

# Technology Introduction to New Type of Polarization Maintaining Optical Fibre

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**Abstract:** In order to solve the problem of cracking during the polarization maintaining optical fibre polishing and to meet the miniaturization requirement of gyroscope, correspondingly there are two types of new polarization maintaining optical fibre developed by YOFC: the polarization maintaining optical fibre for large mode area devices and 60 $\mu$ m reduced-cladding polarization maintaining optical fibre. The two types of optical fibre have the perfect geometric consistency, mechanical reliability and the full temperature crosstalk performance, which is able to be applied to relevant application fields very well.

**Key words:** Polarization Maintaining Optical Fibre, for Device, Reduced-cladding, Polishing, Miniaturization

## 1 Introduction

Polarization maintaining optical fibre has been widely used for the fields, such as fibre-optic gyroscope, electric power industry, sensor and so on. The different fields have different requirements on product performance of polarization maintaining optical fibre. In order to solve the problem of cracking during the polarization maintaining optical fibre polishing and to meet the miniaturization development requirement of gyroscope, correspondingly there are two types of new polarization maintaining optical fibre developed by Yangtze Optical Fibre and Cable Joint Stock Limited Company (hereinafter referred to as YOFC, Stock Code of 6869.HK): the polarization maintaining optical fibre for large mode area devices and 60 $\mu$ m reduced-cladding polarization maintaining optical fibre.

### 1.1 Polarization Maintaining Optical Fibre for Large Mode Area Device

With the development of various kinds of communication device related to polarization maintaining optical fibre, the quantity demanded of polarization maintaining optical fibre for large mode

area device has increased greatly. At present, the annual domestic demands exceed 2500 km. However, since those types of domestic optical fibres cannot meet the strict use requirements of customers, the home market of polarization maintaining optical fibre for device has been dominated by foreign optical fibre and the status have not been shaken by home-made optical fibre for many years. YOFC has redesigned the profile structure of stress rod and optimized the dosage concentration in stressed zone, the size of stressed zone and the drawing process. Through the improvements above, the performances of polarization maintaining optical fibre for device developed by YOFC have been improved markedly. The cracking rate of polishing at room temperature is lower than 0.1% and the fracture rate of optical fibre at the temperature cycling tests is lower than 0.1%.

### 1.2 60 $\mu$ m Reduced-cladding Polarization Maintaining Optical Fibre

At present, in the fields, such as optical fibre sensor and other device applications, miniaturization has become the technology development orientation of device. Only after the polarization maintaining optical

fibre products have been verified by the using environmental test of smaller bending radius, it can meet the requirement of miniaturization devices. When using a relatively smaller bending radius, the optical fibre will bear relatively larger bending stress, which has a significant impact on the attenuation performance and birefractance performance. That extremely restrains the application of the optical fibre in the miniaturization devices. So a polarization maintaining optical fibre with a smaller size and a better bending performance shall be designed. For this reason, we developed the 60 $\mu\text{m}$  reduced-cladding polarization maintaining optical fibre, which reduced the cladding diameter from 80 $\mu\text{m}$  to 60 $\mu\text{m}$ . This 60 $\mu\text{m}$  reduced-cladding polarization maintaining optical fibre not only meets the loop diameter requirements of about 10mm, but also has a better bending performance.

## 2 Development of YOFC Polarization Maintaining Optical Fibre Product

The development of polarization maintaining optical fibre in YOFC starts in 2004, and after one year the polarization maintaining optical fibre with a working band of 1310nm had been developed successfully. The quality of this product is comparable to the products of Fujikura and Corning. The successful development of YOFC polarization maintaining optical fibre has started the new era of domestic polarization maintaining optical fibre and marked the maturity of the quality and process of domestic polarization maintaining optical fibre.

Over the years, YOFC adheres to the concept of quality first for the production of polarization maintaining optical fibre to control the productive process, and adopts the standardized product line management mode to perform a detailed management on the design, research and development, production, marketing and after-sales of polarization maintaining optical fibre. Up to now, the series of polarization maintaining optical fibre developed by YOFC have been applied to most mass-produced domestic fibre-optic gyroscope of various model numbers,

which account for more than 60% of the market.

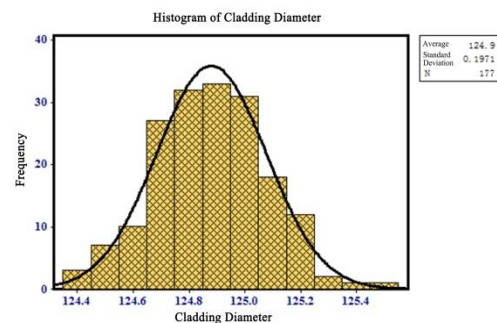
## 3 Product Performance Introductions to New Type of Polarization Maintaining Optical Fibre

### 3.1 Polarization Maintaining Optical Fibre for Large Mode Area Device

The every working procedures in the productive process of YOFC polarization maintaining optical fibre for large mode area device is under a strict controlling, at the same time YOFC has optimized the profile structure of stressed zone, reduced the internal stress of stressed zone and optimized the reliability performance of optical fibre. There are several advantages as follow: good geometric consistency, perfect optical fibre compatibility and perfect polishing hydrolysising performance with details as follow.

#### 3.1.1 Geometric consistency

The YOFC polarization maintaining optical fibre for large mode area device has a perfect geometric consistency, of which cladding diameter fluctuation is less than 0.6 $\mu\text{m}$  and cladding non-circularity fluctuation is less than 0.3%, details are shown in the figure 1:



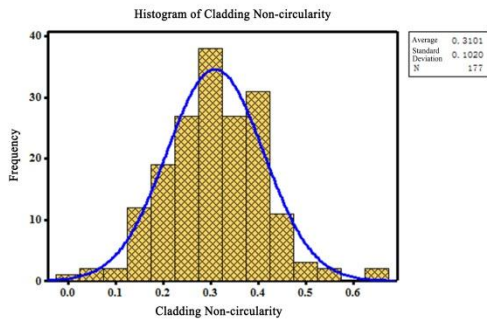


Figure 1 Optical Fibre Geometric Consistency

### 3.1.2 Optical fibre compatibility

After the welding of YOFC polarization maintaining optical fibre for large mode area device and the business competitor's optical fibre and multiple crosstalk testings, the variable typical crosstalk values after and before tests are less than 0.3 dB which is less than the industrial standard of 1.0 dB, details are shown in figure 2:

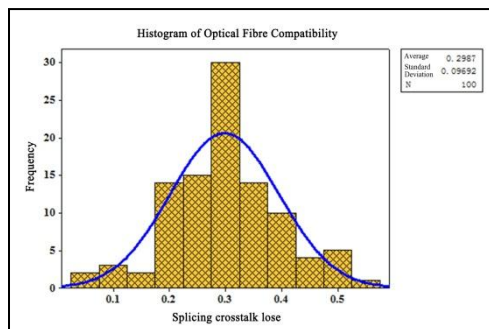


Figure 2 Optical Fibre Compatibility

### 3.1.3 Polishing Hydrolysis Performance

Expose the end face of polished polarization maintaining optical fibre for large mode area device to an environment of high temperature and high humidity (85°C, 85%RH) for routine observation. Observe the hydrolysis conditions of optical fibre end face at 24h, 48h, 96h and 1.8h, each typical optical fibre end face is shown in Table 1. It is observed that there are hydrolysis phenomenons on the end face stressed zones of old products. The new products in the field of hydrolysis are comparable to business competitor, even better.

Meanwhile, YOFC polarization maintaining optical fibre for large mode area device has passed the verification of multiple domestic significant device manufacturers in Zhuhai, Shenzhen, Dongguan and Shanghai, and mass-produced orders from several manufacturers have received.

Table 1 End Face Comparison after Hydrolysis

Samples	24 h	48 h	96 h	168 h
New products				
Old products				
Business competitor's products				

### 3.2 60µm Reduced-cladding Polarization Maintaining Optical Fibre

The coating diameter of YOFC 60µm reduced-cladding polarization maintaining optical fibre has been reduced from 165µm to 100µm by reducing the cladding diameter of the optical fibre from 80µm to 60µm, which reduces the size of optical fibre and saves over 35% volume, as shown in Figure 3.

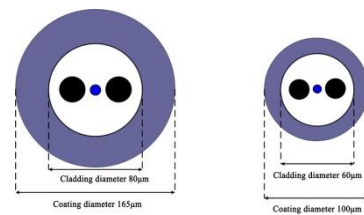


Figure 3 Optical Fibre Structure

YOFC 60µm reduced-cladding polarization

maintaining optical fibre has strictly controlled the perform fabrication processes parameters and reasonably design the ratio of internal and external coating, and ensured the reliability of optical fibre at the same time. There are two major advantages: excellent macro-bending performance and mechanical performance with details as follow.

### 3.2.1 Macro-bending Performance

YOFC 60 $\mu$ m reduced-cladding polarization maintaining optical fibre has an excellent macro-bending performance. 20 mm bending diameter can wind 30 loops, the macro-bending loss of 60 $\mu$ m reduced-cladding polarization maintaining optical fibre (@1550nm) is 0.005 dB and the macro-bending loss of 80 $\mu$ m polarization maintaining optical fibre (@1550nm) is 0.01 dB. So the 60 $\mu$ m reduced-cladding polarization maintaining optical fibre has a better macro-bending performance with details as shown in Figure 4.

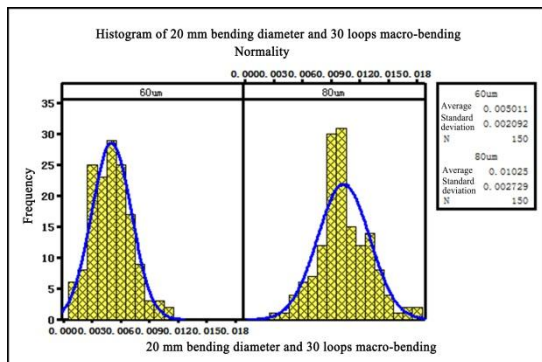


Figure 4 Macro-bending Performance

### 3.2.2 Mechanical Performance

According to the test results above, the tensile strength at break of 50% of YOFC 60 $\mu$ m reduced-cladding polarization maintaining optical fibre is 4.54GPa, and the value of stress-based parameter nd is 21.2, which are better than the requirements of international standard.

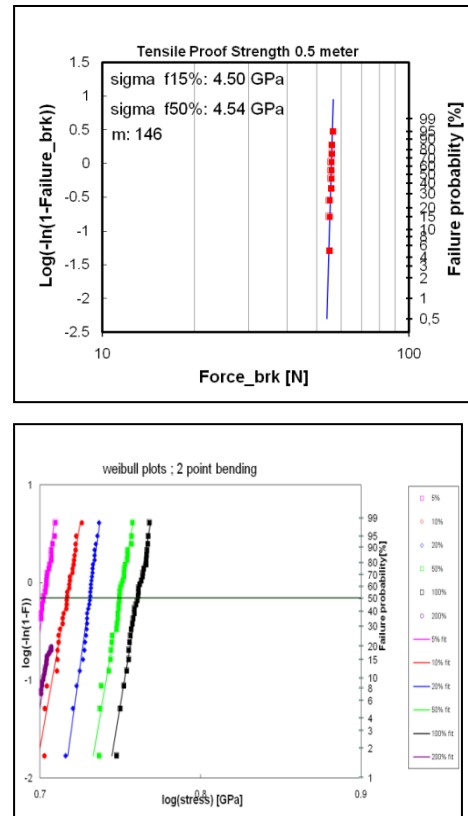


Figure 5 Mechanical Performance

From the above, all testing results of YOFC 60 $\mu$ m reduced-cladding polarization maintaining optical fibre are in the industry leading level.



#### 4 Summary

In general, with the constant growing of the product application and market of domestic polarization maintaining optical fibre product, the quality and applicability of polarization maintaining optical fibre product has been improved constantly. But there still is a gap between the optical fibre product performance and the application expectation. Thus the optimization of polarization maintaining optical fibre performance and the improvements of the stability, consistency and applicability of optical fibre

performance are still the main tasks for the manufacturers.

As the leading specialty optical fibre manufacturer in China, YOFC will continue to focus on the quality control of polarization maintaining optical fibre and provide with customers with high performance and high stability series of polarization maintaining optical fibre products. And make our contribution to the development of fibre-optic gyroscope, optical fibre sensing and optical fibre communication in China!

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