

# Analysis on the Performance of the Optical Fiber Pressure Sensor and Application Technology

Hou Wei<sup>1, a</sup>

<sup>1</sup> Chongqing College of Electronic Engineering, Chongqing, China, 401331

<sup>a</sup> sina001007@163.com

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**Abstract.** Optical fiber sensing and optical fiber communication has a lot of similarities, and they are based on the basic properties of the fiber and advantages. The most distinguishing feature of optical fiber used for communication is tempting bandwidth, and used for sensing and testing tend to focus on a point of change, using the physical properties of the fiber can achieve high accuracy and stability. Similar to other sensors, optical fiber sensing sensor process as the role of the sensing optical fiber is measured to make change of its internal light signal, test data is obtained by demodulation corresponding relation. On the accuracy of measurement, by raising the production level and improve the methods of demodulation, the overall accuracy of the optical fiber pressure sensor to achieve the commercial standard, such as high temperature measuring reliability of special occasion was obviously higher than that of electronic pressure sensor. This article mainly analysis the performance of the optical fiber pressure sensor and its application in the field of weighing technology.

## Introduction

Very many different kinds of fiber optic sensor, according to the characteristic parameters of different modulation light waves can be classified as phase modulation, the intensity modulation type, wavelength modulation type and polarization modulation type. According to the sensing mechanism can be divided into functional and the light type, functional fiber optic sensor through the optical fiber direct monitoring of external factors change modulation device itself, to learn the change of the external physical quantity which is the advantage of compact structure, high sensitivity, but it must use the special optical fiber and advanced detecting technology, so high cost. And pass through other sensitive element type optical fiber sensor is perception outside the change of the quantity, the fiber itself not only have the effect of the light sensitive device. Because of it's no special optical fiber and special technology, easy realization, low cost, but also had lower sensitivity, often used in sensitivity requirement is too high.

## The overview of optical fiber pressure sensor and type

Optical fiber pressure sensor is based on the measured pressure is converted to optical fiber F - P interfere with the change of the cavity length L to measure analysis, the principle of design, structure diagram as shown in figure 1. 2 pieces of optical fiber end surface coating will be by laser micro processing technology with quartz capillary sealing form F - P cavity interference. From the light of the incident optical fiber into after the first reflector M1 form the first bunch of reflected light and the first bundle of transmitted light. The transmitted light reflected F - P cavity into optical fiber end face of the M2, be M2 reflect form the second reflected light beam. The light reflected by M1 to return to the incident optical fiber, and the first form interference light beam reflected light. Under the action of outside pressure, optical fiber F - P cavity of the cavity length will have corresponding change, which realized the pressure of F - P cavity length modulation. Figure in the Lc for F - P cavity length, the distance between the two weld Lg for fiber optic sensor standard according to the use of optical fiber in optical fiber sensor can be divided into light and the sensor model.

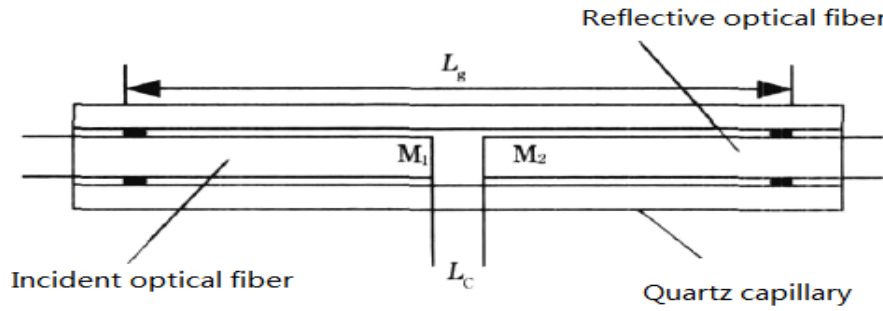


Figure 1 optical fiber pressure sensor structure

The type of fiber optic sensor:

1) The type optical fiber sensor, also known as functional fiber optic sensor. This kind of sensor in use process, need to combine with other specific sensitive element used to complete the sensing function, in the process of the whole sensing using optical fiber optical signal transmission. This kind of sensor, which makes use of optical fiber resistance to electromagnetic interference and the advantages of corrosion resistance, under normal circumstances, this kind of sensor used by ordinary single mode optical fiber, optical fiber for communication optical structure is relatively simple, so this kind of sensor cost is low.

2) The sensor type optical fiber sensor, the corresponding type is also known as functional fiber optic sensor. This kind of sensor is using the optical fiber in optical transfer, more use of the nature of the optical fiber as the sensing part, when the external of optical fiber, the corresponding changes of internal transmission light signal, through signal processing to get the parameters being tested. This kind of sensor with optical fiber as the core, take full advantage of optical fiber features such as resistance to electromagnetic interference, at the same time, the accuracy of optical signal to improve the sensing accuracy.

### The performance analysis of optical fiber pressure sensor

**Temperature characteristic of sensor.** Pearl fiber optic method pressure sensor encapsulated in metal pipe and air pressure pump connected, such guarantee air pressure and air pressure in the tube on the pump pressure gauge shows pressure value. Put one end of the tube by the sensor in high temperature furnace, by high temperature furnace control the temperature of the environment, you need to achieve high temperature pressure measurement.

Using metal tube length is 35 cm, sensing head is located in the tube end, at the end of a metal tube fixed a matching nut, metal tube and nuts and metal pipe and the joints of the fiber with sealant to seal. In this way it is pearl pressure sensor can protect optical fiber method; 2 it is a long metal tube can make the head into the center of the tube type high temperature heating zone, this makes the experimental data more accurate. According to the above methods encapsulated fiber pearl pressure sensor object diagrams are shown in figure 2 below.



Figure 2 for temperature sensor physical experiment

**The optical fiber pressure sensor technology index analysis.** a. The sensitivity test. Sensitivity of the sensor is crucial to determine the accuracy of measurement, the coefficient of optical fiber pressure sensor calibration before, first of sensor sensitivity tests. Because the production of optical fiber method pearl sensor range is 5 MPa, so within 1 MPa pressure sensitivity measurement experiment.

b. Accuracy and linearity. Produced by the optical fiber pressure sensor through the demodulation instrument demodulation in at the output value and the relative error of digital pressure gauge display value, its relative error in the stress value is 0.5 MPa, the largest is 2.4%, when the pressure value is 2 MPa to 5 MPa, the maximum relative error is 0.7%, the minimum value is only 0.02%. Through the above data can be seen that the output value at this time the accuracy is very high. According to the experiment data can draw optical fiber pressure sensor in the curve of pressure is the trip, are shown in figure 3 below.

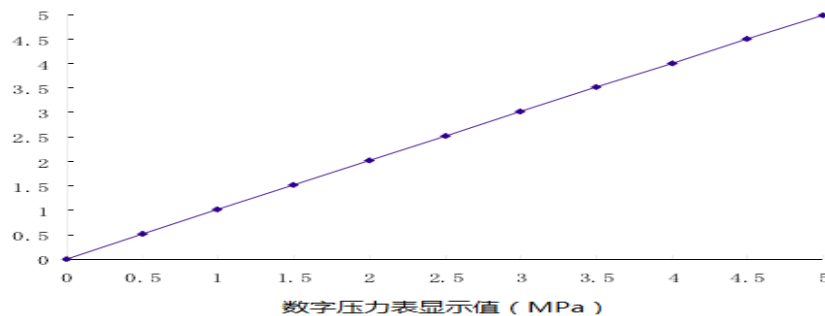


Figure 3 pressure of optical fiber pressure sensor is the curves

c. Repeatability and stability. Application in order to meet the test requirements, the production of optical fiber pressure sensor test the parameters of the repeatability is also very important. In accordance with the standards of domestic repeatability of measurement instruments, in the same environment with the same test instrument is the same data, and the whole operation is repeated in a short time, the consistency of the measurement repeatability. Repeatability experiment was carried out in accordance with the above standards, based on the accuracy and linearity of the experimental analysis of the whole sensor system, it can be seen that the production of pearl fiber method of sensor and its testing system in 5 MPa has good accuracy and linearity range, so using only a short period of time in the process of repeatability test pressure test data are analyzed.

Generally speaking, the stability is refers to the "measuring instrument of its metrological characteristics over time constant ability". For measuring and testing instruments, stability is crucial; stability is the basic premise for all measurement, especially the stability of the short period of time, according to the requirements of actual measurement to test the stability of sensor, and the test time range for 120 minutes.

Within the scope of the sensor in the 120th minute range is plus or minus 0.04 MPa. Here refers to the stability of the production of the stability of the optical fiber pressure sensor and its supporting use of demodulation system. The stability of the optical fiber pressure sensor is mainly depends on the use of technology, this paper USES 157 nm laser producing method, compared with other traditional method of pearl sensor method (such as a manual docking, corrosion, etc.), 157 nm laser manufacturing good controllability and production of high precision, and in this way make the method of pearl sensor is high stability. Demodulation system stability is decided by two parts of hardware and software, the hardware system includes a light source, detector and coupler, optical devices, the performance of these devices to the stability of the hardware system; the stability of the software system is mainly decided by the software algorithm.

## The application of optical fiber pressure sensor in the field of weighing

Intensity modulation type fiber optic pressure sensor is applied to the weighing measurement based on optical fiber itself, only is the advantage of using the optical fiber loss characteristics itself, the outside temperature parameters such as the impact of small, simple and demodulation, demodulation fast, can meet the requirements of high speed vehicle weighing; But in weighing

applications, this type of sensor due to its low sensitivity (optical fiber only bent to a certain degree of wear and tear more apparent), and measuring the length of the fiber is also greatly influenced the result of the measurement, the measurement of recovery time is long, does not meet the needs of continuous measurement. Phase modulation type fiber optic pressure sensor used for weighing in its corresponding speed, high precision and poor stability, but various interferometer can be generally susceptible to interference and other issues, so will the type sensor is used for weighing or has a certain practical difficulties. Because of wavelength modulation type fiber optic pressure sensor in the successful application in other fields, therefore, much attention has been paid to research in the field of weighing focused primarily on fiber Bragg grating pressure sensor, the high measurement precision, repetition performance is good, easy to install, can multipoint measurement at the same time. Compared with other types of optical fiber pressure sensor, the wavelength modulation type fiber optic pressure sensor system cost is high, but as the widespread attention of researchers and optical devices the development of technology, the wavelength modulation type fiber optic pressure sensor used for weighing area will become the research hot spot. In order to achieve real-time monitoring of vehicle load, weighing sensor installed on the vehicle is a requirement of development of information technology, but there is currently no optical fiber sensor in addition to the electronic sensors used for vehicular weighing, comparing three kinds of used for weighing of the optical fiber pressure sensor, due to the particularity of on-board weighing, only the fiber Bragg grating pressure sensor based on wavelength modulation can meet the requirements of vehicle, so the wavelength modulation type fiber Bragg grating pressure sensor can be used for weighing. The type of sensor demodulation speed restrict its weighing applications, therefore, must be looking for a quick can satisfy the fiber Bragg grating demodulation method.

## Summary

In a word, pressure measurement is of great significance, related industries is also growing demand for pressure sensors, as the measurement environment is complicated, the traditional pressure sensor have been unable to meet with the core of optical fiber optical fiber pressure sensor with its corrosion resistance, the advantages of small volume and is not subject to electromagnetic interference, gradually emerging in the field of stress tests.

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