multi-parameter online monitoring issues;
Advantages of OFS
Early Warning Platform

- **Intrinsic Safety**: data collection and transmission can be fully achieved through the fiber which is intrinsic safe;

- **Multi location and multi parameter**: The on-line remote monitoring at multi locations (over a few kilometers) and with multi parameters can be achieved with an optical fiber network.

- **Multi-functional**: one fiber-optic sensor may probe a variety of gases, such as CO, O₂ and CH₄ etc;

- **Intelligent decision-making**: the mine disaster is often caused by geology change, mining vibration, ventilation or support movement. By monitoring all these parameters in an integrated optic fiber intelligent sensor system, it is easier to identify the possible hazard before it occurred, hence enhance the disaster forecast through the early warning system.
Optic Fiber Sensor Systems Developed

- OFS for Mine roof/rock burst disaster detection
- OFS early-warning system for monitoring gases
- OFS early-warning system for fire preventing
- OFS detection system for flood control
- OFS detection system for on-line monitoring the Health and safety of electrical equipments
Fiber-Optic Coal Mine Safety Monitoring/Control System

- **Optic Fiber System:**
  - Methane
  - Strain
  - Microseism
  - Flood
  - Spontaneous Combustion
  - Electrical Equipment

![Diagram showing Fiber-Optic Coal Mine Safety Monitoring/Control System](image-url)
Fiber Mine Roof Safety Monitoring

- Strain and Displacement Monitoring
- Seismic / Rock Burst Monitoring

Rock Burst Damage
Optic Fiber Methane Disaster Monitoring and Warning System

- Combine the Information of the concentration of methane gas, temperature and other parameters to set up a multi-variable expert system for early warning.

- Enhance the monitoring capacity for early warning.
Test Results of Optic Fiber Methane Sensor

6 km Fiber cable

Different type of Methane sensors
Optic Fiber Methane Disaster Monitoring and Warning System
OFS in the Fire Prevention and Control

Early warning mechanism of the natural fire in the mined-out area,

- Trace gas sensor to replace the tube bundle system
- Temperature measurement
- Analysis of changes in the gas composition

Optic gas sensors CO/CH4/O2

Distributed temperature sensor

Analysis of changes in the composition of gas, fire warning

Detect abnormal temperature point, finding fire positioning

Ground surveillance equipment to issue warning

Adjust the wind valves to carry out the ventilation control
Based on Fiber-optic Distributed Temperature Sensor for Fire Detection

- Measure the temperature distribution along a 6 km fibre

Monitor System

Sensing Fiber

Temperature distribution in a mined out area
Fire Early Warning and Positioning on the Transport Belt

- Fiber sensing cable is embedded in the belt
- Point sensors to monitor motor temperature
- Intelligent cable with embedded fiber
Application of OFS in Flood Control

- Auto-mine drainage system
  - Fiber water level gauge,
  - Automatic drainage system
- Monitoring water pressure in water-rich layer

Filed Comparison Test
OFS for Electrical and Mechanical Equipment Condition Monitoring

- Substation switchgear temperature monitoring
- Cable distributed temperature monitoring, fire early warning
- Intelligent Cable
- Fire early warning and positioning fire on the transport belt
Substation Switchgear Temperature Monitoring

- FBG signal demodulation instrument
- Optic fiber
- Substation control room
- Fiber optic cable terminals Box

There are 6 to 12 temperature sensors in each switchgear.
Outline

- Optic Fibre Sensor Products
- Optic Fiber Sensor Systems for monitoring hazard sources
- Demonstration Projects
Demonstration Project

- Zibo Coal Mine Group: black-Ling coal mine
- Liaoning Fuxin Coal Mine Gas Power Plant
- Laiwu GuJiaTei Iron-mine
- Beijing's First Iron Ore Tailing Dam
- Yankuang East Rail Power Substation
- ShengLi Oil Field
Zibo Black-Ling Coal Mine Demonstration Project

- Temperature sensor
- Seismic Waves Sensor
- Strain Sensor
- Methane Sensor
Zibo Black-Ling Coal Mine Demonstration Project

Illustration of Fiber Optic Sensor Installed in a Mine.
Fiber Optic temperature sensor and methane sensor installed in an underground coal mine.
Zibo Black-Ling Coal Mine Demonstration Project

Recorded seismic wave signal
Zibo Black-Ling Coal Mine Demonstration Project
Zibo Black-Ling Coal Mine Demonstration Project
Coal Mine Power Plan
Methane Monitoring
Two-Week Test Results
Laiwu GuJiaTei Iron-Mining Program
Laiwu GuJiaTei Iron-Mining Program
Beijing's First Iron Ore Tailing Dam
Beijing's First Iron Ore Tailing Dam
Beijing's First Iron Ore Tailing Dam
Yankuang East Rail Power Substation

Fiber-optic safety monitor in high voltage switchboard
Yankuang East Rail Power Substation

Fiber-optic safety monitor in high voltage switchboard
Yankuang East Rail Power Substation
Yankuang East Rail Power Substation
ShengLi Oil Filed

Prepare for install the sensor

The measurement is taken as the sensor is dropped into the oil well.
Measured pressure vs The depth of an oil well

Measured wavelength variation vs temperature

\[ y = 0.000011 x^2 + 0.009499 x + 1527.982768 \]

\[ R^2 = 0.999975 \]
Fiber-optic sensors provide a reliable means for real-time monitoring and analysis of a variety of mine risk sources;

Fiber-optic sensor integrated safety monitoring system can issue early disaster warning based on multi-parameters such as the roof movement, the rock burst, hazard gas, water damage and spontaneous fire etc;

After years of R&D effort, both optic sensors and integrated systems have been well advanced. The performance and stability of the sensor system have been widely tested in different applications.

At present, the temperature sensing system has been certified, a number of other products have been on-site tested and will be gradually deployed in the wider field;

The introduction of the fiber-optic sensor hazard monitoring and analyzing platform will play a key role in making our mines safer, greener and more efficient.