Medium and High Power Laser Transmission Optical Fibre Assembly

1. Industry Background

As an important symbol of the development of science and technology in the 20th century and one of the pillars of photo-electronic technology in the modern information society, the laser technology and laser industry have received extensive attention all over the world. Among them, laser processing, as an important application of laser technology, has been comprehensively and thoroughly used in the traditional industries, and promote the traditional industrial manufacturing technologies constantly updated. Nowadays, laser processing has the ability to cut, weld, punch, carve, wash and clad various materials, and has the characteristics such as high processing accuracy and high processing efficiency, which the traditional technologies do not have.

As the link between laser and materials to be processed, laser transmission optical fibre assembly is indispensable in the process of laser processing. It realizes the flexible transmission of laser and leads the laser precisely to the area to be processed, which is an important part of precision processing.

2. Specifications of YOFC Laser Transmission Optical Fibre Assembly

Depending on different applications, the assemblies are mainly HP-SMA or YLD80 optical fibre connectors (as shown in Figure 1), and each can be divided into two types, with or without water cooling according to different transmission power. In addition, to further improve the heat dissipation and other functions, the YLD80 optical fibre connectors are divided into two types, with or without sapphire.

Figure 1 Laser Transmission Optical Fibre Assembly Product (left is YLD80, right is HP-SMA)

Yangtze Optical Fibre and Cable Joint Stock Limited Company (hereinafter referred to as YOFC) has developed a series of laser transmission optical fibre assemblies based on market applications. The basic specifications and models are shown in Table 1.

Table 1 Specifications and Models of Laser Transmission Optical Fibre Assemblies

Parameter	Specifications	
Connector Type	**YLD80**	**HP-SMA905**
Core Diameter (mm)	4	3.167-3.172
Outer Diameter (mm)	10	9.5
Outer Diameter of Armored Optical Cable (mm)	Armored pipe/plastic-coated armored pipe: ϕ4, ϕ5, ϕ6, ϕ8, ϕ10	
Length of Optical Fibre Assembly (m)	2±0.05, 3±0.05, 5±0.05 (customizable)	
Numerical Aperture NA	0.22±0.02	

YOFC reserves the right to the final interpretation of the above terms.

Core Diameter of Optical Fibre (μm)	SI200/SI400/SI600/SI800 (customizable)
Concentricity (μm)	< 6
Operating Wavelength (nm)	400~2400

3. Features of YOFC Laser Transmission Optical Fibre Assembly

1) Perfect Laser Transmission Optical Fibre Assembly Solution

The main component of the laser transmission optical fibre assembly is the laser transmission optical fibre and the corresponding optical fibre connectors. As a leading manufacturer of specialty optical fibres, YOFC can select or develop applicable optical fibres and match corresponding optical fibre connectors according to different applications and characteristics of the laser to be transmitted. For semiconductor laser applications, Table 2 gives recommendations of maximum laser transmission power for customers to choose from. In laser transmission of the optical fibre, higher maximum laser power transmission of optical fibre with same core diameter can be obtained when matching with the QBH connector.

Table 2 Recommendations for Maximum Laser Transmission Power

Core Diameter	200μm	400μm	600μm	800μm
HP-SMA	100W	200W	300W	400W
YLD80	200W	400W	600W	700W

2) High Laser Transmission Efficiency and Temperature Stability

The key focus of the laser transmission optical fibre assembly under high power condition are the laser transmission efficiency and temperature stability . The optical fibre with 600μm core matched with the sapphire YLD80 optical fibre connector was selected in the experiment. The initial incident power of the 1064nm laser is 550W. Eight-hour uninterrupted pulse laser transmission tests for the laser transmission optical fibre assembly were carried out under the following conditions, and the test results are shown in Figure 2.

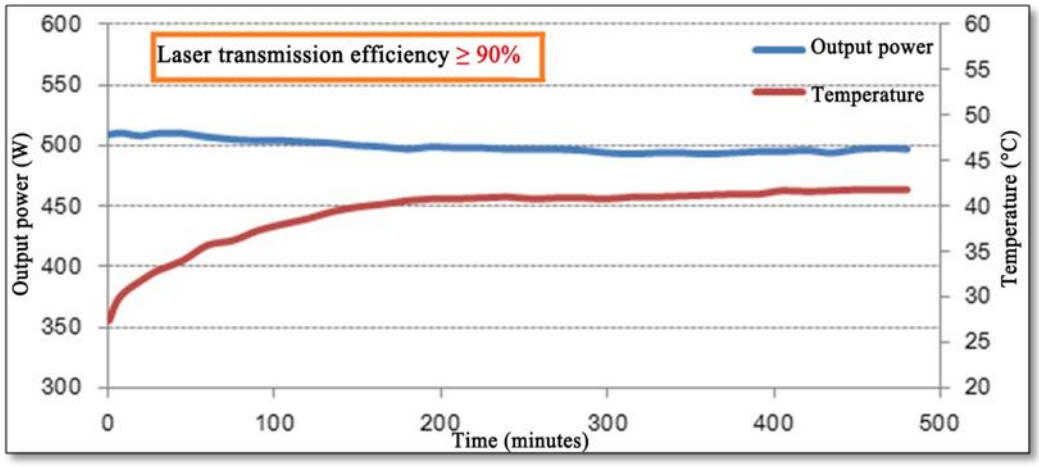


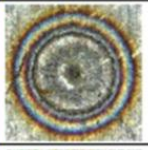
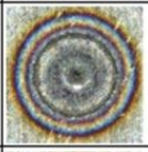
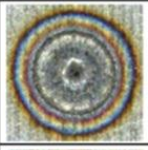
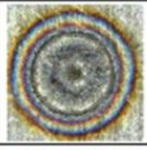
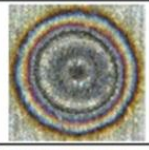
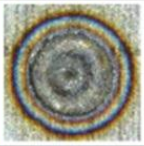
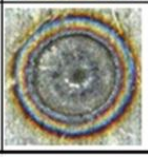
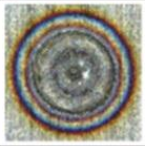
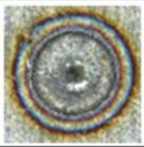
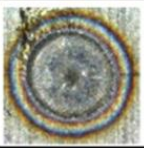
Figure 2 Results of Laser Transmission Tests (peak power: 6kw, pulse width: 6.2ms, repetition frequency: 15Hz)

In 8 hours, the average output power of the assembly is 500.0±5.7W, **the instability is less than 1.5%, and the efficiency of laser transmission is over 92%.** After a period of transmission stabilization, **the temperature of the assembly connector is stabilized at 41℃.** It can be seen that the laser transmission performance of this laser transmission optical fibre assembly developed by YOFC is excellent, and the assembly is stable and reliable in use.

3) Excellent Laser Processing Effect

Taking laser welding as an example, the IPG laser is used in the verification. The samples in contrast are from YOFC and a foreign business competitor. They both have 200μm core and similar structures. The result shows that the single pulse energy of the two samples is almost the same when conducting overall tests under a certain set of parameters. Table 3 shows the comparison of the two optical fibre welding indexes in the actual laser welding verification.

Table 3 Comparison of Laser Welding Performance between YOFC Optical Fibre and A Foreign Business Competitor's Optical Fibre

Comparison of the corresponding weld spot radius of optical fibre between YOFC's fibre and a Foreign Business Competitor's fibre (unit: μm)						
The optical fibre of YOFC	251	252	250	256	252	252.2
The optical fibre of the foreign business competitor	253	245	247	250	256	250.2
Comparison of the corresponding weld depth of optical fibre between YOFC's fibre and a Foreign Business Competitor's fibre (unit: μm)						
The optical fibre of YOFC	354	322	343	362	363	348.8
The optical fibre of the foreign business competitor	366	355	370	325	353	353.8
Comparison of the corresponding weld depth of optical fibre between YOFC's fibre and a Foreign Business Competitor's fibre (unit: μm)						
Type	(0, 0)	(35, 30)	(−35, 30)	(−35, −30)	(35, −30)	Average
The optical fibre of YOFC						/
The optical fibre of the foreign business competitor						/

The shapes and radii of weld marks of the two samples are similar. But the weld penetration depth of the YOFC optical fibre is slightly lower than that of the foreign company. Since the difference is small, it only causes little influence in practical use.

In addition to the conventional single-core laser transmission optical fibre assembly, YOFC has also developed the multi-core bunched laser transmission optical fibre assembly (Figure 3). The improved technology can also prevent the high temperature negative influence of high power. According to customer's actual usage needs, we can also provide rectangular or square bunched products. YOFC will adhere to the "customer, responsibility, innovation, win-win" values and provide efficient solutions for the laser energy transmission market.

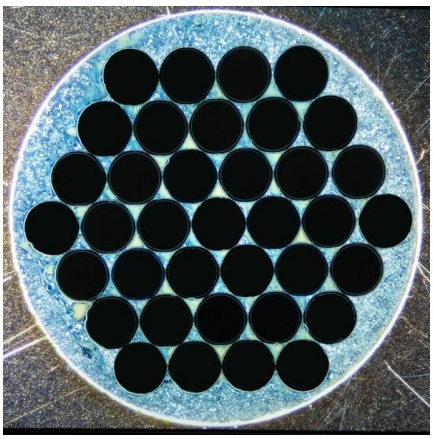


Figure 3 Bunching End Face of Multi-Core Bunched Laser Transmission Optical Fibre Assembly

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