830 Douglas Ave.
Dunedin, FL 34698
(727)733-2447
Fax:(727)733-3962
www.OceanOptics.com

Ocean Optics Inc.
First in Photonics™

A HALMA GROUP COMPANY

Optical Fiber Assemblies

Installation and Operation Instructions

Overview

Ocean Optics offers an extensive line of standard and premium grade optical fibers and accessories – including patch cords, bifurcated assemblies, splice bushings, and splitters – for a variety of SR, UV-VIS and VIS-NIR applications. All optical fibers couple easily via SMA terminations to Ocean Optics miniature fiber optic spectrometers, light sources, and sampling optics.

Optical fibers offer great flexibility as the core of our spectrometer interface systems. They allow you to easily connect the optical interface from one application to another to create an almost endless variety of optical sensing systems.

Ocean Optics optical fibers are silica-core and silica-clad fibers optimized for the SR (190–1100 nm), UV-VIS (300–1100 nm), or VIS-NIR (450–2200 nm) wavelength ranges. The standard length of a fiber assembly is two meters, and assemblies are available in diameters ranging from 4 μm to 1500 μm.

We design our premium-grade optical fiber assemblies for maximum optical transmission, long-life, and encase them in a rugged jacketing that protects the fiber and prolongs its life. The sections that follow discuss premium-grade optical fiber assemblies in more detail.

Optical Fiber Use and Care Notes

Follow the tips below to optimize the use and lifetime of your Ocean Optics fibers:

- Remove the plastic cover from the SMA 905 Connectors gently. Pulling the connector away from the fiber when removing the cover will permanently damage the fiber.
- Inspect the fibers periodically to ensure that the fibers are transmitting light. Broken fibers stop transmitting light. Visually inspect the fibers for light transmission from time to time.
- Avoid coiling the fiber too tightly. While the momentary bend radius of a fiber is typically 200x the diameter of the fiber, the maximum bend radius of a fiber that you fix in place is 400x the diameter of the fiber (e.g. 16 cm for a 400 μm fiber). Bending the fiber past this threshold causes attenuation and can cause permanent damage to the fiber.

- Avoid exceeding the temperature thresholds for the fiber materials: For standard fibers, the temperature threshold for the polyimide fiber is 300 °C, while the PVC cabling is rated to 100 °C. For premium-grade fibers, Ocean Optics rates the entire assembly to 220 °C.
- Avoid bending the fiber in sharp angles. A bending radius of less than 200x can cause permanent fiber damage.
- Cover the SMA 905 connectors with the supplied caps when the fiber is not in use.
- Clean the fiber ends periodically with lens paper and distilled water, alcohol, or acetone. Avoid scratching the surface.
- Avoid immersing the fiber in caustic materials or other materials that can damage quartz, nickel, steel, aluminum, or the epoxy.

Premium-grade Optical Fiber Assemblies

Ocean Optics premium-grade optical fiber assemblies are our best optical fibers available for spectroscopy. The materials and specifications used to manufacture our premium-grade line result in a rugged, high-performance fiber that can withstand environments our lab-grade fibers cannot.

See **Table 3: Premium-grade Fiber Specifications** in the *Optical Fiber Assembly Specifications* section at the end of this document for specific technical information on our premium line of fibers.

Fiber Assembly Types

The following sections detail the various types of fiber assemblies, as well as usage tips and manufacturing information.

General Fiber Assembly Information

The following list provides information on the composition and manufacturing of all optical fiber assemblies:

- Buffer Materials – Glass fiber is fragile, and would be useless for most applications if a suitable buffer material were not protecting it. Buffer materials consist of polymer or metallic coatings that provide mechanical strength (either polyimide, acrylate, aluminum, gold or copper).

  Premium-grade fibers feature a pure fused-silica fiber core and a fluorine-doped cladding, surrounded by a polyimide buffer (except 1000um and single mode, which have acrylate).

- Cabling Materials – Cabling further protects the buffer-coated fiber. Our standard laboratory cabling is blue PVC, but other cabling types (such as stainless steel monocoil) are available.

  Premium-grade fibers feature silicone-coated steel monocoil with Nomex braiding.

Manufacturing Notes: The fiber ends are cleaved, epoxied onto the SMA 905 Connectors, and polished.

Patch Cords

Patch cords are single strands of optical fiber. The active part of the patch cord consists of a silica core surrounded by a silica cladding material. See buffer and cabling material information above for more information.

Bifurcated Assemblies and Splitters

Bifurcated assemblies and splitters allow you to route light from a single location to multiple locations, or to collect light from multiple locations and route that light to a single location. The assemblies are “Y” shaped, with a breakout typically located midway down the length of the fiber.

The common end of bifurcated fiber assemblies has two fibers side-by-side. The spatial difference between each of the fibers may be critical to your application. If this difference is important, you will need a splitter. The common end of a bifurcated fiber can be coupled to a larger diameter single fiber with a splice bushing, creating a functional splitter.

Splice Bushings and Bulkhead Fittings

Splice Bushings couple two SMA 905-terminated fibers. To couple the fibers, screw each fiber into the splice bushing until tight. Tighten by hand only.

Bulkhead Fittings are used to fix a fiber onto a panel. Install the bulkhead by drilling a hole in the wall where you intend to mount the fiber. Fasten the back of the bulkhead fitting using the lock washer and nut provided.

Solarization-resistant Fibers

When using an ultraviolet light source with standard fibers, the UV radiation from the light source degrades the silica over time. This results in increased absorption and invalid data, a phenomenon referred to as fiber solarization.

Ocean Optics solarization-resistant fibers consist of a silica core surrounded by silica cladding material.

Optical Fiber Color Codes

When using an Ocean Optics optical fiber assembly, you can determine the fiber diameter and the fiber type by examining the color bands on the ends of each fiber. The table below contains color-coding data to assist you in identifying fiber information:

Each optical fiber consists of a color-coded boot (flush against the SMA 905 Connector) and a color band (at the base of the boot).

Color-coding on ends of fiber

Table 1: Boot Color Information (A)

	Blue	High-OH content fiber (UV/VIS)
	Red	Ultra-low-OH content fiber (VIS/NIR)
	Gray	Solarization-resistant fiber (UV/VIS)

Table 2: Color Band Information (B)

	Purple	8 μm diameter singlemode
	Blue	50 μm diameter
	Green	100 μm diameter
	Yellow	200 μm diameter
	Gray	300 μm diameter
	Red	400 μm diameter
	Orange	500 μm diameter
	Brown	600 μm diameter
	Clear	1000 μm diameter

On premium-grade fibers, Ocean Optics engraves the diameter of each fiber on all connectors containing a single fiber.

Optical Fiber Assembly Specifications

Table 3: Premium-grade Fiber Specifications

Specification	Value
Operating wavelength:	
UV-VIS (High OH)	300-1100 nm
NIR (Ultra-low OH)	400-2200 nm
UV (Solarization-resistant)	190-1100 nm
Jacketing	Silicone Monocoil
Bare fiber	Pure fused-silica core and fluorine-doped cladding (appropriate buffer)
Fiber profile	Step-index multimode (8 μm fiber is single mode)
Numerical aperture	0.22 +/-0.02 (24.8°), .12 for single mode fibers
Core to cladding ratio	1 to 1.10 (for core diameters larger than 200 μm), 1:1.2 for 100um and 1:2.4 for 50um 125um OD for single mode fibers
Jacketing	Silicone-coated steel monocoil with Nomex braid
Terminations	Precision SMA 905 Connectors (standard)
Operating temperature	Up to 220 °C
Bend radius:	
Momentary	200x fiber diameter
Long-term	400x fiber diameter

Table 4: Standard Fiber Specifications

Specification	Value
Buffer	Acrylate (for 1000 μm and single mode fibers) Polyimide (for 50, 100, 200, 400, 600, and 1000 μm fibers) Aluminum (and others) (for 300 and 400 μm Aluminum solarization-resistant fibers)
Jacketing	Zip Tube Tefzel (for 200, 320, and 500 μm fibers) Others available
Epoxy	Epotek 353ND Epotek 354ND (when required) Others available
Temperature range	Acrylate: -40 °C to 100 °C Polyimide: -40 °C to 300 °C Aluminum (and others): -269 °C to 400 °C
Sheathing/cabling	PVC with Kevlar reinforcement (standard) PEEK (optional) PVC Monocoil (optional) BX flexible metal sleeve (optional)
Terminations	SMA 905 Connectors
Fiber core	Pure silica
Cladding	Doped fused silica
Fiber profile	Step-index multi-mode
Operating wavelengths: UV-VIS VIS-NIR UV-SR	 300-11000 nm 400-2200 nm 190-1100

Table 4: Standard Fiber Specifications (Cont'd)

Specification	Value
Numerical aperture	0.22
Recommended minimum bend radius: Momentary Long-term	 200x the fiber radius (for standard patch cords) 400x the fiber radius (for standard patch cords)

Table 5: Fiber Specifications for High-OH, Low-OH, and SR

Core Size (um)	NA	Ratio	Core Tolerance	Cladding OD(um)	Cladding Tolerance	Buffer Material	Buffer Nominal Thickness	Buffer Nominal Diameter	Buffer Tolerance	Operating Temp Range (Deg C)	Proof Test	Long term bend rad (in)	Short Term Bend Radius (in)
9	0.12+/-.02		+/-0.5um	125	+/- 3um	Acrylate	60	245	+5/-5um	-50C to 85C	100KPSI		
50	0.22+/-.02	2.4	+/- 5um	120	+5/-5um	Polyimide	17um	153um	+2/-3um	-65C to 300C	100KPSI	1.57	0.79
100	0.22+/-.02	1.2	+/-3um	124	+5/-5um	Polyimide	17um	153um	+2/-3um	-65C to 300C	100KPSI	1.57	0.79
200	0.22+/-.02	1.1	+/- 4um	220	+/-4um	Polyimide	10um	239	+5/-5um	-65C to 300C	100KPSI	3.15	1.57
300	0.22+/-.02	1.1	+/- 6um	330	+/- 7um	Polyimide	20um	370	+10/-10um	-65C to 300C	100KPSI	4.72	2.36
320	0.22+/-.02	1.1	+/-6um	352	+/-8um	Polyimide	16um	384um	+10/-10um	-65C to 300C	100KPSI	5.04	2.52
400	0.22+/-.02	1.1	+/- 8um	440	+/- 9um	Polyimide	20um	480	+7/-7um	-65C to 300C	100KPSI	6.30	3.15
440	0.22+/-.02	1.1	+/- 9um	484	+/- 9um	Polyimide	16um	516	+10/-10um	-65C to 300C	100KPSI	6.93	3.46
500	0.22+/-.02	1.1	+/- 10um	550	+/-10um	Polyimide	20um	590	+10/-10um	-65C to 300C	100KPSI	7.87	3.94
550	0.22+/-.02	1.1	+/- 10um	605	+/-10um	Polyimide	16um	637	+10/-10um	-65C to 300C	100KPSI	8.66	4.33
600	0.22+/-.02	1.1	+/- 10um	660	+/- 10um	Polyimide	25um	710	+10/-10um	-65C to 300C	100KPSI	9.45	4.72
1000UV	0.22+/-.02	1.05	+/- 20um	1050	+/- 15um	Acrylate	50um	1250	+/-40um	-50C to 85C	100KPSI	11.81	5.91
1000VIS	0.22+/-.02	1.1	+/- 20um	1100	+/- 15um	Acrylate	50um	1300	+/-40um	-50C to 85C	100KPSI	11.81	5.91
200	0.22+/-.03	1.1	+/- 4um	220	+/-4um	Aluminum	45um	310	+/-21um	-269C to 400C	100KPSI	1.57	0.79
300	0.22+/-.02	1.1	+/- 6um	330	+/- 6um	Aluminum	45um	420	+/-21um	-269C to 400C	100KPSI	2.36	1.18
400	0.22+/-.02	1.1	+/- 8um	440	+/- 9um	Aluminum	45um	530	+/-21um	-269C to 400C	100KPSI	3.15	1.57