



A Furukawa Company

FIBER OPTIC SOLUTIONS

## GYROSIL® PM SENSING OPTICAL FIBERS

FOR FIBER OPTIC GYROSCOPE APPLICATIONS

Rad-Hard PM Optical Fiber  
Polarization-Maintaining Sensing Optical Fiber  
Erbium-Doped Optical Fiber

OFS  
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[www.ofsoptics.com](http://www.ofsoptics.com)

OFS is an industry leader in optical fiber design or modification for highly customized applications.

As your optical fiber solutions partner, we develop the right fibers, cables, and other specialty optical fiber products to meet and exceed the requirements of your application.

GyroSil® Polarization-Maintaining Sensing Fibers (PM) are reduced diameter, dual stress rod fibers designed for use in fiber optic gyroscopes where long lengths and small diameter coils are a requirement. OFS has been manufacturing polarization-maintaining optical fibers since the early 90's when TruePhase® PM Optical Fibers were introduced for telecommunications applications.

GyroSil Rad-Hard PM Optical Fiber is a new addition to the GyroSil Polarization-Maintaining (PM) Sensing Optical Fibers line of reduced diameter fibers. Also highlighted in this brochure is a standard OFS erbium optical fiber with good radiation performance suitable for gyroscope ASE sources.

### Polarization-Maintaining (PM) Optical Fiber

PM optical fibers are designed to have two distinct axes that each guide light at a different speed due to slightly different refractive indices. This "birefringence" is induced by building a significant degree of non-symmetrical stress in the fiber core. Non-PM optical fiber has a slight amount of birefringence caused by small geometrical asymmetries, bending or temperature changes. The larger stresses built into a PM optical fiber allow linearly polarized light which is launched into only one of the axes (either slow or fast), to be guided with negligible cross coupling to the opposing axis. Applications enabled by PM fiber include interferometry, modulators, and optical fiber sensors such as gyroscopes.

### Characteristics of PM Optical Fiber

The birefringence and crosstalk performance of a PM optical fiber is measured through these parameters:

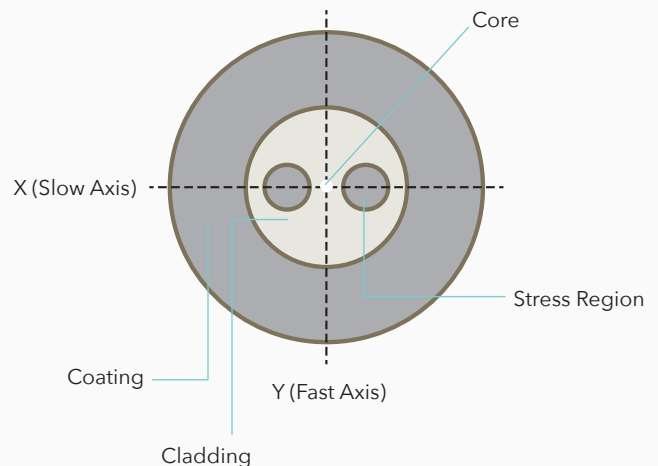
- **h-parameter:** measures the degree to which the fiber maintains a linear polarization state - Amount of crosstalk per unit length  $h = \tanh^{-1} (P_y/P_x) / L$ , where  $P_x$  is power exiting launched axis and  $P_y$  is power exiting opposing axis.

(example:  $10^{-5}/m$ )

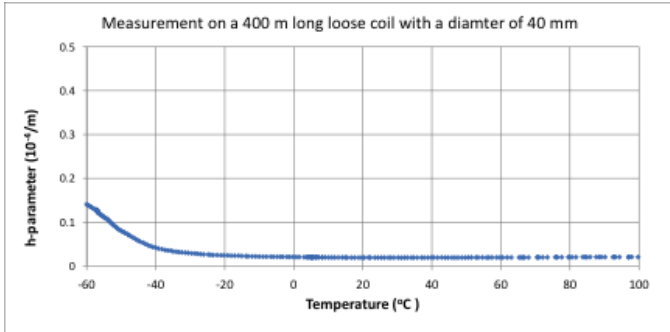
- **Beat length\*:** the length over which the phase difference between the 2 axes differs by  $2\pi$  - Typical values are 2 mm to 5 mm (the shorter the beat length, the greater the birefringence).

\* OFS specifies the beat length at the operating wavelength (1550 nm). A 2.5 mm beat length at 1550 nm will correspond to a beat length just over 1 mm measured at 633 nm, assuming a linear wavelength dependence.

### Dual Stress Rod PM Optical Fiber



**GyroSil PM Sensing Optical Fiber**



*H-Parameter performance of GyroSil 1550 - 155 over temperature range of -60 to 100 °C*

In addition to high birefringence and low h-parameter, GyroSil PM sensing fibers have high numerical aperture, for excellent bend performance in small diameter coils. The dual acrylate coating system provides a soft inner layer to cushion the fiber during bend and a harder outer layer to protect against abrasion and other environmental contaminants.

A new proprietary processing method allows us to manufacture up to 150 kilometers from a single preform with high reliability and uniformity. Our stringent standards ensure small variation between preform draws.

Specifications			
Optical Properties		Optical Properties	
	GyroSil 1550-155	GyroSil 1550-135	GyroSil 840-175B
Center operating wavelength	1550 nm	1550 nm	840 nm
Cut-off wavelength	< 1500 nm	< 1500 nm	< 800 nm
Mode field diameter @ 1550 nm	6.4 ± 0.5 μm	6.4 ± 0.5 μm	4.3 ± 1.0 μm
Attenuation @ 1550 nm	< 1.0 dB/km	< 1.0 dB/km	< 4.0 dB/km
PM Properties			
h-parameter, shipping spool at room temperature	< 2 x 10 <sup>-5</sup> 1/m	< 2 x 10 <sup>-5</sup> 1/m	h-parameter, shipping spool at room temperature < 2 x 10 <sup>-5</sup> 1/m
Beat length @ 1550 nm	< 3.5 mm	< 3.5 mm	Beat length @ 840 nm ≤ 1.8 mm
Beat length @ 633 nm*	< 1.5 mm	< 1.5 mm	Beat length @ 633 nm** < 1.4 mm
Geometrical			
Cladding diameter	80 ± 1 μm	80 ± 1 μm	Cladding diameter 80 ± 1 μm
Coating diameter	155 ± 5 μm	135 ± 5 μm	Coating diameter 175 ± 5 μm
Core concentricity error	< 0.5 μm	< 0.5 μm	Core concentricity error < 0.5 μm
Proof test level	100 kpsi	100 kpsi	Proof test level 100 kpsi
<b>Order by Part Number</b>	<b>27322</b>	<b>35889</b>	<b>88265</b>

\* Estimated from 1550 nm beat length measurement by linear extrapolation.

\*\* Estimated from 840 nm beat length measurement by linear extrapolation.

Designed with a pure silica core, GyroSil Rad-Hard PM Optical Fiber enables fiber optic gyroscope performance in radiation environments. In addition to outstanding radiation performance, this optical fiber offers excellent PM properties as well as stability over temperature.

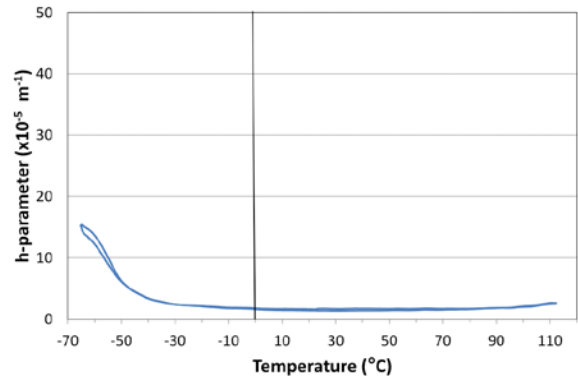
OFS has designed a novel index profile that eliminates the germanium typically used to dope the core of optical fibers. Germanium doped fibers are highly sensitive to radiation which results in induced attenuation to such a degree that performance is compromised. Pure silica core fiber offers radiation induced losses many times lower than germanium doped fibers and radiation performance in the GyroSil Rad-Hard PM is further optimized through draw conditions. The depressed clad design with an 80  $\mu\text{m}$  cladding diameter yields a fiber with excellent bend performance to accommodate the long length, small diameter coils used in gyroscopes. The dual acrylate coating system with a softer inner layer cushions the fiber during bend while the harder outer layer protects against abrasion and other environmental contaminants.

A new proprietary processing method allows us to manufacture up to 150 kilometers from a single preform with high reliability and uniformity. Our stringent standards ensure small variation between preform draws.

### GyroSil 1550 Rad-Hard PM Optical Fiber

GyroSil Rad-Hard PM Optical Fibers for Optical Fiber Gyroscopes are made with Pure Silica core for improved-radiation resistance. They have reduced diameter cladding of 80  $\mu\text{m}$  plus excellent bend performance in small diameter coils. The base fiber with 1550 nm operating wavelength is offered with a 145  $\mu\text{m}$  diameter dual acrylate coating.

**GyroSil 1550 Rad-Hard PM**  
H-Parameter over temperature



H-parameter performance over temperature range -65 to 110 °C measured on 200 m of fiber wound in a coil with 20 mm diameter.

### GyroSil Rad-Hard PM Fiber Specifications

#### GyroSil 1550 Rad-Hard PM

Optical Properties	
Center operating wavelength	1550 nm
Cut-off wavelength	< 1550 nm*
Mode field diameter @ 1550 nm	8.9 $\pm$ 0.5 $\mu\text{m}$
Attenuation @ 1550 nm	< 1 dB/km
PM Properties	
h-parameter, shipping spool at room temperature	< 5 $\times 10^5 \text{ 1/m}$
Beat length @ 1550 nm	< 4.0 mm
Beat length @ 633 nm**	< 1.7 mm
Geometrical	
Cladding diameter	80 $\pm$ 1 $\mu\text{m}$
Coating diameter	145 $\pm$ 7 $\mu\text{m}$
Core concentricity error	< 0.5 $\mu\text{m}$
Proof test level	100 kpsi
<b>Order by Part Number:</b>	<b>27304</b>

\* Cutoff is optimized for application in a coiled configuration at the operating wavelength, 1550 nm

\*\* Estimated from 1550 nm beat length measurement by linear extrapolation.

### RightWave® Erbium-doped Optical Fibers

OFS offers RightWave Erbium-doped Optical Fibers for ASE source applications with a high NA and moderate erbium concentration. The 80 μm clad allows for very tight bend radii without compromising device reliability. HG980-80 features high-power conversion efficiency with low back-scattering for ASE stability, excellent lot-to-lot uniformity, and low, consistent splice loss. OFS EDF products meet the most stringent standards for performance and reliability.

Accurate prediction of EDF performance is essential to applications design. OFS offers specialized OASiX® Amplifier Simulation System Software, which allows the designer to predict EDFA performance at all pump powers for the specific lot of EDF purchased. OASiX is also available in a DLL version for compatibility with external optimization tools.

Specifications		
	RightWave ASE 25 80	RightWave HG980
<b>Optical Properties</b>		
Peak absorption @ 1530 nm	25 ± 3 dB/m	17.0 ± 2.0 dB/m
Numerical aperture	0.31 ± 0.02	0.26 ± 0.02
Cutoff wavelength	930 nm	920 nm
Mode field diameter @ 1550 nm	4.3 ± 0.7 μm	5.1 ± 0.7 μm
Cladding diameter	80 μm	125 μm
Coating diameter	165 μm	245 μm
Loss @ 1200 nm	≤ 25 dB/km	≤ 10 dB/km
Core eccentricity	≤ 0.5 μm	≤ 0.3 μm
<b>Mechanical and Testing Data</b>		
Proof test level	2% (200 kpsi)	2% (200 kpsi)
<b>Order by Part Number:</b>	<b>35644</b>	<b>61379</b>

**Typical Applications:** ASE Source Applications Pumping at either 980 or 1480 nm\* • Small Form-factor ASE Sources  
\* FITEI® 1480 Pump Laser Diode Module (with Isolator) available. For more information, ask your sales representative.

**Options:** Coils, Custom Designs, Customized Spectral Shape, HG980 80 also Available in Standard 125 μm, Cladding Size with 250 μm Coating, and Tighter Optical Property Specifications

### Next Generation PM Designs

For next generation / enhanced performance gyroscopes, OFS Labs has broad capabilities in the area of fiber modeling, design and fabrication. Our R&D team will work with you to create fiber designs/prototypes that will bring you to the next level of performance. Once a prototypes is approved, the design can be rapidly transferred to manufacturing.



**For additional information please contact your sales representative.**

You can also visit our website at [www.ofsoptics.com](http://www.ofsoptics.com) or call 1-888-fiberhelp (1-888-342-3743) USA or 1-770-798-5555 outside the USA.



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