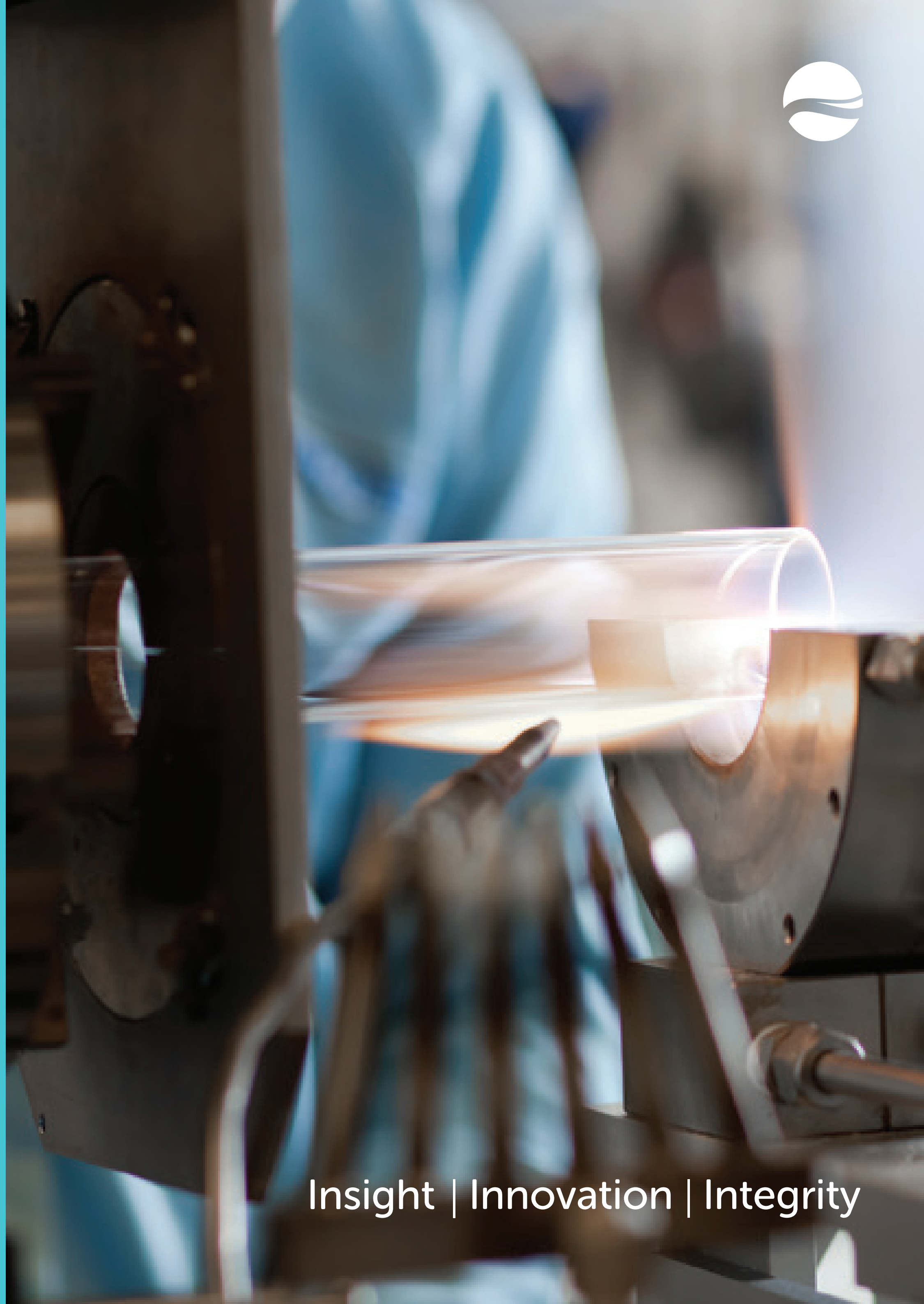
Products & Services
Volume 7

FIBERCORE


Insight | Innovation | Integrity

Contents

SECTION		PAGE
1	**About Fibercore**	6 - 9
2	**Sectors**	
	Harsh Environment	10 - 11
	Aerospace & Defence	12 - 13
	Energy & Infrastructure	14 - 15
	Biomedical	16 - 17
	Telecommunication	18 - 19
	Industrial (Process Monitoring)	20 - 21
	Fiber Lasers and Amplifiers	22 - 23
	Industry, Application and Product Guide	24 - 25
3	**SM Fiber *for Harsh Environments (Hermetic Carbon and High Temperature), Ultra Bend Insensitive, RGB and Near Infra Red***	**26 - 37**
	SM Fiber For Visible RGB Through To Near IR	28 - 30
	High Temperature Acrylate Coated SM Fiber	31
	Polyimide Coated SM Fiber	32 - 33
	Dual Band Carbon Coated SM Fiber	34
	Dual Band Bend Insensitive Fiber	35
	Pure Silica Core SM Fiber	36 - 37
4	**Photosensitive Fiber *for FBGs for use in Temperature, Strain and Biomedical Sensors and Telecoms Components***	**38 - 41**
	Boron Doped Photosensitive Fiber	40
	Highly Germanium Doped Fiber	41
5	**Multicore Fiber *for Medical Shape Sensing, Data Center Transmission Cables and Temperature/Strain Sensors***	**42 - 45**
	Multicore Fiber	44
	Fan Outs	45

FIBERCORE

SECTION		PAGE
6	**PM Fiber *for Fiber Optic Gyros, Sensors, Telecoms, EDFAs and All Fiber Polarizers***	**46 - 55**
	Standard PM Fiber	48
	Polyimide Coated PM Fiber	49
	Telecoms PM Fiber	50 - 51
	PM Gyro Fiber	52 - 53
	Pure Silica Core PM Fiber	54
	Zing™ Polarizing Fiber	55
7	**Spun Fiber *for Current Sensors, Current Transformers and Faraday Effect Sensors***	**56 - 58**
	Spun HiBi	58
8	**Doped Fiber *for Amplifiers and Lasers***	**60 - 71**
	Erbium Doped Fiber IsoGain™	62 - 63
	Erbium Doped Fiber AstroGain™	64
	PM Erbium Doped Fiber	65
	Triple-Clad Doped Fiber	66
	Dual Clad Erbium/Ytterbium Doped Fiber	68
	Isolating Wavelength Division Multiplexer CP-IWDM	69
	Other Doped Fibers	70
	OEM Amplifier GainBlock	71
9	**Passive Cladding Pumped Fiber *for Fiber Lasers, Cladding Pump Amplifiers, Combiners and CATV/FTTx Systems***	**72 - 75**
	Low Index Double Clad Passive Fiber	74
	All Silica Double Clad Fiber	75

SECTION		PAGE
10	**Multimode Fiber *for Harsh Environments (Hermetic Carbon and High Temperature)***	**76 - 81**
	Graded Index Multimode Fiber	78
	Graded Index Multimode Pure Silica Core Fiber	79
	Large Core Fiber	80 - 81
11	**Fiber Bragg Gratings**	**82 - 84**
	FBGs	83 - 84
12	**Complementary Products**	**86 - 97**
	Fiber Optic Cables	88 - 93
	• Downhole Fiber Optic Cable	89
	• Slickline Fiber Optic Cable	90
	• Wireline Fiber Optic Cable	91
	• Fiber In Metal Tube	92
	• Wire Armored Metal Tube	93
	Ruggedized Sleeving and Buffering	94
	Pigtails and Patchcords	95
	Coreless Fiber	96
	Quarter Wave Plate Fiber	97
13	**Additional Services**	98
14	**Fibercore's Commitment**	100
15	**A-Z of Acronyms**	101
16	**Equations**	102
17	**Global Representatives**	Inside Back Cover

About Fibercore

Fibercore has delivered over 35 years of innovation and excellence at the top of its profession, developing and manufacturing specialty optical fibers.

The company continues to embody the spirit of innovation, technical excellence and quality, which has seen it flourish through the first three decades of monumental changes in both technology and its impact on society.

Established in 1982, Fibercore was formed as a spin-out from the world-renowned Optical Fiber Group of the University of Southampton, to offer the specialty optical fibers developed at the University, commercially.

Since 2003, Fibercore has increased its manufacturing capabilities ten-fold and introduced 'World-Class Manufacturing' philosophies to what was traditionally viewed as a scaled-up laboratory process. Our focus is firmly on the future, the recent expansion of the sales, marketing and development teams and the introduction of new photonics engineers into our skill base enables us to continue our commitment to the specialty fiber industry.

Fibercore products are used in an exceptionally broad and growing range of applications spread throughout more than 50 countries.

The applications include Oil & Gas, Fiber Optic Gyroscopes (FOGs), fiber optic hydrophones, fiber lasers, fiber amplifiers (EDFAs), current sensors, embedded sensors, medical devices, government and corporate research agencies and fibers for next generation telecommunications systems. The list just keeps on growing.

Fibercore's acquisition of Fibertronix places emphasis on an extended range of MM and SM fibers including graded index and pure silica core with high temperature coatings. In addition, the development of new double clad and triple clad passive fibers extend our reach into the fiber laser and high power amplifier market. Continued advances in Fibercore's Multicore fiber technology have resulted in the availability of new Spun Multicore fiber for 3D shape sensing. Within FOG, further enhancements to birefringence and coating package design have kept our market-leading HB-G range at the top of the performance tree.

For more information about Fibercore, new products, career options **visit us at Fibercore.com**

Heritage

1982 Spun Low-Birefringence Fiber

1983 Bow-Tie Polarization Maintaining Fiber And Zing™ Polarizing Fiber

1987 Neodymium Doped Fiber

1988 Erbium Doped Fiber

1989 Spun Bow-Tie, Elliptically-Birefringent Fiber

1993 Erbium-Ytterbium Co-Doped Fiber

1998 Intrinsically Photosensitive Boron Co-Doped Fiber

1999 All-Silica, 'Cladding Pump' Rare-Earth Doped Fiber

2002 50µm, Low-Loss And Highly Bend-Insensitive Single-Mode Fiber

2009 Pure-Silica Core Single-Mode Fiber For Use In UV-Visible Applications

2010 Re-Introduction of Improved Zing™ Polarizing Fiber

2012 Re-Introduction of Improved Spun Bow-Tie, Elliptically-Birefringent Fiber

2013 High Temperature Coatings, Pure Silica Core Fiber, Portfolio for Oil & Gas Industry

2014 Acquisition of Fibertronix. Multicore Fiber, Multimode Fiber, Through the Coating FBGs, Cables for Oil & Gas, Double Clad Passive Fiber

2016 Completion Of Hydrogen Chamber

2017 Silicon Photonic Fiber
TC Fiber
High NA / High Bandwidth Fiber

2018 New Gyroscope Fibers
New 7-Core Fiber
B3 Fibers
PMCP Fiber

Technical Partnership

The success of your project is all that matters. Fibercore doesn't just sell specialty fibers - we'll work with you, putting everything that we have learned in the Industry at your disposal.

Fibercore has the depth and breadth of experience and engineering expertise in specialty fiber to make a real contribution to your project – from the very first contact, through supporting you in the selection of exactly the right fiber, all the way to on-time delivery and beyond. It is this exceptional level of intense, technical support that makes our customers return, year after year. We design the right solution for your need beyond the 100+ pages of this brochure. And if we cannot assist you with anything, then we will say so and do our utmost to use our unmatched knowledge to direct you towards someone who can.

1. Do you need specialty fiber?

- Have you got unanswered questions about fiber?
- Would you like more support from a fiber expert?
- Contact us

E: info@fibercore.com
T: +44 (0)23 8076 9893
www.fibercore.com/ask

2. Discuss with our fiber engineers

- Receive detailed feedback and analysis
- Research in the industry's online source of specialty fiber information - Fiberpaedia™

www.fibercore.com/applications
www.fibercore.com/fiberpaedia

3. Do you need a sample?

- Request a sample
- Request more in-depth data
- Request a solution

www.fibercore.com/sample

4. Finalize your fiber selection

- SM Fiber
- Photosensitive
- Multicore Fiber
- PM Fiber
- Spun Fiber
- Doped Fiber
- Passive Cladding Pumped
- Multimode Fiber
- Fiber Bragg Gratings
- Complementary

www.fibercore.com/products

5. Is Fibercore the right partner?

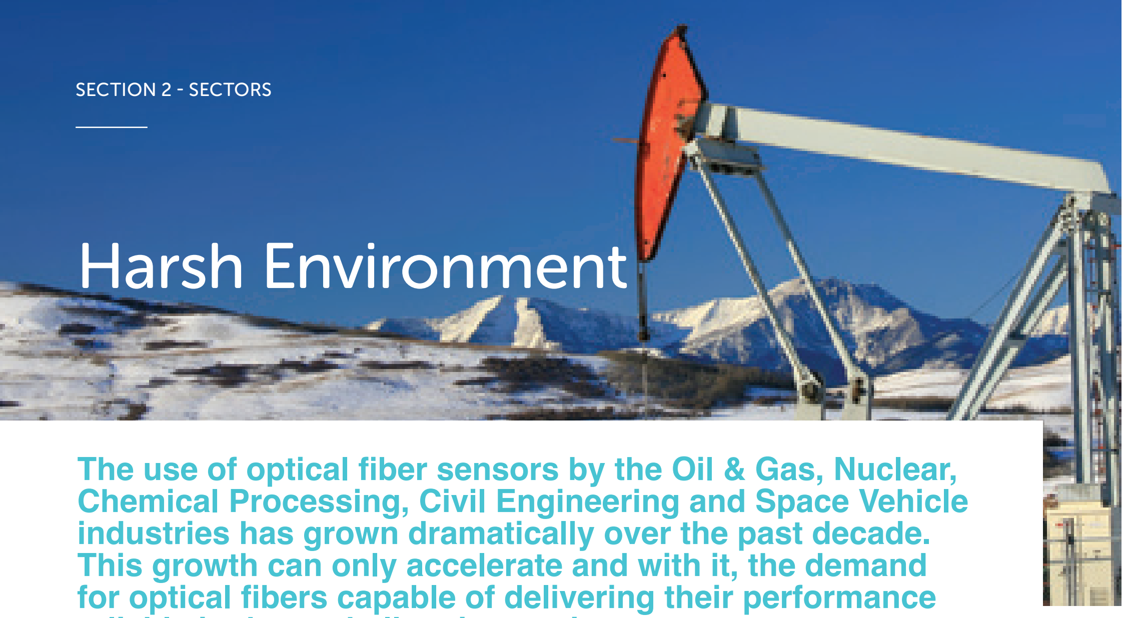
- Over 30 years at the forefront of specialty fiber technology
- Purpose built state-of-the-art facilities
- ISO9001 quality
- ISO14001 environment
- OHSAS18001 health and safety
- ISO10012 test and measurement

www.fibercore.com/facilities

6. What else do you need?

- Fiber qualification & reliability testing
- Fiber test & measurement
- Fusion splicing
- Hydrogen testing
- Custom preform & fiber development
- Custom & Multifiber
- Fiber calculator & EDF S/W
- Development projects

www.fibercore.com/ask
www.fibercore.com/calculator



Harsh Environment

The use of optical fiber sensors by the Oil & Gas, Nuclear, Chemical Processing, Civil Engineering and Space Vehicle industries has grown dramatically over the past decade. This growth can only accelerate and with it, the demand for optical fibers capable of delivering their performance reliably in these challenging environments.

Typical telecommunications fiber is designed for benign environments in temperatures that range from -55°C to +85°C, degrading optically when used outside of this temperature range and when in certain environments with hydrogen, chemicals or radiation. Due to these factors, special coatings are available to address a greater temperature range and to handle certain chemical environments. In addition, the glass chemistry must be modified to address environments with hydrogen or radiation.

Applications

Radiation (Nuclear and Aerospace)

There are multiple applications where optical fiber is exposed to ionizing radiation such as nuclear power plants, nuclear storage facilities, space applications and some research facilities containing high energy physics/particle accelerators. Fibercore has both single-mode and multimode fiber that has been designed specifically to be minimally impacted by ionizing radiation. These optical fibers are used for communication links that go through such environments and are also used for a variety of sensing applications such as distributed temperature sensing (DTS) and strain sensing.Products ideal for a radiation environment include: pure silica core single-mode (pg. 36-37) and graded index pure core multimode (pg. 79).

Oil and Gas

The Oil and Gas (O&G) industry has been using downhole optical fiber in wells where the temperatures can reach beyond 300°C and where hydrogen is present. These fibers are often used for distributed temperature (DTS) and acoustic (DAS) sensing for multiple applications such as frack monitoring and other process optimization, telemetry for downhole tools, pressure sensing and for strain monitoring. Fibercore offers coatings suitable for 150°C, 300°C and beyond, along with a carbon coating over the glass to prevent water or hydrogen ingress. Fibercore offers pure silica core single-mode fiber (pg. 36-37) and a graded index pure core multimode fiber (pg. 79) that has been designed and manufactured to minimize optical loss due to hydrogen exposure.

Products ideally suited to O&G environments, especially downhole, include single-mode and multimode fiber with carbon high temperature acrylate coating (pg. 78), pure silica core single-mode and graded index pure core multimode with polyimide or carbon polyimide (pg. 36 & 79), fiber Bragg gratings (FBGs) (pg.83) and fiber optic cables (pg. 88-93).

Cryogenic

For applications where temperatures will be below -60°C, standard telecommunications fiber will not perform optimally and a special polyimide coating is necessary. Liquid natural gas facilities and pipelines, where temperatures can drop to approximately -180°C, commonly use optical fiber for monitoring temperatures (DTS and/or DAS) to look for signs of leakage. These optical fibers are housed in fiber optic cables to allow for protection of the fiber during placement of the cable. Deployment of optical fiber in cryogenic applications is typically in cable (pg. 88-93) and uses polyimide coated single-mode and multimode fibers (pg.32 & 78).

Acoustic/Seismic

In the O&G industry, fiber optic hydrophones and geophones are used to aid in the evaluation of existing reservoirs and to search for new reservoirs. In these devices, optical fiber is wound in a coil over a compliant mandrel at relatively small diameters, which is challenging if not impossible for standard telecommunications fiber to maintain guidance of the light. These sensors are either lowered downhole into the oil or gas well for vertical seismic profiling (VSP), laid on the subsea floor for ocean bottom seismic (OBS) or placed on the terrestrial surface for seismic profiling.

Fibercore offers a variety of smaller clad diameter fibers with reduced diameter coatings with higher numerical apertures to allow for superior performance in these challenging devices; 50μm and 80μm single-mode fibers (pg. 30 & 33).

Chemical

In some applications, optical fiber is conveyed into the area where optical sensing is desired. The fluid to convey the fiber can be detrimental to the optical fiber coatings. Fibercore has suitable coatings to not only survive the conveyance of the fiber but also to withstand the residual chemical environment that remains after the operation. Pure silica core single-mode and graded index pure core multimode polyimide coated fiber (pg. 36-37 & 79) are ideally suited for harsh chemical environments. In addition, the single-mode fibers can have FBGs written into them as well and this area can be coated with chemically sensitive materials that will expand/contract in the presence of certain target chemicals. In this way, the fiber can become a distributed chemical sensor. FBGs (pg. 83) and our pure silica core single-mode polyimide coated fiber (pg. 36-37) provide the components for this type of sensing.

SECTION 2 - SECTORS

Aerospace and Defence

The fundamental benefits of lightweight, small size and immunity from EMI have enabled optical fiber technology to gain widespread acceptance in Aerospace and Defence. Today, an ever growing list of applications for specialty fiber is topped by Fiber Optic Gyroscopes (FOG), Avionics, LIDAR, Asset Monitoring, Sonar and Perimeter Security.

The Aerospace and Defence (A&D) sectors were amongst the very first to embrace optical fiber technology. Originally this was for communications and now, increasingly for sensing.

A broad spectrum of A&D applications use specialty optical fibers to enhance performance and reliability from fiber optic gyroscopes (FOGs), through hydrophones, geophones, phased array radar, avionics, perimeter and asset security and LiDAR to inter-satellite communications.

Applications

Fiber Optic Gyroscopes (FOGs)
FOGs are interferometric sensors that make use of the Sagnac effect to detect and measure rotation. They are used in ship, submarine, ROV and aircraft navigation, helicopter, missile and gun-sight stabilization, precision positioning of artillery and satellite receivers to name but a few.

The sensing element in a FOG is typically a precision coil of PM fiber with a length of fiber between 100m and 5,000m, depending on the degree of precision required. FOGs can equal the performance of the very best ring laser (RLGs) and iron ('spinning mass') gyros, with the benefits of reduced manufacturing costs and a higher reliability of up to thirty times that of competing technologies, which negates the need for servicing the product, saving lifetime costs.

The entire optical circuit of a high precision FOG may be formed using a range of fibers that have been developed in unison to be fully compatible, delivering optimal performance with minimal effort.

FOG specific Fibercore products include:

- PM Gyro Fiber (pg. 52): Reduced diameter for sensing coils, delivering enhanced mechanical reliability and reduced package size
- Zing™ Polarizing Fiber (pg. 55): Single polarisation fiber to increase PER
- Erbium Doped Fiber IsoGain™ I-25H (pg. 63): High absorption EDF for ASE light sources
- Fiber coils (upon request): Ultra high precision, quadrupole-wound sensor coils

Space Environments
Space qualified FOGs:
Radiation tolerant (RT) variants of both PM (pg. 53) and SM (pg. 36-37) fibers have been used in FOGs deployed by most of the World's space agencies for spacecraft and satellite use. The proprietary core and inner cladding formulation reduces radiation induced attenuation (RIA) by up to fifty times, when compared with conventional fibers. Fibercore products are delivering their performance in geostationary orbit, on the surface of Mars and to the furthest reaches of our Solar System.

Laser Communications:
Fiber lasers and amplifiers are now used increasingly in free-space inter-satellite and satellite-to-ground communications. Fiber based Laser Communications Terminals (LCTs) offer reduced weight, lower power requirements and 100X faster data rates than comparable RF systems and are therefore ideally suited for satellite and spacecraft deployment. Fibercore's Erbium Doped Fiber AstroGain™active fiber range (pg. 64) has been developed specifically for this task.

Embedded Sensors / Asset Monitoring
By embedding optical fibers into an airframe or other structure (with or without the inclusion of fiber Bragg gratings (FBGs) (pg. 83) that structure becomes 'smart', capable of sensing its environment with respect to temperature, vibration, pressure, strain, shape etc.
These techniques were pioneered in the 1980s, notably by McDonnell Douglas Aircraft Corporation and were also used by NASA in the development of adaptive wing aircraft. Fibercore's low and ultra-low profile fibers (pg. 30 & 53) are ideally suited to embedded use, particularly when combined with specialized, harsh environment coatings.

Light Detection and Ranging (LiDAR)
Primarily used for ultra-precise, 3D distance measurement, LIDAR has many applications from atmospheric sensing, wind-shear detection, geological mapping, surveying in mines/quarries to obstacle detection in autonomous vehicles. Fibercore's EDF (pg. 62-67) and EYDF (pg. 68 & 70) active fiber products and matching passive fibers (pg. 72) are ideally suited to use in LIDAR.

In-Flight Network and Entertainment Systems
Optical fiber has higher bandwidth and lower weight than copper cable and is ideally suited to avionics use, from flight systems through to in-flight entertainment. Relatively short distances tend to favour the use of multimode (MM) fiber (pg.76), including radiation resistant and bend insensitive variants. These fibers are ideal for the tight bend-radii encountered in the increasingly dense fiber environment of a typical airframe.

Acoustic and Seismic Sensors
Fiber based 'listening devices', hydrophones and geophones are being used in marine, submarine and terrestrial security. High strength (300+ kpsi), very highly bend insensitive fibers (pg. 28 & 41), often combined with FBGs (pg. 83) are ideally suited to this class of sensor.

Perimeter and Border Security
Both distributed acoustic sensors (DAS) and 3-axis point sensing can deliver exceptional perimeter and border security. These are capable of detecting and analysing footfall and pinpointing tunnelling activity in real time. A number of police stations have already been equipped with these systems, with excellent results.

Fibercore has developed both cable (pg. 88 - 93) and fiber solutions that are now being deployed in these applications.

Energy and Infrastructure

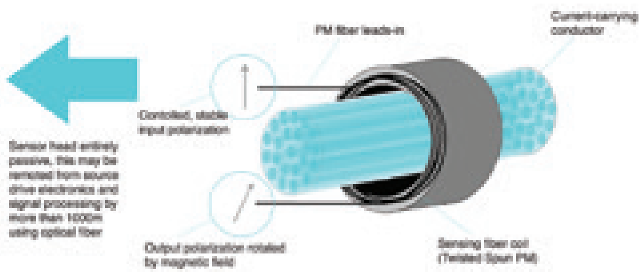
The entire World is critically dependent upon the security and integrity of its transport, data and energy infrastructures. Increasingly, it is fiber optic sensing technologies using specialty optical fibers that are responsible for monitoring these infrastructures to ensure their smooth running.

This applies equally to the supply of energy, distribution of internet data and the transportation of people and goods. Optical fibers are widely used throughout these industries with a growing use of fiber optic monitoring of electrical power distribution, structural health monitoring and intrusion sensing.

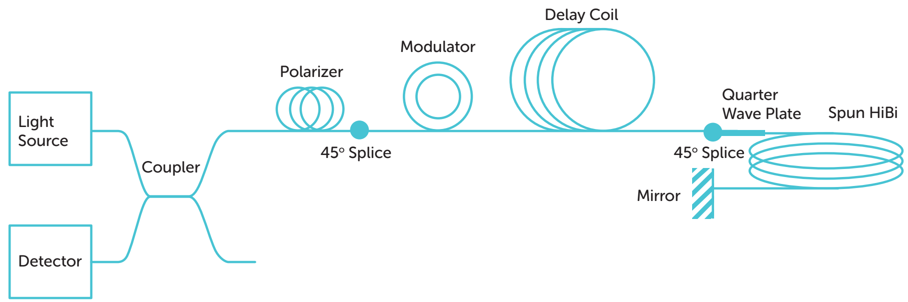
Applications

Energy (for Oil & Gas see pg. 10)
As the smart grid develops, accurate and instant information on the electrical power loading is required. Subsequently, fiber optic current sensors have been developed, which allow almost instant measurement of the electrical current at any point within the network. These fiber optic current sensors (FOCS), also known as optical current transformers, utilise the fiber optic Faraday effect to allow monitoring of current in high voltage power lines and transformers. Fibercore's spun fiber (pg. 58) is at the heart of products where high stability fiber design is critical to enable high accuracy current sensing. The fibers allow highly sensitive and accurate current sensing over a wide range of environmental conditions, including: temperature variation and vibration, suitable for the rigors of real life applications. In addition to the spun fiber within the product, Fibercore's PM fiber (pg. 48) for delay lines and Zing™ (pg. 55) for polarization control are used in combination to result in world-class current sensors.

Faraday Effect Current Sensor Schematic

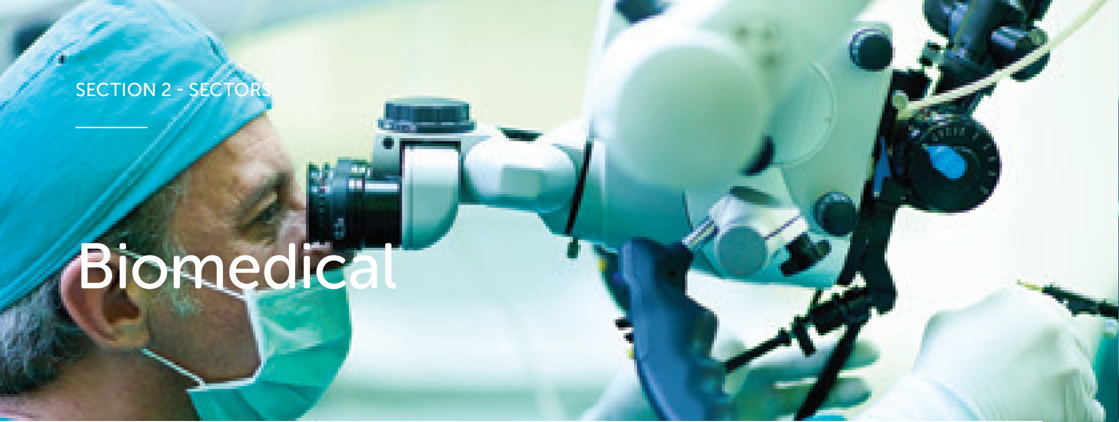


Details of Current Sensor Architecture



Infrastructure
With optical fiber having the ability to be used as a sensor or have sensors written into the fiber directly, information can be gained on the health of a component or system remotely and over long lengths. Some examples are:

1. Embedding optical fiber into power cablesto look for hot spots along the cable, which would indicate insulation breakdown or cable damage and to maximize the potential of the insulated power cable by allowing increased current flow up to the temperature rating of the cable.
2. Embedding fiber Bragg gratings (FBGs) (pg.83) into wind turbine blades to monitor strain and to count the number of flex cycles to evaluate component fatigue.
3. Using radiation resistant optical fiber (pg. 53-54 & 79), for use in communication and sensing (distributed temperature, strain and point sensors) in nuclear storage and operations facilities.
4. Embedding optical fiber into dams to monitor leakage via distributed temperature sensing and monitoring strain either through FBGs or through Brillouin scattering for distributed strain.
5. Using optical fiber at critical junctures on bridges to monitor movement and strain through the use of FBGs (pg. 83) or Brillouin (pg. 29-30) scattering for distributed strain.
6. Small fiber optic cables can be embedded into concrete structures allowing for monitoring of the concrete curing process via temperature (DTS) (pg. 78) and strain (Brillouin (pg. 29-30) or FBG's (pg. 83)) allowing the user to optimize the process.
7. LIDAR, Light Detection and Ranging, uses specialty optical fiber for the transmission of the light. LIDAR is being used for driverless cars and aerial mapping (pg. 62-63 & 66).



Biomedical

The use of optical fiber in the Biomedical industry has grown rapidly from simple light and image guides and power delivery for cutting and cauterizing through to next generation imaging, advanced diagnostics, 'smart' catheters and robotics. This escalation in sophistication requires a greater need for more refined specialty optical fibers.

With a full range of ultra violet (UV) (pg. 36), visible and near-IR single-mode (SM) fibers (pg. 28) in both polarization maintaining (PM) (pg. 48) and non-PM variants, multicore (MCF) fiber (pg. 42), fiber Bragg gratings (FBGs) (pg. 83), small clad, high numerical aperture (NA) (pg. 30), polyimide coated fiber and side hole fiber (upon request), Fibercore's range of advanced optical fibers are suitable for a wide range of biomedical applications. These fibers find use within in vivo and in vitro applications, ranging from medical probes to advanced microscopy techniques. Fibercore can offer coatings suitable for both EtO (ethylene oxide), autoclave and other sterilization techniques.

The use of optical fiber in biomedical applications such as minimally invasive surgery (MIS), vascular intervention, ophthalmology, cosmetic procedures and dentistry is increasing with ever evolving, custom designed optical fibers. Fibercore's culture is to partner with our customers to find creative and innovative solutions to provide the optimal specialty optical fiber, resulting in robust and reliable imaging guidance and diagnostic tools.

Applications

3D Shape Sensing

Vascular and interventional radiology (VIR) requires imaging systems, such as X-rays or CT scanners, to assist with the guidance of angioplasty and catheter delivered stents. However, through the use of Fibercore's multicore fiber with FBGs inscribed along the length, the need for constant imaging using these techniques can be removed. The fiber is able to sense its own shape, enabling a 3D reconstruction of the path it is taking within the body in real time.

Pressure Sensing

Twin hole (or side hole) fibers can be optimized to be sensitive to the hydrostatic pressures experienced within the body. This opens up various biomedical applications such as the precise location and measurement of pressure fluctuations within an artery, which can be an indicator of coronary artery disease (atherosclerosis).

Haptic Sensing

Haptic sensing, or the ability to give touch feedback remotely, allows robotic surgery tools and non-direct mechanically coupled tools to be used with a greater dexterity. The use of Fibercore's reduced cladding diameter fibers with FBGs allows miniature strain sensors to be embedded within the tool, which enables a signal to be returned and converted into a mechanical feedback at the surgeon's hands. This gives surgeons a natural feel when using such tools as if they were touching the soft tissue of the body directly.

Optical Coherence Tomography (OCT)

OCT is an optical imaging acquisition technique that uses light waves to form images of translucent or opaque materials. Images appear as either 2D or 3D layered cross-section of an optical scattering media. One of the most well known areas of OCT imaging is for ophthalmology for retinal mapping. In ophthalmology, OCT measurements allow an ophthalmologist to thoroughly map and measure the thickness of the retina as well as aide in the early detection, diagnosis and treatment for retina disease and other conditions.

Spectroscopy

Spectroscopy is the technology of the dispersion of an object's light into its component colours (i.e. energies). By performing this dissection and analysis of an object's light, we are able to infer the physical properties of that object such as luminosity, temperature, mass and composition. This technology can be used in medical diagnostics such as blood sugar, pulse oximetry, neonatal research, urology, neurology and many other biomedical applications.

Telecommunication

The continual growth in bandwidth demand, fueled by an internet connected society is driving technical developments of devices and components used in the telecommunication architecture.

These devices are required to become more efficient, smaller in size and have wider bandwidth, while still driving performance forward.
Such requirements have driven specialty optical fibers into volume telecommunications markets.

Erbium Doped Fiber Amplifiers (EDFAs)

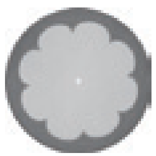
Erbium doped fibers (pg. 62-65) are the standard choice for optical amplification. However, their demands vary depending upon the application of the amplifier. Low cost, C-band, low signal power, high efficiency amplifiers typically utilize erbium doped core pump fiber, such as the IsoGain™ I-4(980/125) and I-6(980/125) (pg. 62). As power level requirements increase, for example >400mW core pump power, high cut-off wavelength fibers provide better efficiency, such as I-4(980/125)HC.

With a growing demand to push the spectral bandwidth of amplifiers, L-band amplifiers are becoming more common. These would require very long lengths of standard erbium doped fibers to be used. Where reduction of the total length is required, Fibercore offers highly doped fibers including: I-12(980/125)HC and I-15(980/125)HC (pg. 63).

Mini and micro EDFAs are popular for small package size C-band amplifiers, which require highly doped fibers, dramatically reducing the coil lengths. Higher absorption and reduced cladding diameter fibers such as I-25H(1480/80) (pg. 63) give improved mechanical reliability, shorter lengths and excellent bend loss.

To address the needs of satellite-to-satellite and satellite-to-ground communication, space grade erbium doped fibers have been developed: AG980H and AG980L (pg. 64).

High Power Amplifiers – Ytterbium Erbium Doped Fiber Amplifiers (YEDFAs)



High power amplifiers for telecoms and CATV require double or triple cladding fibers, which allow the pump light directly into the cladding of the fiber, increasing its utilization. This in turn increases the signal power level, allowing signals in excess of 1W to be used. Unique to the industry, Fibercore manufacture an all-silica double clad fiber with a circular outer cladding and a petal structure inner cladding (pg. 68). The all-silica design means it can be stripped, cleaved, spliced and recoated like a standard optical fiber, without the need for low index recoat material. The circular cladding ensures the fiber sits within V-grooves centrally, avoiding problems associated with competing octagonal cladding structures.
For mode mixing, the petal structure gives efficient coupling of the pump light into the core of the fiber.
For the new generation of even higher power amplifiers, around 5W, Fibercore provides a specialized fiber, TC1500Y(11/125)HD (pg. 66), also with a circular clad design.

OEM Amplifier GainBlock

As the splice recoating technology required for double and triple clad fibers is different to a standard core pump fiber, Fibercore offers a pre-assembled unit called an OEM Amplifier GainBlock (pg. 71). This unit incorporates a WDM, high power splices, cladding pumped gain fiber and heat sinking to allow easy upgrade of lower power amplifiers to higher power levels, without significant engineering investment.

Silicon Photonics

Fibercore have developed extremely small core diameter fibers at 1550nm which are optimized for direct coupling to silicon waveguides. These result in 1550nm SM fibers with MFDs down to 3µm and NAs up to 0.42, significantly reducing the insertion losses between fiber and chip, SM1500ES(3/125) (pg. 29).

Multimode Large Core Fibers

Multimode pumps typically use fiber with a 105µm core diameter and a 125µm cladding diameter. Fibercore offers three variants (pg. 80) of this standard pump fiber: MMSC(105/125)0.22 with a 0.22 NA, MMSC(106.5/125)0.22 with a 0.22 NA and MMSC(102/125)0.26 with a 0.26 NA.

Fused Taper Coupler Fibers

Fused taper coupler performance and manufacturing yields can be optimized by utilizing Fibercore's SM step index fibers, which do not have a fluorine ring, often used in telecoms fibers, which can introduce instabilities in the coupler manufacturing process.
Fibercore's SM980(5.8/125) (pg. 28) dual window fiber and SM1500 (pg. 29) fiber range are ideally suited for coupler manufacturing.

PM Fiber for Coherent Communications and Lyot Depolarizers

Polarization maintaining (PM) (pg. 48) fiber is used for coherent communications where the bandwidth of a fiber is increased 100% by utilizing two polarization states. Fibercore's Telecoms PM Fiber (pg. 50) is designed to offer outstanding core circularity and concentricity for excellent splice performance, while also ensuring low crosstalk between the polarization states. This range offers PM fibers for 1550nm, 14XXnm, 1310nm and 980nm.

Conversely, PM fibers are also used as Lyot depolarizers for depolarizing Raman amplifier pumps. By splicing two specific lengths of PM fibers together with the stress axis offset by 45°, an all-fiber depolarizer can be manufactured.
The HB14XXT (pg. 51) fiber has been specifically designed to offer the best-in-class birefringence, allowing short length depolarizers to be achieved.

Industrial (Process Monitoring)

Small size, lightweight, immunity from electromagnetic interference (EMI), high bandwidth and the ability to provide truly distributed measurements make fiber optic sensing the optimum technology for many aspects of process monitoring. Specialty fibers boost sensor performance and enhance functionality over other technologies.

Existing technologies today suffer from electromagnetic interference (EMI), temperature limitations or size constraints, all of which limit the accuracy or usability of such sensors. By utilizing optical fibers, these challenges can be avoided, bringing additional sensing opportunities to industrial processes.

Metrology

Image courtesy of Mahr

Polarization Maintaining (PM) fibers, for example Fibercore's HB range of highly birefringent fibers (pg. 48), are extremely useful for measuring small distances with high accuracy. The Bow-Tie stress applying parts (SAPs) ensure the input polarization state is kept stable during movement, vibration and temperature changes, ensuring polarization dependant effects do not degrade the accuracy of the measurement. PM fibers are available from visible to near infrared (IR) wavelengths, offering various options depending upon whether the application uses interferometry, time of flight or other measurement methodology.

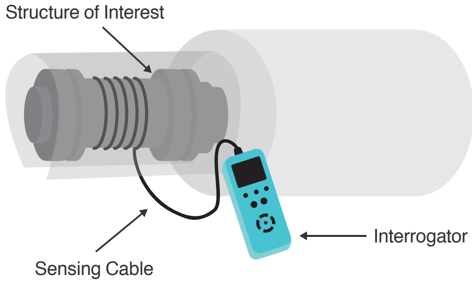
Visible wavelength PM fibers, for example HB450 and HB600 (pg. 48), are often used within interferometers where the distance measurement accuracy is better than the wavelength of the light used.

For ultra-small probes, 80μm and 60μm cladding diameter PM fibers are available in our PM Gyro Fiber range (pg. 52). These allow for smaller cross sections and improved mechanical lifetime when deployed with extremely tight bends.

Condition Monitoring

Movable parts are prone to wear and tear, which can result in catastrophic failure if they are not repaired or replaced when damage is induced. Statistical distributions can be used to give a probabilistic approach to maintenance but this method would not avoid a catastrophic failure in the case of abnormal wear.

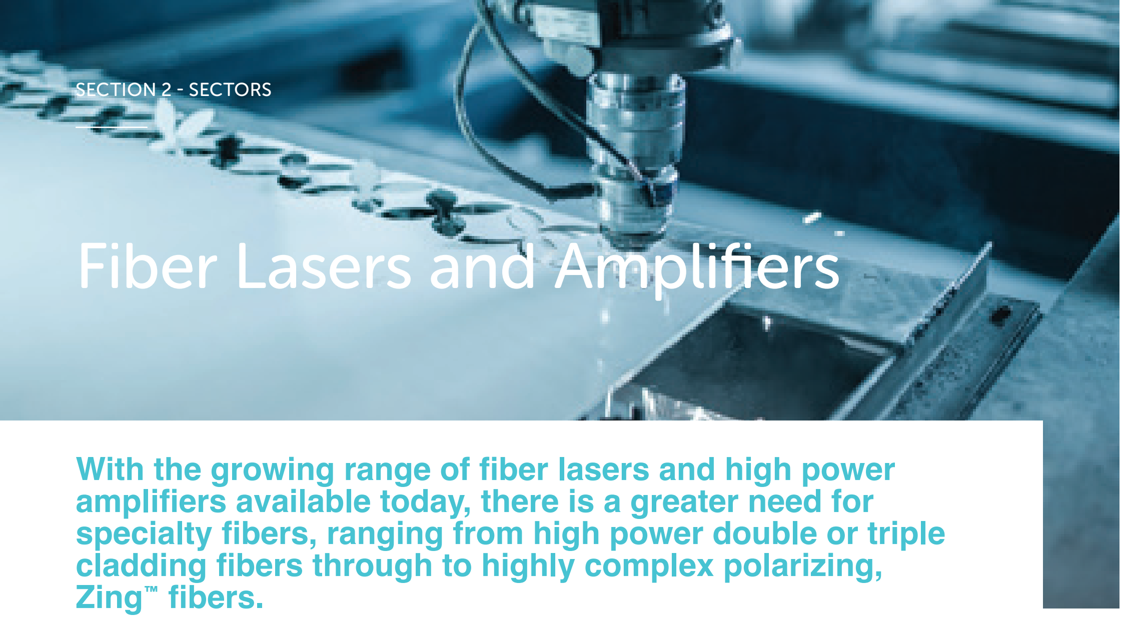
Fiber Bragg gratings (FBGs) (pg. 83) provide a method of monitoring vibrations on mechanical structures, which can be indicative of wear or even manufacturing error. These vibrations can be monitored live and automatic warnings triggered when an abnormal vibration occurs. For mass transportation devices, such as trains and aircrafts, this can save lives. For difficult to access industrial equipment, such as subsea pumps, this can ensure repairs are scheduled only when they are due, avoiding costly recovery processes.



Wind turbines provide an interesting example of using FBGs for not only condition and vibration monitoring of the rotating parts, but also strain sensing along the blades. This allows active feedback to correlate the blade pitch with the strain on the blades to enable optimized energy conversion in light or heavy wind.

Temperature sensing

Multimode (MM) and single-mode (SM) optical fiber are used for continuous distributed temperature sensing (DTS) to provide constant thermal monitoring. Multimode based systems have a sensing reach of ~30km, while single-mode have a reach of ~100km. To help improve the temperature range of the sensing, high temperature acrylate coatings can offer continuous use up to 150°C and polyimide coatings offer use up to 300°C. For more extreme temperature ranges, metal coatings such as gold can be used to push beyond 300°C, for example in turbines. These coatings, with the exception of metal coatings, can also be used in conjunction with Fibercore's femtosecond laser written high temperature FBGs, which give extended thermal range beyond standard FBGs.



Fiber Lasers and Amplifiers

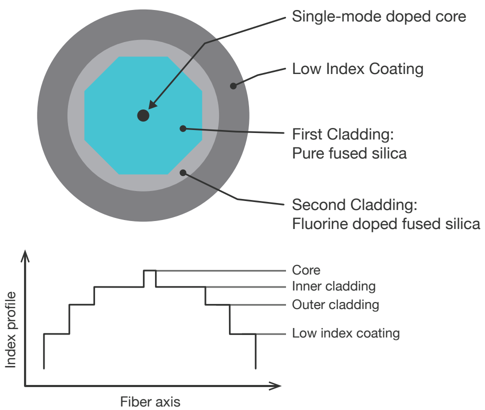
With the growing range of fiber lasers and high power amplifiers available today, there is a greater need for specialty fibers, ranging from high power double or triple cladding fibers through to highly complex polarizing, Zing™ fibers.

These products require high quality manufacturing to ensure outstanding reliability when used at extreme optical power levels and reassurance that the manufacturing processes can scale to meet the global demand of the market. Fibercore's position as the highest volume specialty fiber manufacturer enables us to address the fiber laser and amplifier market with high quality technical products to enable the next generation of fiber lasers to ramp to high volumes.

Triple Cladding Ytterbium/Erbium Doped Fibers

Fibercore's new range of triple cladding fibers (pg. 66) are designed for fiber lasers and high power CATV and telecoms amplifiers. Their unique triple cladding structure is designed to encapsulate the mode mixing octagonal pump guide within a circular outer cladding, enabling lower splice losses and lower splice variability associated with fibers with octagonal outer regions. This triple cladding structure also gives an additional mode confinement structure to reduce the amount of pump light at the cladding-coating interface to aid coating reliability.

Fibercore's triple-clad erbium/ytterbium doped fibers (TC1500YHD) (pg. 66) are designed as single-mode, high-power CATV and telecommunications amplifier fibers. The TC1500Y(6/125)HD offers a smaller Mode Field Diameter (MFD) for higher efficiency levels at output signal power around 1W. The TC1500Y(11/125)HD is designed for output signal power at 5W and above.



The TC1060Y(10/125)0.08HD (pg. 66) is a ytterbium doped fiber designed for use in pulsed and CW fiber lasers. The composition is optimized to avoid the effects of photodarkening to ensure long lifetime and high reliability.

Passive Double Cladding Fibers

Passive double cladding fibers (pg. 72) are designed to transport the single-mode (SM) signal in the core and the pump light in the cladding from one location to another. These fibers are typically utilized in multimode pump combiners where the combined power of multiple multimode pumps are combined into the passive double cladding fiber and transported to the active double or triple cladding fiber.

For the fiber laser industry, Fibercore has developed the DC1060(20/400)0.065HD and DCSC(135/155/320)LI, which enable compatibility to high power ytterbium doped fibers. For the telecoms industry, the DC1500(11/125)0.12HD and DC1500(6/125)0.21HD enable compatibility to 11μm and 6μm MFD erbium/ytterbium doped active fibers.

To enable successful integration into components, the passive double clad fibers have been designed to be compatible with pump combiner manufacturing technology and have a germanium doped core, making the fibers photosensitive for fiber Bragg grating (FBG) inscription. Subsequently, these fibers may be used as part of the main gain stage cavity of a laser or as part of a Master Oscillator Power Amplifier (MOPA) design.

Multimode Large Core Fibers

Multimode pumps typically use fiber with a 105μm core diameter and a 125μm cladding diameter. Fibercore offers three variants (pg. 80) of this standard pump fiber: MMSC(105/125)0.22 with a 0.22 NA, MMSC(106.5/125)0.22 with a 0.22 NA and a MMSC(102/125)0.26 with a 0.26 NA.

Pre-Amplifier Fibers

Depending on the fiber laser architecture, pre-amplifiers are often used to reduce the gain level required from the power amplifier in a MOPA system. Fibercore offers a ytterbium doped, core pump fiber (pg. 70), DF1100 for a 1060nm pre-amplifier and a full range of erbium doped fibers in the IsoGain™ range (pg. 62), but specifically I-15(980/125)HC offers a high absorption level to enable short fiber lengths.

PM and Polarizing Fibers

Fibercore offers a polarization maintaining (PM) erbium doped fiber (pg. 65), DHB1500 with the ability to amplify and maintain polarization for PM fiber laser applications. As well as the doped fibers, Fibercore offers passive PM fibers within the Telecoms PM Fiber range (pg. 50), suitable for wavelengths from 980nm though to 1550nm and beyond. For applications that require a single polarization state, the HB-Z Zing™ (pg. 55) polarizing fiber range can act as an all-fiber distributed polarizer with variants at 1060nm and 1550nm. To avoid Polarization Dependant Gain (PDG), particularly in laser diode seeded MOPA systems, Telecoms PM Fiber makes an excellent choice for use in Lyot depolarizers.

Industry, application and product guide

Industry	Application	SM Fiber (pg. 26)	Photo-sensitive Fiber (pg. 38)	Multicore Fiber (pg. 42)	PM Fiber (pg. 46)	Spun Fiber (pg. 56)	Doped Fiber (pg. 60)	Passive Cladding Pumped Fiber (pg. 72)	Multimode Fiber (pg.76)	FBGs (pg. 82)	Cables (pg. 86)
Harsh Environment	Radiation (Nuclear and Aerospace)	■			■				■		
	Distributed Sensing-Acoustic (DAS), Strain (DSS)	■	■							■	■
	Distributed Temperature Sensing (DTS)	■	■						■		■
	Distributed Pressure Sensing (DPS)	■	■		■					■	■
	FBG Sensing	■	■	■	■					■	
	Cable and Umbilical Integrity Sensing	■	■						■		■
	Geophones & Hydrophones	■			■					■	
	Cryogenic	■							■		■
	Chemical Sensing	■									
Aerospace and Defencet	Fiber Optic Gyroscopes (FOGs)	■			■		■				
	Space - Laser Communications						■				
	Embedded Sensors / Asset Monitoring	■			■					■	
	Light Detection and Ranging (LiDAR)	■			■		■	■			
	Hydrophones	■			■					■	
	Perimeter Security Sensing (Acoustic & Seismic)	■								■	
Energy and Infrastructure	Current Sensors				■	■					
	Nuclear Storage and Operations	■			■				■		
	Strain & Temperature Monitoring-Cables, Wind Turbine blades, Concrete, Bridges									■	■
	Infrastructure - LiDAR				■		■				
Biomedical	3D Shape Sensing	■	■	■		■				■	
	Medical Probes - Pressure Sensing, Illumination	■		■	■			■	■	■	
	Haptic Sensing	■		■	■					■	
	Optical Coherence Tomography (OCT)	■			■						
	Spectroscopy, Confocal Microscopy	■			■				■		
	DNA Sequencing, Flow Cytometry	■			■						
Telecommunications	Erbium Doped Fiber Amplifiers (EDFAs) & Radiation tolerant EDFAs	■					■			■	
	High Power Amplifiers - EDFAs & Ytterbium Erbium Doped Fiber Amplifiers (YEDFAs)	■					■	■	■	■	
	OEM Amplifier GainBlock						■				
	Silicon Photonics	■									
	Fused Taper Couplers	■									
	Coherent Communications and Lyot Depolarizers				■						
	Raman Amplifiers	■			■						
	Space Division Multiplexing (SDM)			■							
	Multimode Pumps								■		
Industrial (Process Monitoring)	Metrology	■		■	■						
	Condition Monitoring	■								■	
	Temperature Sensing	■	■	■					■	■	■
	Faraday Effect Current Sensors	■			■	■					
	Embedded Sensors	■	■	■	■				■	■	
	Chemical Sensing	■	■						■	■	
	Pressure Sensing	■	■		■					■	
	Lithography	■		■	■						
	Phase Doppler Anemometry (PDA)	■			■						
Fiber Lasers and Amplifiers	Fiber Lasers, Amplifiers, Pre-Amplifiers, Power Delivery				■		■	■	■		
Components and Devices	Couplers - Standard and PM	■		■	■						
	ASE Light Sources	■					■				
	Delay Lines	■			■						
	Lyot Depolarizers				■						
	Laser Diode Pigtails	■							■		
	Quarter Waveplates				■						
	Modulators	■			■						
	Pump Combiners							■	■		
	Fiber Bragg Gratings (FBGs)	■	■	■	■		■	■		■	
	LIDAR	■					■				

SM Fiber

For Harsh Environments, Ultra Bend Insensitive, RGB and Near Infra Red

For ultraviolet, visible and near IR transmission, EDFA pigtailing, sensors & tethered platforms

The single-mode (SM) range of fibers has been designed to perform in a wide range of challenging applications offering wavelengths between 488nm and beyond 1650nm.

The SM-SC range of fibers both extends the range into the UV and also enables use in harsh environments. The fiber offers minimal photo-darkening and reduced susceptibility to the effects of hydrogen ingression when compared with conventional, germanosilicate cored fibers.

The SM range of fibers are offered with a range of numerical apertures from 0.10 to 0.42. The high NA variants reduce bend-induced loss to levels dramatically below those of standard telecommunication fibers. Thus, allowing them to be used in diameters of 10mm or smaller.

The high germania content fibers have considerably enhanced photosensitivity, making them ideal for the fabrication of fiber Bragg gratings (FBGs).

A range of harsh environment coatings are available, including carbon, polyimide and high temperature acrylate.

Ranges of specialty single-mode optical fiber:

SM Fiber For Visible RGB Through To Near IR:
For visible and near IR transmission, EDFA pigtailing, acoustic sensors and depolarized FOGs

High Temperature Acrylate Coated SM Fiber:
For medium to high temperature applications

Polyimide Coated SM Fiber:
For embedded and high temperature applications

Dual Band Carbon Coated SM Fiber:
For harsh environments with medium to high temperature applications

Dual Band Bend Insensitive Fiber:
Telecoms style bend insensitive fibers with specialty coatings

Pure Silica Core SM Fiber:
For hydrogen, radiation and UV applications

SM Fiber For Visible RGB Through To Near IR

450nm to 1750nm single-mode transmission

- 125/245µm fiber for SM transmission from 450nm - 1750nm
- 80/170µm fiber for high reliability, small form-factor telecom components
- Ultra-low & low profile, bend-insensitive fiber for de-polarized FOGs, acoustic sensors & small form-factor sensor components
- High NAs for enhanced bend-insensitivity
- High Ge content offering intrinsic photosensitivity for FBG inscription without hydrogenation

Typical applications:

- Hydrophones/Geophones
- Telemetry
- Down-link fibers
- FBGs
- DTS/DAS/DSS
- Laser diode pigtails
- Biomedical probes
- Couplers

Specifications

125µm diameter SM specialty fibers

	SM450	SM600	SM750	SM800 (5.6/125)	SM980 (3.7/125)	SM980 (4.5/125)	SM980 (5.8/125)
Operating Wavelength (nm)	488 - 633	633 - 780	780 - 830	830 - 980	980 - 1550		
Cut-Off Wavelength (nm)	350 - 450	500 - 600	610 - 750	660 - 800	870 - 970		
Numerical Aperture	0.10 - 0.14				0.21 - 0.23	0.17 - 0.19	0.13 - 0.15
Mode Field Diameter (µm)	2.8 - 4.1 @488nm	3.6 - 5.3 @633nm	4.4 - 6.5 @780nm	4.7 - 6.9 @830nm	3.4 - 4.0 @980nm	4.2 - 4.9 @980nm	5.3 - 6.4 @980nm
Attenuation (dB/km)	≤50 @488nm	≤15 @633nm	≤5.0 @780nm	≤5.0 @830nm	≤2.0 @980nm		
Proof Test (%)	1, 2 or 3 (100, 200 or 300 kpsi)						
Cladding Diameter (µm)	125 ± 1						
Core Cladding Concentricity (µm)	≤0.75	≤1.0			≤0.50		
Coating Diameter (µm)	245 ± 7						
Coating Type	Dual Acrylate						

Specifications continue

125µm diameter SM specialty fibers

	SM1500			
	(4.2/125)	(6.4/125)	(7.8/125)	(9/125)
Operating Wavelength (nm)	1520 - 1650			
Cut-Off Wavelength (nm)	1350 - 1520			1300 - 1500
Numerical Aperture	0.29 - 0.31	0.19 - 0.21	0.15 - 0.17	0.13 - 0.15
Mode Field Diameter (µm)	4.0 - 4.5 @1550nm	6.0 - 6.8 @1550nm	7.4 - 8.6 @1550nm	8.5 - 9.9 @1550nm
Attenuation (dB/km) @1550nm	≤1.5	≤0.5	≤0.4	≤0.35
Proof Test (%)	1, 2 or 3 (100, 200 or 300 kpsi)			
Cladding Diameter (µm)	125 ± 1			
Core Cladding Concentricity (µm)	≤0.50	≤0.75		≤0.4
Coating Diameter (µm)	245 ± 7			
Coating Type	Dual Acrylate			
Operating Temperature (°C)	-55 to +85			

Silicon photonic fiber

	SM1500ES(3/125)
Operating Wavelength (nm)	1510 - 1650
Cut-Off Wavelength (nm)	1400 - 1500
Numerical Aperture	0.38 - 0.42
Mode Field Diameter (µm)	3.0 - 3.4 @1550nm
Attenuation (dB/km)	≤30 @1550nm
Proof Test (%)	1 (100 kpsi)
Cladding Diameter (µm)	125 ± 1
Core Cladding Concentricity (µm)	≤0.3
Coating Diameter (µm)	245 ± 7
Coating Type	Dual Acrylate
Operating Temperature (°C)	-55 to +85

Specifications continued

Reduced diameter SM specialty fibers

	SM800(4.2/80)	SM980(4.5/80)	SM1250(5.4/80)	SM1250(9/80)
Operating Wavelength (nm)	830 - 980	980 - 1550	1310 - 1550	
Cut-Off Wavelength (nm)	660 - 800	870 - 970	1150 - 1250	
Numerical Aperture	0.14 - 0.18	0.17 - 0.19	0.19 - 0.21	0.11 - 0.13
Mode Field Diameter (µm)	3.7 - 4.9 @830nm	4.2 - 4.9 @980nm	5.0 - 5.7 @1310nm	8.2 - 9.9 @1310nm
Attenuation (dB/km)	≤3.0 @830nm	≤2.0 @980nm	≤1.0 @1310nm	≤2.0 @1310nm
Proof Test (%)	1, 2 or 3 (100, 200 or 300 kpsi)			
Cladding Diameter (µm)	80 ± 1			
Core Cladding Concentricity (µm)	≤0.50			
Coating Diameter (µm)	170 ± 5			
Coating Type	Dual Acrylate			
Operating Temperature (°C)	-55 to +85			

	SM1500				
	(4.2/50)	(4.2/80)	(5.3/80)	(6.4/80)	(7.8/80)
Operating Wavelength (nm)	1520 - 1650				
Cut-Off Wavelength (nm)	1350 - 1520				
Numerical Aperture	0.29 - 0.31		0.23 - 0.25	0.19 - 0.21	0.15 - 0.17
Mode Field Diameter (µm)	4.0 - 4.5 @1550nm		5.0 - 5.6 @1550nm	6.0 - 6.8 @1550nm	7.4 - 8.6 @1550nm
Attenuation (dB/km) @1550nm	≤2.0	≤1.5	≤0.8	≤0.5	≤0.35
Proof Test (%)	1, 2 or 3 (100, 200 or 300 kpsi)				
Cladding Diameter (µm)	50 ± 1	80 ± 1			
Core Cladding Concentricity (µm)	≤0.50				
Coating Diameter (µm)	110 ± 6	170 ± 5			
Coating Type	Single Acrylate	Dual Acrylate			
Operating Temperature (°C)	-55 to +85				

High Temperature Acrylate Coated SM Fiber

- High temperature acrylate coatings to withstand temperatures up to 150°C continuous
- Low profile, bend insensitive fibers for downhole seismic sensors, high temperature distributed pressure sensors, temperature sensors, down-links and telemetry
- Enhanced photosensitivity

Typical applications:

- Geophones
- DTS, DAS, DSS and DPS
- Embedded sensors
- Fiber Bragg Gratings (FBGs)
- Temperature sensors

Specifications

	SM1500 (5.3/80)HT	SM1500 (6.4/80)HT	SM1500 (6.4/125)HT	SM1500 (7.8/125)HT	SM1500 (9/125)HT
Operating Wavelength (nm)	1520 - 1650				
Cut-Off Wavelength (nm)	1350 - 1520				1300 - 1520
Numerical Aperture	0.23 - 0.24	0.19 - 0.21		0.15 - 0.17	0.13 - 0.15
Mode Field Diameter (µm)	5.0 - 5.6 @1550nm	6.0 - 6.8 @1550nm		7.3 - 8.3 @1550nm	8.5 - 9.9 @1550nm
Attenuation (dB/km) @1550nm	≤0.8	≤0.5		≤0.4	≤0.35
Proof Test (%)	1, 2 or 3 (100, 200 or 300 kpsi)				
Cladding Diameter (µm)	80 ± 1		125 ± 1		
Core Cladding Concentricity (µm)	≤0.5			≤0.75	≤0.4
Coating Diameter (µm)	170 ± 5		245 ± 7		
Coating Type	High Temperature Acrylate				
Operating Temperature (°C)	-55 to +150				

Polyimide Coated SM Fiber

For embedded and high temperature applications

- Polyimide coated enabling survival at temperatures up to 300°C
- Ultra-low and low profile, bend insensitive fiber for downhole seismic geophone sensors and high temperature distributed pressure and temperature sensors
- Enhanced photosensitivity
- Maintains composite material strength when embedded

Typical applications:

- Downhole sensors
- Geophones
- DTS, DAS, DSS and DPS
- Embedded sensors
- FBGs
- Biomedical in vivo sensors
- High temperature sensors

Specifications

	SM1250 (10.4/125)P *	SM1500 (4.2/125)P	SM1500 (6.4/125)P	SM1500 (7.8/125)P	SM1500 (9/125)P
Operating Wavelength (nm)	1260 - 1650	1520 - 1650			
Cut-Off Wavelength (nm)	1190 - 1330	1350 - 1520			1300 - 1500
Numerical Aperture	0.11 - 0.14	0.29 - 0.31	0.19 - 0.21	0.15 - 0.17	0.13 - 0.15
Mode Field Diameter (µm)	9.6 - 11.2 @1550	4.0 - 4.5 @1550nm	6.0 - 6.8 @1550nm	7.4 - 8.6 @1550nm	8.5 - 9.9 @1550nm
Attenuation (dB/km)	≤0.7 @1310nm ≤0.6 @1550nm	≤2.5 @1550nm	≤0.75 @1550nm	≤0.7 @1550nm	≤0.6 @1550
Proof Test (%)	1 or 2 (100 or 200 kpsi)				
Cladding Diameter (µm)	125 ± 2				
Core Cladding Concentricity (µm)	≤0.75	≤0.5	≤0.75		≤0.4
Coating Diameter (µm)	155 ± 5				
Coating Type	Polyimide				
Operating Temperature (°C)	-55 to +300				

Specifications continued

	SM1500 (4.2/50)P	SM1500 (4.2/80)P	SM1500 (5.3/80)P *	SM1500 (6.4/80)P *	SM1500 (7.8/80)P
Operating Wavelength (nm)	1520 - 1650				
Cut-Off Wavelength (nm)	1350 - 1520				
Numerical Aperture	0.29 - 0.31		0.23 - 0.25	0.19 - 0.21	0.15 - 0.17
Mode Field Diameter (µm)	4.0 - 4.5 @1550nm		5.0 - 5.6 @1550nm	6.0 - 6.8 @1550nm	7.4 - 8.6 @1550nm
Attenuation (dB/km) @1550nm	≤3.0	≤2.5	≤1.5	≤0.75	≤0.7
Proof Test (%)	1 or 2 (100 or 200 kpsi)				
Cladding Diameter (µm)	50 ± 2	80 ± 2			
Core Cladding Concentricity (µm)	≤1.0	≤0.5	≤0.5		≤0.75
Coating Diameter (µm)	71 ± 5	102 ± 5			
Coating Type	Polyimide				
Operating Temperature (°C)	-55 to +300				

* Special easier to strip polyimide coating available for window stripping, for applications such as FBGs.

Dual Band Carbon Coated SM Fiber

- Hermetic coating
- High operating temperature, up to 150°C and 300°C
- Low attenuation
- Excellent core cladding concentricity
- Hydrogen resistant

Typical applications:

- Distributed temperature sensors (DTS)
- Distributed acoustic sensors (DAS)
- Distributed strain sensors (DSS)

Specifications

	SM1250(10.4/125)CHT	SM1250(10.4/125)CP
Operating Wavelength (nm)	1260 - 1650	
Cut-Off Wavelength (nm)	1190 - 1330	
Numerical Aperture	0.11 - 0.14	
Mode Field Diameter (µm)	9.6 - 11.2	
Attenuation (dB/km)	<0.6 @1310nm <0.4 @1550nm	<0.7 @1310nm <0.6 @1550nm
Proof Test (%)	1 or 2 (100 or 200 kpsi)	
Cladding Diameter (µm)	125 ± 2	
Core Cladding Concentricity (µm)	≤1.0	
Coating Diameter (µm)	245 ± 15	155 ± 5
Coating Type	Carbon High Temperature Acrylate	Carbon Polyimide
Operating Temperature (°C)	-55 to +150	-55 to +300

Dual Band Bend Insensitive Fiber

Telecoms style bend insensitive fibers with specialty coatings

- Low splice loss to standard telecoms fibers
- Dual band 1310nm and 1550nm transmission
- High temperature coatings for use up to 150°C and 300°C
- Low attenuation
- G.657.B3 level bend insensitivity

Typical applications:

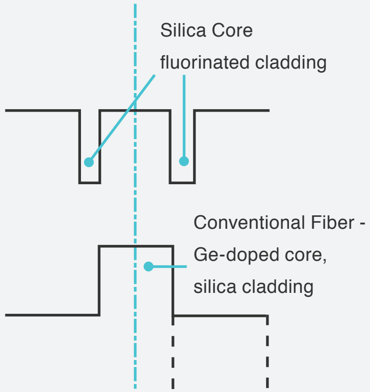
- Low weight/small size avionics cables
- Data center transceivers
- Oil & Gas distributed sensors
- Silicon photonics
- Well integrity monitoring

Specifications

	SM1250B3(9.8/80)	SM1250B3(9.8/125)
Operating Wavelength (nm)	1310 - 1625	
Cut-Off Wavelength (nm)	1100 - 1260	
Numerical Aperture	0.13	
Mode Field Diameter (µm)	8.0 - 9.2 @1310nm 9.0 - 10.4 @1550nm	
Attenuation (dB/km)	≤0.7 @1310nm ≤0.5 @1550nm	≤0.6 @1310nm ≤0.4 @1550nm
Proof Test (%)	2 (200 kpsi)	
Cladding Diameter (µm)	80 ± 1	CHT: 125 ± 2 P: 125 ± 1
Core Cladding Concentricity (µm)	<1.0	
Coating Diameter (µm)	170 ± 5	CHT: 245 ± 15 P: 155 ± 5
Coating Type *	Dual Layer Acrylate	Carbon and HTA Polyimide
Operating Temperature (°C)	-55 to +85	CHT: -55 to +150 P: -55 to +300
Bend Induced Attenuation @1550nm (dB/turn)		
10mm Bend Radius	≤0.03	
7.5mm Bend Radius	≤0.08	
5mm Bend Radius	≤0.15	

* Other coating packages are available upon request

Pure Silica Core SM Fiber



- Excellent hydrogen resistance
- Reduced radiation induced attenuation
- Various NAs for bend insensitivity
- Coatings for temperature use up to 150°C and 300°C
- Carbon option for hermetic sealing
- Hydrogen test data available

Typical applications:

- DTS/DAS/DSS
- Sensing in radiation environments
- Microscopy
- Sensing using UV light
- Coiled acoustic
- Biomedical probes
- Sensing in hydrogen environments

See specification details on page 37.

Coatings Order Guide

Dual Layer Acrylate = No order code
Polyimide = P
Carbon High Temperature = CHT
Carbon Polyimide = CP

Order Code Example

SM1250SC(9/125) with a Carbon High Temperature coating: SM1250SC(9/125)CHT

Specifications

	SM300-SC	SM400-SC	SM1250SC (9/125)*	SM1500SC (7/80)	SM1500SC (7/125)
Operating Wavelength (nm)	320 - 430	405 - 532	1260 - 1650	1520 - 1650	
Cut-Off Wavelength (nm)					
Dual Layer Acrylate	≤310	≤400	1190 - 1330	1400 - 1500	
Polyimide (P)	-	-	1190 - 1330	1350 - 1520	
Numerical Aperture	0.12 - 0.14		0.11 - 0.14	0.17 - 0.19	
Mode Field Diameter (µm)	2.0 - 2.4 @350nm	2.7 - 3.3 @480nm	9.2 - 10.8 @1550nm	6.7 - 7.6 @1550nm	
Attenuation (dB/km)					
Dual Layer Acrylate	≤70 @350nm	≤50 @430nm ≤30 @532nm	≤0.8 @1310nm ≤0.8 @1550nm	≤0.4 @1550nm	≤0.7@1550nm
Polyimide (P)	-	-	≤0.8 @1310nm ≤0.8 @1550nm	≤0.75 @1550nm	≤0.7 @1550nm
Carbon High Temperature (CHT)	-	-	≤0.8 @1310nm ≤0.8 @1550nm	-	≤0.7 @1550nm
Carbon Polyimide (CP)	-	-	≤0.8 @1310nm ≤0.8 @1550nm	-	≤0.7 @1550nm
Proof Test (%)	1 or 2 (100 or 200 kpsi)				
Cladding Diameter (µm)	125 ± 1		125 ± 2	80 ± 1	125 ± 2
Core Cladding Concentricity (µm)	≤0.75				
Coating Diameter (µm)					
Dual Layer Acrylate	245 ± 7		245 ± 15	170 ± 5	245 ± 7
P	-	-	155 ± 5	105 ± 5	155 ± 5
CP	-	-	155 ± 5	-	155 ± 5
CHT	-	-	245 ± 15	-	245 ± 15
Coating Type	Dual Layer Acrylate		Dual Layer Acrylate P*, CHT, CP	Dual Layer Acrylate P	Dual Layer Acrylate P, CHT, CP
Operating Temperature (°C)					
Dual Layer Acrylate	-55 to +85				
P	-	-	-55 to +300		
CP	-	-	-55 to +300	-	-55 to +300
CHT	-	-	-55 to +150	-	-55 to +150

* Special polyimide, for strip and recoat FBGs, available.

Photosensitive Fiber

For Temperature, Strain and Biomedical Sensors and FBGs

High photosensitivity fibers for rapid manufacture of FBGs

Fibercore's photosensitive (PS) series of fibers have a high germania and boron co-doped core composition, enabling high reflectivity gratings to be written without the need to hydrogen-load. The mode field diameters of the boron co-doped fibers are engineered so gratings may be spliced into standard telecommunications, or pigtailing fiber with minimal excess loss.

Fibercore offers a series of high germania SM1500 single-mode fibers for distributed sensors and splice free sensor arrays. The cores of these fibers contain more than 5X the germania content of standard telecommunications fibers. This enables gratings to be written with or without hydrogen loading, whilst maintaining low attenuation around 1550nm. The addition of polyimide coated versions of these fibers extends the range, to cover high temperature harsh environment applications.

Typical applications:

- Temperature sensors
- Strain sensors
- Biomedical sensors
- 3D shape sensing
- Pressure sensors

There are two ranges in this section:

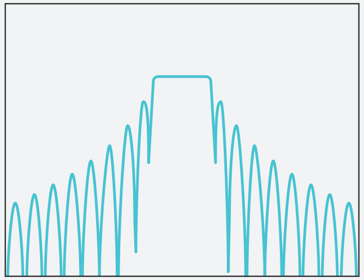
Boron Doped Photosensitive Fiber:

Intrinsically photosensitive fibers for Bragg grating fabrication

Highly Germanium Doped Fiber:

High NA single-mode fibers in three different fiber diameters for writing FBGs with or without hydrogenation

Boron Doped Photosensitive Fiber



Intrinsically photosensitive for grating fabrication

- Rapid formation of high reflectivity FBGs – Without hydrogenation
- For use 'straight from the shelf'
- Strong and consistent photosensitivity
- Compatible with standard telecommunications and pigtailing fibers
- Minimal excess loss during splicing

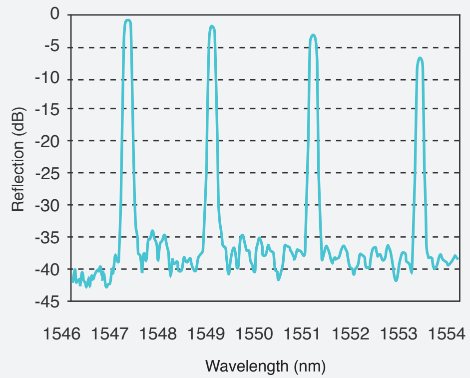
Typical applications:

- FBGs
- Fiber lasers
- Temperature sensors
- Strain sensors
- Biomedical sensors

Specifications

	PS750	PS980	PS1250/1500
Operating Wavelength (nm)	780 - 980	980 - 1310	1260 - 1650
Cut-Off Wavelength (nm)	610 - 750	850 - 950	1100 - 1260
Numerical Aperture	0.12 - 0.14		
Mode Field Diameter (µm)	4.4 - 5.9 @780nm	5.6 - 6.8 @980nm	8.8 - 10.6 @1550nm
Attenuation (dB/km)	30 (typical) @780nm	20 (typical) @980nm	10 (typical) @1310nm 120 (typical) @1550nm
Proof Test (%)	1 (100 kpsi)		
Polarization Mode Dispersion (ps/m)	-	-	≤0.006 (typical) @1310nm
Cladding Diameter (µm)	125 ± 1		
Coating Diameter (µm)	245 ± 7		
Coating Type	Dual Acrylate		
Operating Temperature (°C)	-55 to +85		

Highly Germanium Doped Fiber



Intrinsically photosensitive fibers for grating fabrication in distributed strain and temperature sensors

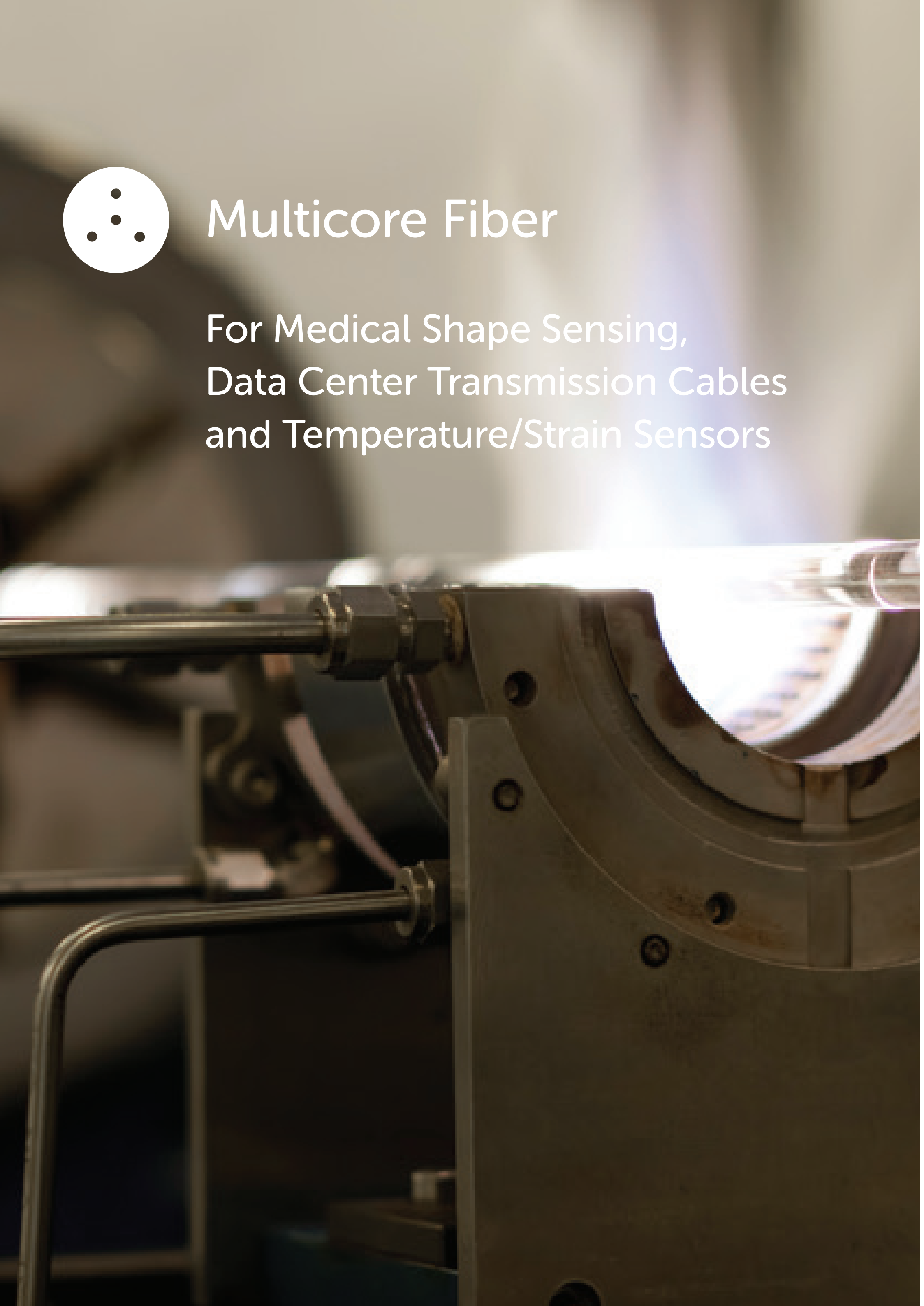
- More than 5X Germania level of standard telecommunications fibers
- Suitable for inscription of long arrays with or without hydrogen loading
- High temperature polyimide coating variants available for harsh environment applications (see page 33 - Polyimide Coated SM Fiber)

Typical applications:

- Temperature sensors
- Strain sensors
- Biomedical sensors
- Hydrophones
- Geophones
- Fiber Bragg Gratings (FBGs)

Specifications

	SM1500(4.2/50)	SM1500(4.2/80)	SM1500(4.2/125)
Operating Wavelength (nm)	1520 - 1650		
Cut-Off Wavelength (nm)	1350 - 1500		
Numerical Aperture	0.29 - 0.31		
Mode Field Diameter (µm)	4.0 - 4.5 @1550nm		
Attenuation (dB/km)	≤2.0 @1550nm	≤1.5 @1550nm	
Proof Test (%)	1, 2 or 3 (100, 200 or 300 kpsi)		
Cladding Diameter (µm)	50 ± 1	80 ± 1	125 ± 1
Core Cladding Concentricity (µm)	≤0.5		
Coating Diameter (µm)	110 ± 6	170 ± 5	245 ± 7
Coating Type	Single Acrylate	Dual Acrylate (Single by Special Order)	
Operating Temperature (°C)	-55 to +85		



Multicore Fiber

For Medical Shape Sensing, Data Center Transmission Cables and Temperature/Strain Sensors

Multicore fibers for medical shape sensing, data center transmission cables and temperature/strain sensing

In the telecoms sector, multicore fibers can be used to dramatically reduce the amount of space required for cables and connectors in data centers and exchanges. By combining multiple signal lines into a single connector, space division multiplexing schemes can be utilized to save space and give high bandwidth cables. For the biomedical sector, the fiber has photosensitive cores, allowing Fiber Bragg Grating (FBG) inscription into each core, giving the ability to use the fiber as a 3D shape sensor, as deployed in catheters and other medical tools for minimally invasive procedures.

Typical application sectors:

- Biomedical
- Telecommunications
- Components
- Defence
- Industrial

There are two ranges in this section:

Multicore Fiber:

4 and 7 core variants for 1550nm sensor and telecommunication applications

Fan Outs:

Packaged 3D waveguide unit to breakout the signal lines of the multicore fibers

Multicore Fiber

Single fiber with multiple cores

- Simultaneous transmission of different signals down different cores
- Photosensitive core designs for FBG inscription
- Suitable for 3D shape sensing applications using Spun Multicore Fiber SSM-7C1500(6.1/125)
- Can be used as the transmission line for high data rate cables in data centers
- Custom designs possible – more cores, mismatched cores, different core positions

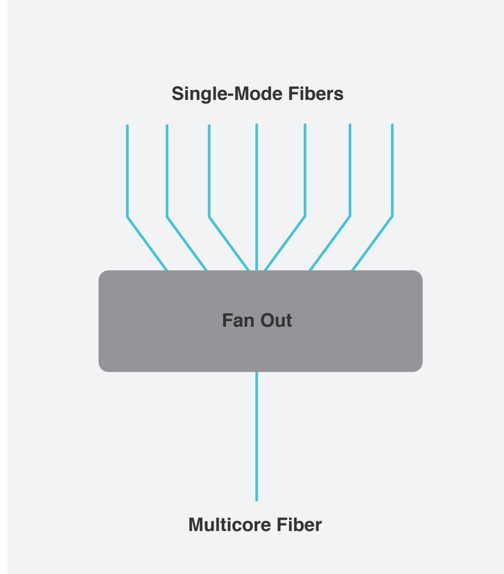
Typical applications:

- 3D shape sensing
- Data center transmission cables
- Temperature and strain sensors
- Structural Health Monitoring (SHM)
- Active Optical Cables (AOC)
- Space Division Multiplexing (SDM) transmission cables
- Silicon photonics
- Quantum Key Distribution (QKD) (non-spun)

Specifications

	SM-4C1500 (8.0/125)/001	SM-7C1250 (5.2/125)	SM-7C1500 (6.1/125)	SSM-7C1500 (6.1/125)
Operating Wavelength (nm)	1520 - 1650	1310	1520 - 1650	
Cut-Off Wavelength (nm)	1300 - 1500	1190 - 1310	1300 - 1500	
Numerical Aperture	0.14 - 0.17	0.20 - 0.22		
Mode Field Diameter (µm)	7.4 - 8.5 @1550nm	4.8 - 5.6 @1310nm	5.7 - 6.5 @1550nm	
Proof Test (%)	0.5 (50 kpsi)	1 (100 kpsi)		
Cladding Diameter (µm)	124 ± 2	125 ± 1		
Core Spacing (µm)	50 (nominal)	35 (nominal)		
Core Position Shape	Square	Hexagon plus central core		Hexagon plus central core Spun
Coating Diameter (µm)	245 ± 12	245 ± 7	245 ± 10	200 ± 7
Coating Type	Dual Acrylate			
Operating Temperature (°C)	-55 to +85			

Fan Outs



Plug-and-play component for multicore fibers

- Compact package size
- High data rates

Typical applications:

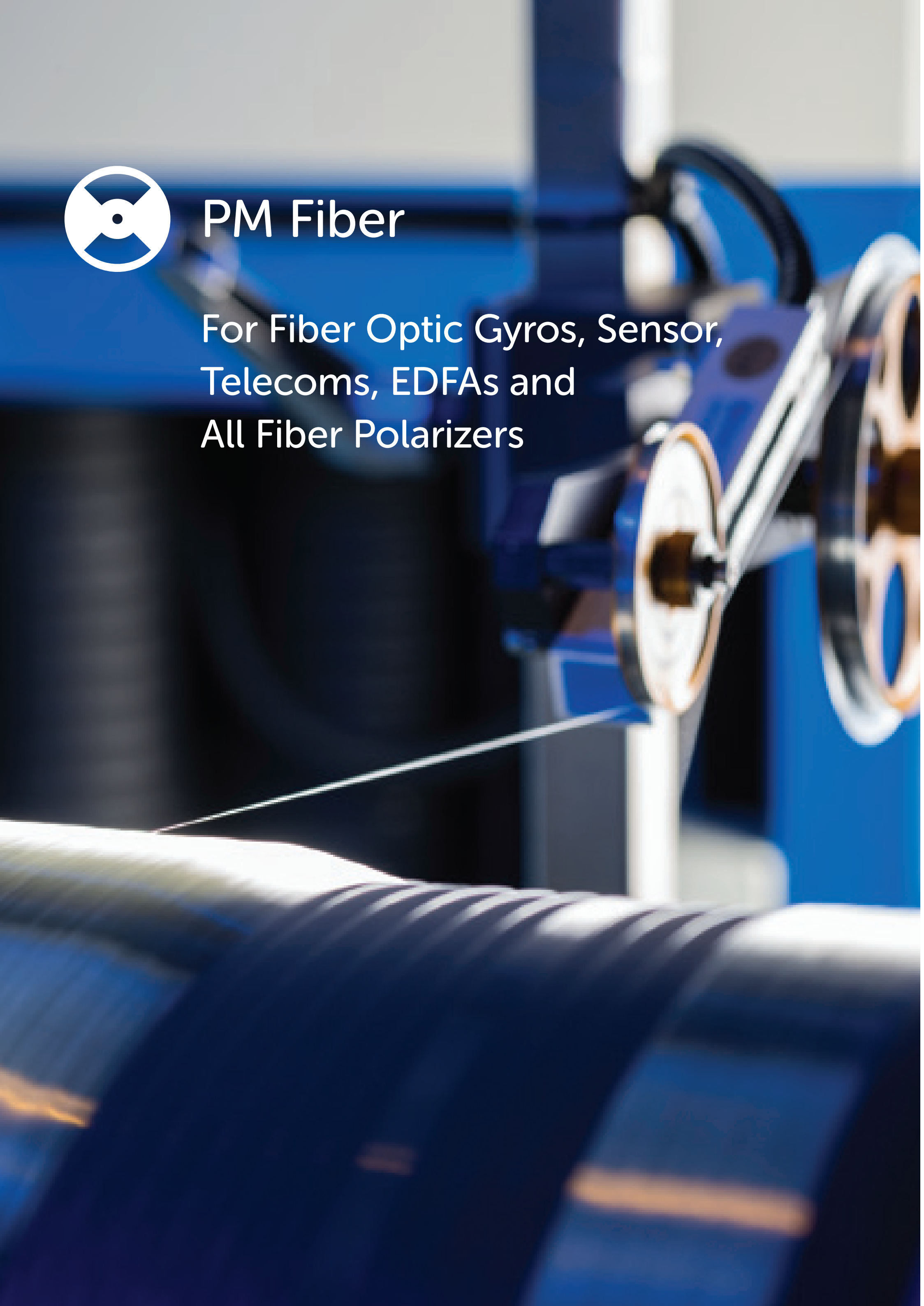
- 3D shape sensing
- 2D bend sensing
- Active Optical Cables (AOCs)
- High bandwidth telecommunications
- Distributed sensing

Specifications

	FAN-4C	FAN-7C	
Operating Wavelength (nm)	1550		1310
Insertion Loss (dB)	1 (typical)	1-2 (typical)	
Number of Cores	4	7	
Crosstalk (dB)	≤-45		
Core Configuration	Square	Hexagon plus central core	
Single Core Fibers	SMF-28 or Equivalent		
Multicore Fibers	SM-4C1500(8.0/125)/001	SM-7C1500 (6.1/125) SSM-7C1500 (6.1/125)	SM-7C1250 (5.2/125)
Operating Temperature (°C)	0 to +85		
Connectorization	Single core: None, LC/PC, LC/APC, FC/PC, FC/UPC, SC/PC, SC/APC, MTP/APC and others upon request MCF: None, FC (narrow keyway), SC (all in PC or APC) and others upon request		

PM Fiber

For Fiber Optic Gyros, Sensor, Telecoms, EDFAs and All Fiber Polarizers



Highly birefringent (HiBi) is designed for high-performance interferometric and polarimetric sensors, integrated optics and coherent communications

The Bow-Tie Stress Applying Parts (SAPs) act as opposing wedges generating optimum stress distribution within the fibers, giving the very best in performance. Our Bow-Tie fibers can be customized for optimum performance for each particular application.

- 90 million meters in service worldwide
- More than 1,000,000m shipped every month

Typical applications:

- Coherent communications
- Biomedical imaging
- Fiber optic gyroscopes
- Metrology
- Fused tape couplers
- All-fiber polarizers

Application specific variants:

Standard PM Fiber:

125/250µm, bend-insensitive fibers for sensor and research applications between 488nm and 1550nm

Polyimide Coated PM Fiber:

125/145µm, polyimide coated fibers for high temperature embedded sensor and medical applications at 830nm, 1310nm or 1550nm

Telecoms PM Fiber:

125/245µm and 125/400µm fibers for telecommunications and EDFA applications at wavelengths between 980nm and 1550nm

PM Gyro Fiber:

80/175µm, broad temperature range, dual coated fibers for fiber optic gyro applications at 830nm, 1310nm or 1550nm

Pure Silica Core PM Fiber:

Photodarkening resistant PM fiber for UV and blue wavelengths

Zing™ Polarizing Fiber:

80/170µm and 125/245µm, short beat-length fibers for high performance, all-fiber polarizers

Standard PM Fiber

Highly birefringent polarization maintaining fibers

- Seven standard wavelengths, 488nm to 1550nm
- Maximum birefringence – Minimum stress
- Exceptional polarization maintaining ability

Typical applications:

- Interferometric sensors
- Diode pigtails
- Coherent beam delivery
- Modulators
- Delay lines
- Spectroscopy
- Biomedical sensors
- Optical Coherence Tomography (OCT)

Specifications

	HB450	HB600	HB750	HB800	HB1000	HB1250	HB1500
Operating Wavelength (nm)	488 - 633	633 - 780	780 - 830	830 - 1060	1060 - 1300	1300 - 1550	1520 - 1650
Cut-Off Wavelength (nm)	350 - 470	500 - 600	610 - 750	600 - 800	840 - 1020	1030 - 1270	1230 - 1520
Numerical Aperture	0.10 - 0.13	0.14 - 0.18					
Mode Field Diameter (µm)	3.0 - 4.1 @488nm	2.8 - 3.7 @633nm	3.5 - 4.6 @780nm	3.7 - 4.9 @830nm	4.8 - 6.3 @1060nm	5.8 - 7.9 @1310nm	7.0 - 9.2 @1550nm
Attenuation (dB/km)	≤100 @488nm	≤15 @633nm	≤8 @780nm	≤5 @830nm	≤3 @1060nm	≤2 @1310nm	≤2 @1550nm
Beat-Length (mm) @633nm	≤2.0						
Proof Test (%)	1 (100 kpsi)						
Cladding Diameter (µm)	125 ± 1						
Core Cladding Concentricity (µm)	≤0.75	≤1.0					
Coating Diameter (µm)	245 ± 7						
Coating Type	Dual Layer Acrylate						
Operating Temperature (°C)	-55 to +85						

Polyimide Coated PM Fiber

Polarization maintaining fiber for high temperature applications

- Survives composite embedding temperatures up to 300°C
- Photosensitive core for FBG inscriptions
- Suitable for autoclave sterilization temperatures

Typical applications:

- High temperature sensors
- Downhole sensors
- Interferometric sensors
- Medical probes
- Embedded sensors

Specifications

	HB800P	HB1250P	HB1500P
Operating Wavelength (nm)	830 - 1200	1300 - 1550	1520 - 1650
Cut-Off Wavelength (nm)	600 - 800	1030 - 1270	1230 - 1520
Numerical Aperture	0.14 - 0.18		
Mode Field Diameter (µm)	3.7 - 5.0 @830nm	5.8 - 7.8 @1310nm	7.0 - 9.2 @1550nm
Attenuation (dB/km)	≤5 @830nm	≤2 @1310nm	≤2 @1550nm
Beat-Length (mm) @633nm	≤2.0		
Proof Test (%)	1 (100 kpsi)		
Cladding Diameter (µm)	125 ± 2		
Core Cladding Concentricity (µm)	≤1.0		
Coating Diameter (µm)	155 ± 5		
Coating Type	Polyimide		
Operating Temperature (°C)	-55 to +300		

Telecoms PM Fiber

For EDFA pumps, Raman pump Lyot depolarizers and telecommunications applications

- Ultra-short beat-length variants for superior polarization performance
- Splice compatible with both standard SM fibers and other PM fibers
- Available in both 245µm and 400µm coating diameters
- Tested in accordance with Telecordia GR-20-CORE
- Excellent geometry for splicing

Typical applications:

- Pump diode pigtails
- Erbium Doped Fiber Amplifier (EDFA)
- Cable Television (CATV)
- Interferometric sensors
- Lyot depolarizers

Specifications

	HB980T	HB1250T (245)	HB1250T (400)	HB1480T (245)	HB1480T (400)	HB1500T (245)	HB1500T (400)
Operating Wavelength (nm)	980 - 1310	1300 - 1480		1480 - 1550		1520 - 1650	
Cut-Off Wavelength (nm)	870 - 970	1100 - 1290		1290 - 1450		1290 - 1520	
Numerical Aperture	0.13 - 0.15	0.11 - 0.13					
Mode Field Diameter (µm)	5.3 - 6.4 @980nm	8.1 - 9.9 @1310nm		9.1 - 10.8 @1480nm		9.6 - 11.7 @1550nm	
Attenuation (dB/km)	≤3 @980nm	≤2 @1310nm		≤2 @1480nm		≤2 @1550nm	
Beat-Length (mm) @633nm	≤2.0						
Proof Test (%)	1 or 2 (100 or 200 kpsi)						
Cladding Diameter (µm)	125 ± 1						
Core Cladding Concentricity (µm)	≤0.6						
Coating Diameter (µm)	245 ± 7		400 ± 20	245 ± 7	400 ± 20	245 ± 7	400 ± 20
Coating Type	Dual Layer Acrylate						
Operating Temperature (°C)	-55 to +85						

Specifications continued

Ultra-short beat-length

	HB980T(6.6/125)	HB1250T(9/125)	HB14XXT
Operating Wavelength (nm)	980 - 1310	1260 - 1650	1300 - 1650
Cut-Off Wavelength (nm)	870 - 970	1100 - 1250	1100 - 1290
Numerical Aperture	0.11 - 0.13		
Mode Field Diameter (µm)	6.1 - 7.1 @980nm	8.1 - 9.9 @1310nm	9.5 - 11.5 @1465nm
Attenuation (dB/km)	≤2 @980	≤2 @1310nm	≤2 @1480nm
Beat-Length (mm) @633nm	≤1.2		
Proof Test (%)	1 or 2 (100 or 200 kpsi)		
Cladding Diameter (µm)	125 ± 1		
Core Cladding Concentricity (µm)	≤0.4		≤0.6
Coating Diameter (µm)	245 ± 7		
Coating Type	Dual Layer Acrylate		
Operating Temperature (°C)	-55 to +85		

PM Gyro Fiber

The No.1 fiber for fiber optic gyroscopes

Typical applications:

- FOGs
- Current sensors
- Delay lines

- High polarization extinction in coiled applications
- -55°C to +85°C in-coil operating range
- Tight coating diameter tolerance for high accuracy coil winding
- 80µm OD saves space and enhances lifetime
- Radiation tolerant variants for space applications
- High reliability in coiled applications
- High temperature coating variant available for downhole FOGs

Specifications

Short beat-length fiber

	HB800G-SB	HB1500G-SB (6.5/80/135)	HB1500G-SB (6.5/80/155)
Operating Wavelength (nm)	810 - 1000	1520 - 1650	
Cut-Off Wavelength (nm)	660 - 800	1360 - 1520	
Numerical Aperture	0.14 - 0.18	0.19 - 0.21	
Mode Field Diameter (µm)	3.7 - 5.0 @830nm	6.0 - 6.85 @1550nm	
Attenuation (dB/km)	≤5 @830nm	1.5 @1550nm	
Beat-Length (mm) @633nm	≤1.0		
Proof Test (%)	1 or 2 (100 or 200 kpsi) or greater upon request		
Cladding Diameter (µm)	80 ± 1		
Core Cladding Concentricity (µm)	≤1.0		
Coating Diameter (µm)	165 ± 5	135 ± 2	155 ± 5
Coating Type	Dual Layer Acrylate		
Operating Temperature (°C)	-55 to +85		

* **SB** - Short Beat-Length

Call Fibercore for smaller diameter fiber options.

Specifications continued

Standard gyro fiber

	HB800G	HB1250G	HB1500G	HB1500G-HI
Operating Wavelength (nm)	810 - 1000	1280 - 1520	1520 - 1650	
Cut-Off Wavelength (nm)	660 - 800	1030 - 1270	1230 - 1520	1360 - 1520
Numerical Aperture	0.14 - 0.18			0.19 - 0.21
Mode Field Diameter (µm)	3.7 - 4.9 @830nm	5.8 - 7.8 @1310nm	6.9 - 9.3 @1550nm	6.0 - 6.9 @1550nm
Attenuation (dB/km)	≤5 @830nm	≤2 @1310nm	≤2 @1550nm	≤3 @1550nm
Beat-Length (mm) @633nm	≤1.5			
Proof Test (%)	1 or 2 (100 or 200 kpsi) or greater upon request			
Cladding Diameter (µm)	80 ± 1			
Core Cladding Concentricity (µm)	≤1.0			
Coating Diameter (µm)	165 ± 5	170 ± 5		155 ± 5
Coating Type	Dual Layer Acrylate			
Operating Temp (°C)	-55 to +85			

* **SB** - Short Beat-Length   * **HI** - High Index

Radiation tollerant fiber

	HB1500G-RT	HB1500G-RT-SB
Operating Wavelength (nm)	1520 - 1650	
Cut-Off Wavelength (nm)	1230 - 1520	1360 - 1520
Numerical Aperture	0.14 - 0.18	0.19 - 0.21
Mode Field Diameter (µm)	6.9 - 9.3 @1550nm	6.0 - 7.0 @1550nm
Attenuation (dB/km)	≤2 @1550nm	
Beat-Length (mm) @633nm	≤1.5	≤1.15
Proof Test (%)	1 or 2 (100 or 200 kpsi) or greater upon request	
Cladding Diameter (µm)	80 ± 1	
Core Cladding Concentricity (µm)	≤1.0	
Coating Diameter (µm)	170 ± 5	165 ± 5
Coating Type	Dual Layer Acrylate	
Operating Temperature (°C)	-55 to +85	

* **SB** - Short Beat-Length   * **RT** - Radiation Tolerant

Pure Silica Core PM Fiber

Photodarkening resistant PM fiber for UV and blue wavelengths

- Germanium-free pure silica core, designed to remove photodarkening effects
- Polarization maintaining design for short wavelength lasers and sensors
- Single-mode down to 350nm
- Compatible with MM125 coreless end-cap fiber
- Shorter wavelengths available upon request

Typical applications:

- Confocal microscopy
- Environmental monitoring
- DNA sequencing
- Flow cytometry

Specifications

	HB450-SC
Operating Wavelength (nm)	430 - 650
Cut-Off Wavelength (nm)	350 - 420
Numerical Aperture	0.11 - 0.13
Mode Field Diameter (µm)	3.0 - 3.6 @488nm
Attenuation (dB/km)	≤30 @488nm
Beat-Length (mm) @633nm	≤2.5
Proof Test (%)	1 (100 kpsi)
Cladding Diameter (µm)	125 ± 1
Coating Diameter (µm)	245 ± 7
Core Concentricity (µm)	≤0.75
Coating Type	Dual Layer Acrylate
Operating Temperature (°C)	-55 to +85

Zing™ Polarizing Fiber

Bow-Tie single polarization fibers for all-fiber polarizers

- Wide and stable polarizing window with a range of deployment conditions
- Consistently low loss and high PER of 30dB+
- Extreme birefringence with excellent handling characteristics
- Functional tunability

Typical applications:

- Fiber lasers
- Laser diodes
- Fiber Optic Gyroscopes (FOGs)
- Current sensors
- Interferometric sensors

Specifications

	HB830Z (5/80)	HB1060Z (7/125)	HB1310Z (9/80)	HB1550Z (11/80)	HB1550Z (11/80) - 50mm *	HB1550Z (11/125)
Operating Wavelength (nm)	830	1064	1310	1550		
20dB Fast Edge* (nm)	≤790	≤1015	≤1270	≤1500		
3dB Slow Edge* (nm)	≥860	≥1105	≥1370	≥1600		
Polarization Extinction Ratio* (dB)	≥30					
Mode Field Diameter (µm)	4.1 - 7.7 @830nm	6.0 - 8.0 @1064nm	7.0 - 10.3 @1310nm	8.5 - 13.5 @1550nm		10.0 - 12.5 @1550nm
Attenuation (dB/km)	≤20					
Proof Test (%)	1 (100 kpsi)					
Cladding Diameter (µm)	80 ± 1	125 ± 1	80 ± 1			125 ± 1
Core Concentricity (µm)	≤1.0					
Coating Diameter (µm)	170 ± 5	245 ± 7	170 ± 5			245 ± 7
Coating Type	Dual Layer Acrylate					
Operating Temperature (°C)	-55 to +85					

* Typical polarizing performance with deployment conditions of 5m length in a coil.
* Zing™ fibers are designed to provide the polarizing window in a 90mm coil diameter. Variants with an * are designed for smaller diameters of 50mm.

To tune the fiber for your application, changing the length of the fiber and/or the coil diameter, can alter the central wavelength and operating bandwidth. For more information and to discuss your precise requirements, contact us at **sales@fibercore.com**

Spun Fiber

Fibercore's spun fiber is primarily designed for fiber optic Faraday effect current transformers where high stability fiber design is critical to enable high accuracy current sensing

The Spun fiber allows highly sensitive and accurate current sensing over a wide range of environmental conditions including temperature variation and vibration, making it suitable for current transformers deployed outdoors in real life applications. When used in conjunction with Fibercore's PM fiber for delay lines and Zing™ for depolarizers, world-class current sensors can be achieved.

Bow-Tie spun fiber for Faraday effect current sensors

- Circularly birefringent
- Supported by full range of complementary fibers
- Higher Verdet constant at 1310nm than at 1550nm

Typical applications:

- Current sensors
- Current transformers
- Faraday effect sensors

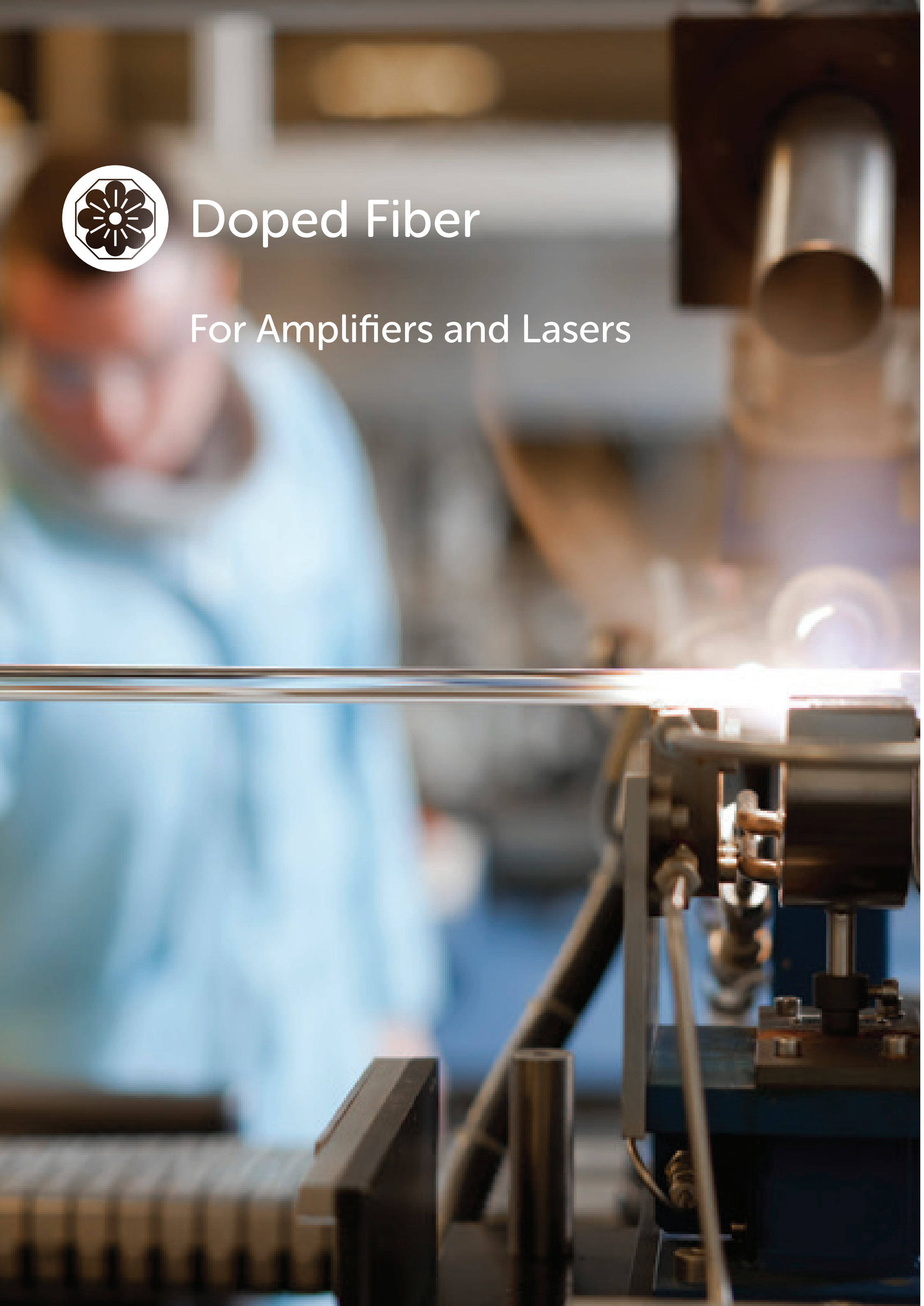
Products in this range:

Spun HiBi Fiber:
- Circularly birefringent
- Thermally stable
- Vibrationally stable
- Highest accuracies possible

Specifications

Spun HiBi

	SHB1250 (7.3/80) - 2.5mm	SHB1250 (7.3/80)	SHB1250 (7.3/125)	SHB1500 (8.9/125)
Operating Wavelength (nm)	1260 - 1510			1510 - 1650
Cut-Off Wavelength (nm)	1100 - 1250			1360 - 1500
Numerical Aperture	0.14 - 0.17			0.13 - 0.16
Mode Field Diameter (µm)	6.2 - 7.8 @1310nm			7.9 - 9.9@1550nm
Attenuation (dB/km)	≤5 @1310nm			≤3 @1550nm
Circular Beat-Length (mm)	63 - 135 @1310nm	63 - 110 @1310nm		86 - 160 @1550nm
Spin Pitch (mm) Nominal	2.5	4.0		
Proof Test (%)	1 (100 kpsi)			
Cladding Diameter (µm)	80 ± 1.5		125 ± 2	
Core Cladding Concentricity (µm)	≤1.0			
Coating Diameter (µm)	165 ± 5		245 ± 7	
Coating Type	Dual Layer Acrylate			
Operating Temperature (°C)	-55 to +85			



Doped Fiber

For Amplifiers and Lasers

Fibercore offers a number of different doped fibers including erbium doped fiber for various ‘C’ and ‘L’ amplifier configurations and ASE applications, all supported by our GainMaster™ simulation software to help you design even the most complex EDFAs

Typical applications:

- DWDM systems
- ‘Metro’ EDFA’s
- Low power fiber lasers
- CATV systems

Products in this range

Erbium Doped Fiber IsoGain™ Multichannel:
Erbium doped fibers for high channel-count DWDM systems

Erbium Doped Fiber AstroGain™:
Space grade erbium doped fibers

PM Erbium Doped Fiber:
Polarization maintaining erbium doped fiber

Triple-Clad Doped Fiber:
Triple-clad doped fiber for high power amplifiers for telecom and CATV

Dual Clad Erbium/Ytterbium Doped Fiber:
All-glass erbium/ytterbium co-doped dual clad fiber. Field-proven in commercial CATV systems

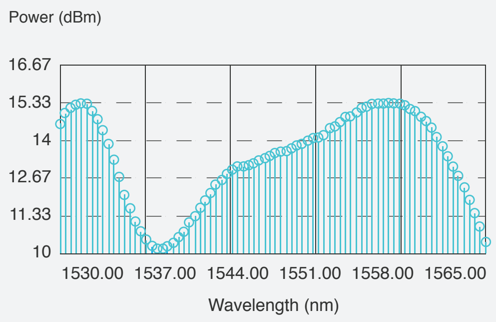
Isolating Wavelength Division Multiplexer CP-IWDM:
Designed for cladding pump applications with double clad erbium/ytterbium doped fiber

Other Doped Fibers:
Pump ranges at 780nm to 830nm and 900nm to 1064nm. Output ranges at around 1088nm and 1075nm to 1100nm. Ideal for student lab classes, low power fiber lasers and single channel amplifiers and fiber lasers

OEM Amplifier GainBlock:
Packaged passive optical unit for integration into amplifiers and fiber lasers

Erbium Doped Fiber IsoGain™

Erbium doped fibers for high channel-count DWDM systems



- Optimized core composition for high channel-count DWDM systems' EDFAs
- World-class leading conversion efficiency
- Suitable for C and L-band amplifiers

Typical applications:

- EDFAs/telecoms
- Fiber lasers
- Biomedical illumination
- Optical Coherence Tomography (OCT)
- LIDAR
- ASE light sources
- Gyros
- Current sensors
- Distributed sensor systems

Specifications

High Efficiency C-Band Erbium Doped Fibers

	I-4(980/125)	I-4(980/125)HC	I-4(980/125)HP	I-6(980/125)
Cut-Off Wavelength (nm)	870 - 970	1050 - 1320	1100 - 1320	870 - 970
Numerical Aperture	0.22 - 0.24		0.19 - 0.22	0.22 - 0.24
Mode Field Diameter (µm)	5.5 - 6.6 @1550nm	5.2 - 5.8 @1550nm	5.7 - 6.6 @1550nm	5.5 - 6.3 @1550nm
Absorption (dB/m) @1531nm	5.0 - 6.7	7.7 - 9.4		7.2 - 8.4
Proof Test (%)	1 (100 kpsi)			
Attenuation (dB/km) @1200nm	≤10			
Polarization Mode Dispersion (ps/m)	≤0.005			
Cladding Diameter (µm)	125 ± 1			
Core Concentricity (µm)	≤0.3			
Coating Diameter (µm)	245 ± 7			
Coating Type	Dual Layer Acrylate			
Operating Temperature (°C)	-55 to +85			

SECTION 8 - DOPED FIBER

Specifications continued

L-Band and C-Band Erbium Doped Fibers

	I-12 (980/125)	I-12 (980/125)HC	I-15 (980/125)HC	I-25 (980/125)
Cut-Off Wavelength (nm)	900 - 970	1200 - 1320		900 - 970
Numerical Aperture	0.21 - 0.23	0.23 - 0.26		
Mode Field Diameter (µm)	5.7 - 6.6 @1550nm	5.0 - 5.5 @1550nm	4.8 - 5.4 @1550nm	5.3 - 6.3 @1550nm
Absorption (dB/m)	14 - 21 @1531nm	17 - 21 @1531nm	27 - 33 @1531nm	35 - 45 @1531nm
Proof Test (%)	1 (100 kpsi)			
Attenuation (dB/km)	≤10 @1200nm			
Polarization Mode Dispersion (ps/m)	≤0.005			
Cladding Diameter (µm)	125 ± 1			
Core Concentricity (µm)	≤0.3			≤0.5
Coating Diameter (µm)	245 ± 7			
Coating Type	Dual Layer Acrylate			
Operating Temperature (°C)	-55 to +85			

Reduced Cladding Erbium Doped Fiber For Mini and Micro EDFAs

	I-15(980/80)HC	I-25H(1480/80)
Cut-Off Wavelength (nm)	1200 - 1320	900 - 1075
Numerical Aperture	0.24 - 0.26	≥0.30
Mode Field Diameter (µm)	4.8 - 5.4 @1550nm	3.8 - 4.7 @1550nm
Absorption (dB/m)	27 - 33 @1531nm	23 - 27 @1531nm
Proof Test (%)	2 (200 kpsi)	1 (100 kpsi)
Attenuation (dB/km)	≤15 @1200nm	≤30 @1200nm
Polarization Mode Dispersion (ps/m)	≤0.005	
Cladding Diameter (µm)	80 ± 1	
Core Concentricity (µm)	≤0.3	≤0.5
Coating Diameter (µm)	170 ± 5	160 ± 5
Coating Type	Dual Layer Acrylate	
Operating Temperature (°C)	-55 to +85	

EDFA simulation software, **GainMaster™** is available on fibercore.com

Erbium Doped Fiber AstroGain™

Space grade erbium doped fibers

- AG980H for high duty cycle space applications
- AG980L for low duty cycle space applications
- Optimized trivalent core matrix for space operation
- High efficiency designs for maximum electrical-to-optical power conversion
- High reliability mechanical design

Typical applications:

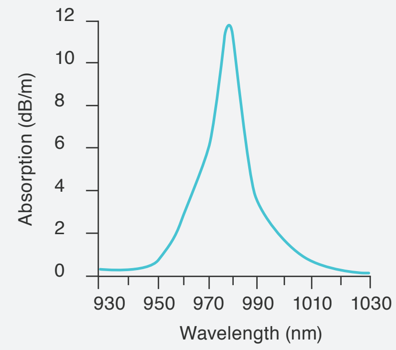
- Amplifiers for inter-satellite communications
- Light sources for earth observation missions
- Light sources and amplifiers for large scale sensing missions

Specifications

	AG980H	AG980L
Cut-Off Wavelength (nm)	900 - 970	
Numerical Aperture	0.22 - 0.24	
Mode Field Diameter (µm)	5.5 - 6.3 @1550nm	
Absorption (dB/m)	5.0 - 7.1 @1531nm	
Proof Test (%)	1 (100 kpsi)	
Attenuation (dB/km)	≤10 @1200nm	
Polarization Mode Dispersion (ps/m)	≤0.005	
Cladding Diameter (µm)	125 ± 1	
Core Concentricity (µm)	≤0.3	
Coating Diameter (µm)	245 ± 7	
Coating Type	Dual Layer Acrylate	
Operating Temperature (°C)	-55 to +85	

EDFA simulation software, **GainMaster™** is available on fibercore.com

PM Erbium Doped Fiber



Polarization maintaining erbium doped fiber

- DHB1500 matched to IsoGain™ I-12(980/125)
- DHB1500-LA designed with lower absorption for higher efficiencies
- Polarization extinction levels of up to -30dB over typical gain lengths of 8 - 14 meters
- Designed for 980nm pumping

Typical applications:

- EDFAs
- Coherent communications
- Amplified Spontaneous Emission (ASE) light source
- Fiber lasers

Specifications

	DHB1500	DHB1500-LA
Cut-Off Wavelength (nm)	860 - 960	
Numerical Aperture	0.22 - 0.26	0.22 - 0.24
Mode Field Diameter (µm)	5.1 - 6.7 @1550nm	5.5 - 6.7 @1550nm
Absorption (dB/m)	12 - 27 @1531nm	3.0 - 5.5 @1531nm
Beat-Length (mm) @633	≤4.0	
Proof Test (%)	1 (100 kpsi)	
Attenuation (dB/km)	≤20 @1200nm	≤15 @1200nm
Cladding Diameter (µm)	125 ± 1	
Core Cladding Concentricity (µm)	≤1.0	
Coating Diameter (µm)	245 ± 7	
Coating Type	Dual Layer Acrylate	
Operating Temperature (°C)	-55 to +85	

LA - Low absorption
EDFA simulation software, **GainMaster™** is available on fibercore.com

Triple-Clad Doped Fiber

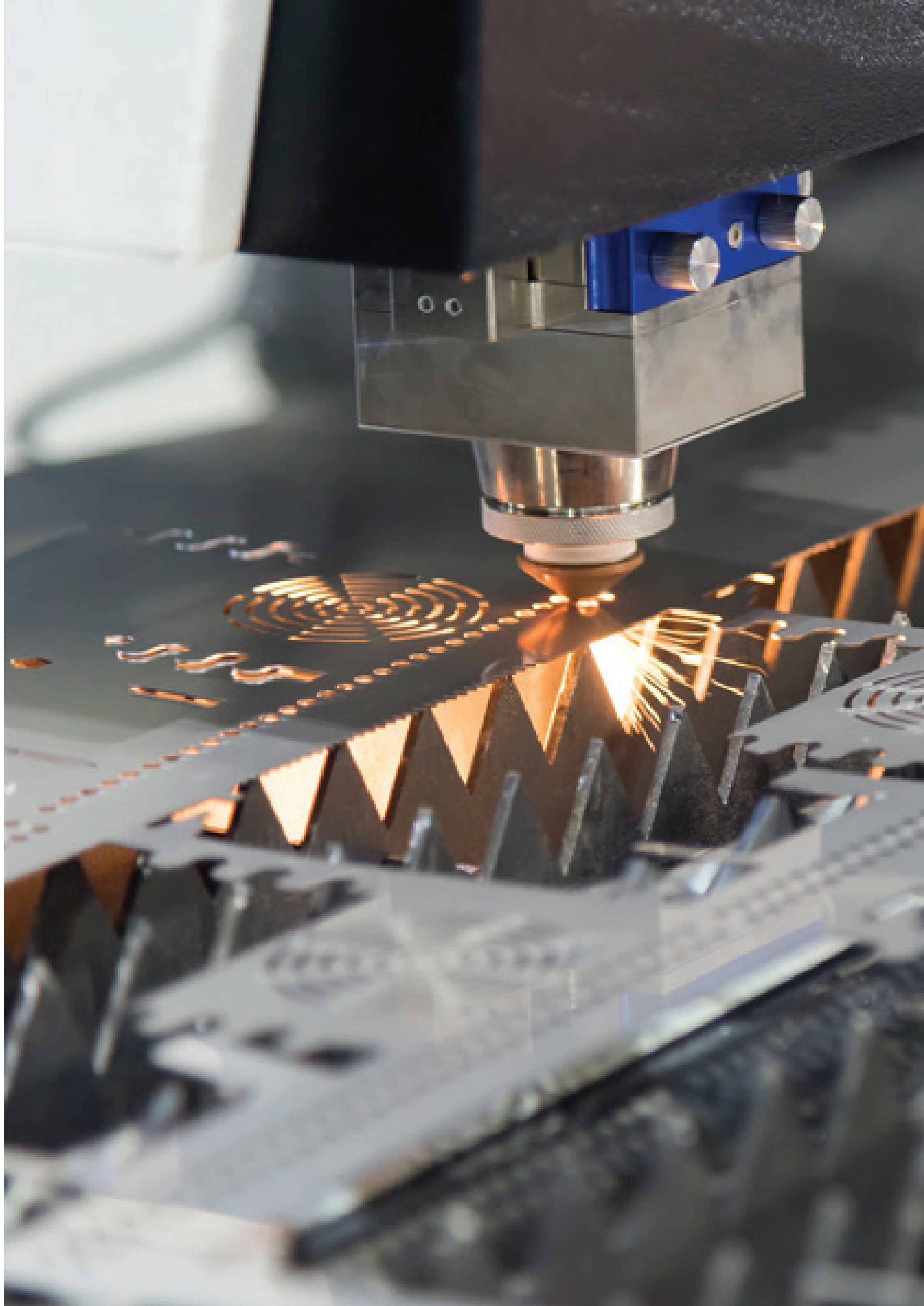
- Circular outer cladding for high splice repeatability
- Easy to strip, cleave and splice
- Octagonal inner structure optimizes pump conversion effectively
- High reliability

Typical applications:
- Fiber lasers
- LIDAR
- CATV

Specifications

	TC1060Y (10/125)0.08HD *	TC1500Y (6/125)HD	TC1500Y (11/125)HD
Laser Core			
Composition	Ytterbium	Erbium and Ytterbium	
Operating Wavelength (nm)	1060	1520 - 1570	
Numerical Aperture	0.07 - 0.08	0.20 - 0.23	0.10 - 0.13
Mode Field Diameter (μm)	-	5.6 - 7.2 @1550nm	9.6 - 12 @1550nm
Single-Mode Core Diameter (μm)	10 - 12	-	-
Cut-Off Wavelength (nm)	-	1290 - 1510	
Peak Core Absorption (dB/m)	-	75 ± 20 @1535nm	
Pump Guide			
Composition	Pure silica with F-doped silica cladding		
Mean Core Diameter (μm)	105 - 115		
Absorption (dB/m)	1.1 - 1.5 @915nm	0.6 - 0.9 @915nm	2.5 - 4.5 @915nm
Numerical Aperture of low index coating w.r.t. silica	0.45 (Nominal)		
General			
Proof Test Level (%)	1 (100 kpsi)		
Coating Type	Low index acrylate		
Cladding Diameter (μm)	125 ± 1		
Coating Diameter (μm)	245 ± 15		

*Passive DC variant available



Dual Clad Erbium / Ytterbium Doped Fiber

All-glass erbium/ytterbium co-doped dual clad fiber

- Optimized for efficient energy transfer
- Can be cleaved and spliced with standard equipment

Typical applications:

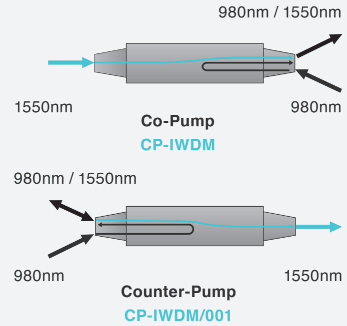
- High power Erbium Doped Fiber Amplifiers (EDFAs)
- Ytterbium/Erbium Doped Fiber Amplifier (YEDFA)
- Fiber lasers
- Light Radar (LIDAR)
- Cable Television (CATV)

Specifications

	CP1500Y	PMCP1500Y(6.0/125)0.2
Laser Core		
Composition	Phosphosilicate with erbium and ytterbium	
Operating Wavelength (nm)	1520 - 1570	
Numerical Aperture	0.20 - 0.22	
Mode Field Diameter (µm)	5.6 - 6.5 @1550nm	5.7 - 6.5 @1550nm
Cut-Off Wavelength (nm)	1290 - 1510	
Absorption (dB/m)	19 (nominal) @1550nm	
Pump Guide		
Composition	Pure silica with F-doped silica cladding	
Numerical Aperture	0.24 - 0.28	0.20 - 0.22
Mean Pump Guide Diameter (µm)	80 - 104	105
Absorption (dB/m)	1 (nominal) @940nm	
General Guide		
Proof Test (%)	1 (100 kpsi)	
Coating Type	Dual Layer Acrylate *	
Cladding Diameter (µm)	125 ± 1	
Coating Diameter (µm)	245 ± 7	250 ± 10
Operating Temperature (°C)	-55 to +85	

* High temperature acrylate variant available upon request

Isolating Wavelength Division Multiplexer CP-IWDM



- Combines a high-power multimode pump and a single-mode signal to a single SMM900 dual clad pump-signal fiber output
- Designed for cladding-pump applications with CP1500Y
- Provides multiplexing and isolation in one small package

Typical applications:

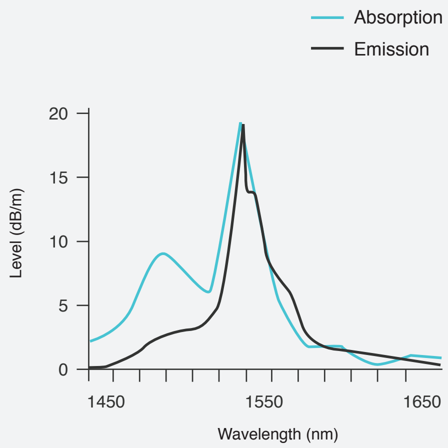
- High power Erbium Doped Fiber Amplifiers (EDFAs)
- Fiber lasers
- WDM systems
- Cable Television (CATV)

Specifications

General Mechanical	Package Size (mm)	5.5 x 54
	Operating Temperature (°C)	0 to +70
	Storage Temperature (°C)	-40 to +85
General Optical	Directivity (dB)	≥40
	Polarization Mode Dispersion (ps)	≥0.25
	Polarization Dependant Loss (dB)	≥0.1
	Isolation @23°C (dB)	≥31
	Signal Wavelength Isolation (dB) (1 to 3)	≥12
S Single-Mode Fiber	Cladding Diameter (µm)	125
	Operating Wavelength (nm)	1550
	Numerical Aperture nominal	0.12
	Max Input @1550nm (mW)	300
P Multimode Input	Cladding Diameter (µm)	125
	Pump Guide Diameter (µm) nominal	105
	Numerical Aperture nominal	0.22
	Max Input @970nm (mW)	5000
C Dual Clad Fiber	Cladding Diameter (µm)	125
	Single-Mode Cut-Off Wavelength (nm)	870 - 970
	Single-Mode NA	0.18 - 0.20
	Pump Guide Diameter (µm) nominal	105
	Pump Guide NA nominal	0.22

Other Doped Fibers

- Core pumped designs
- Emission at 1060, 1085 and 1550nm
- Splice compatible with fused taper couplers
- Low pump threshold designs



Typical applications:

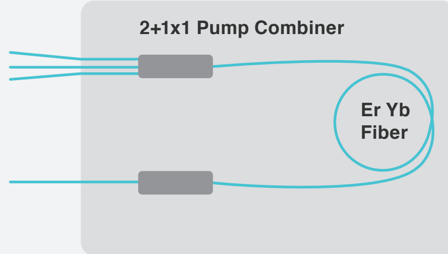
- Fiber lasers
- Amplified Spontaneous Emission (ASE) light source
- Erbium Doped Fiber Amplifier (EDFA)
- Cable Television (CATV)
- Educational kits

Specifications

	DF1000	DF1100	DF1500Y
Operating Wavelength (nm)	1085	1030 - 1100	1550
Cut-Off Wavelength (nm)	875 - 1025	800 - 900	950 - 1050
Numerical Aperture	0.18 - 0.22	0.14 - 0.17	0.20 - 0.24
Mode Field Diameter (µm)	3.9 - 5.0 @1085nm	5.1 - 6.3 @1085nm	5.3 - 6.8 @1550nm
Absorption (dB/m)	4.5 (nominal) @780nm 8.5 (nominal) @810nm 3.5 (nominal) @830nm	1500 (nominal) @977nm	1000 (nominal) @975nm 10 - 15 @1047nm 20 (nominal) @1532nm
Attenuation (dB/km)	≤20 @1085nm	≤50 @1200nm	≤200 @1200nm
Proof Test (%)	1 (100 kpsi)		
Cladding Diameter (µm)	125 ± 1		
Core Cladding Concentricity (µm)	≤0.5		
Coating Diameter (µm)	245 ± 7		
Coating Type	Dual Layer Acrylate		
Operating Temperature (°C)	-55 to +85		
Dopants	Neodymium (Nd)	Ytterbium (Yb)	Erbium / Ytterbium (Er/Yb)

OEM Amplifier GainBlock

Packaged passive optical unit for integration into amplifiers and fiber laser



- Compact package (121 x 83 x 13mm)
- Optional output power ranges
- Simplifies engineering requirements for high power amplifier development

Typical applications:

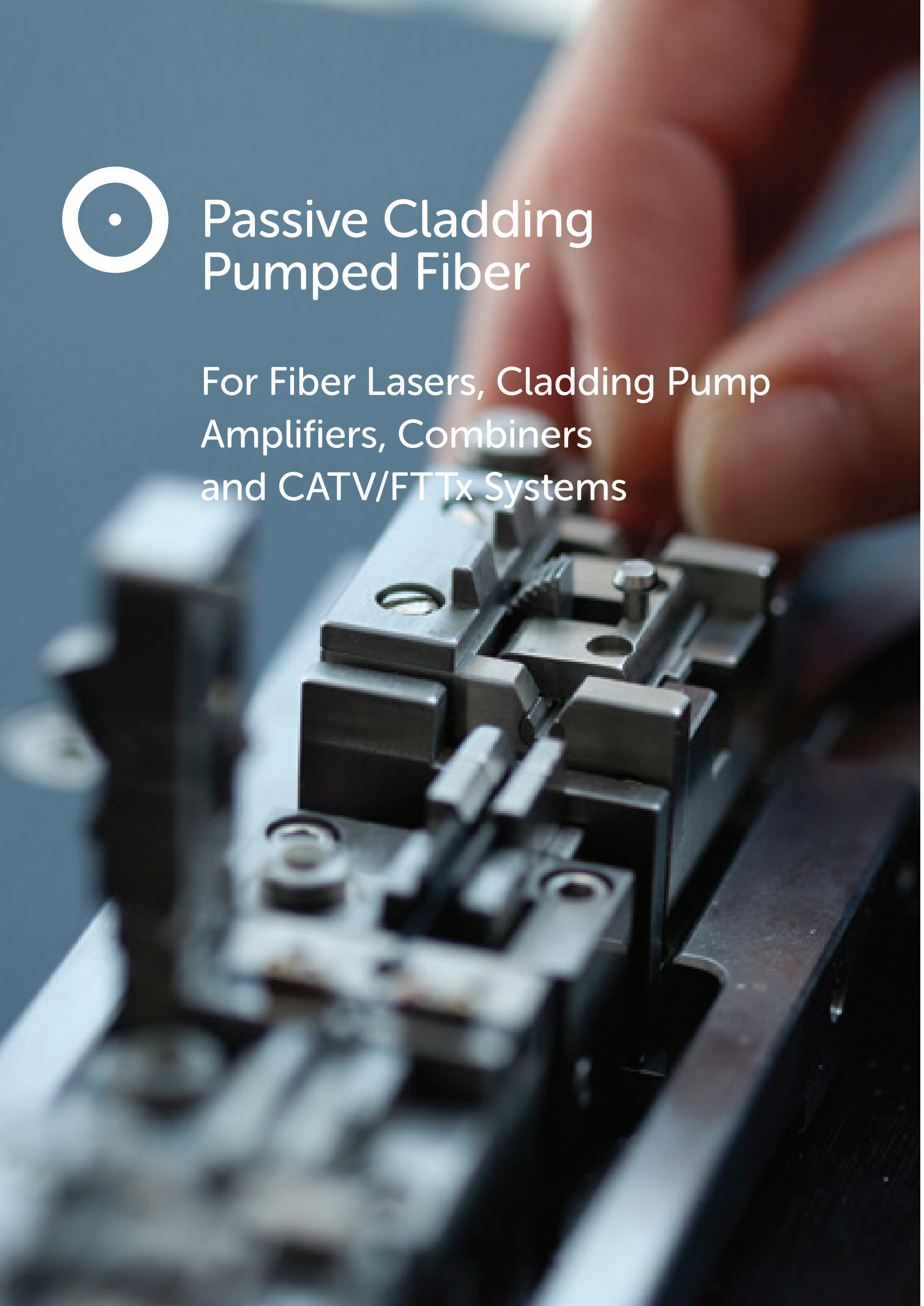
- CATV amplifiers
- LiDAR
- Fiber lasers

Specifications

	GB1550-3W
Operating Wavelength (nm)	1543 - 1565
Output Power (W)	≥3
Input Power (mW)	≥17
Pump Power to reach 3W @940nm (W)	9 typical
Pump Ports	MM 105/125 0.22 NA
Input Signal Port	G652 type SM fiber
Output Signal Port	G652 type SM fiber

Passive Cladding Pumped Fiber

For Fiber Lasers, Cladding Pump Amplifiers, Combiners and CATV/FTTx Systems



Fibercore offer two families of double clad fiber: low index polymer coated double clad fibers and an all silica double clad fiber

Typical applications:

- CATV & FTTx systems
- Cladding pump amplifiers
- Fiber lasers

Products in this range:

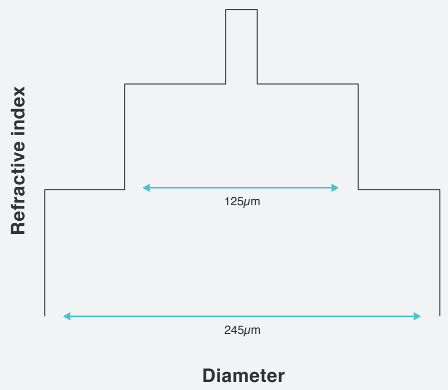
Low Index Double Clad Passive Fiber:

The low index coated double clad passive fibers are designed for high power amplifiers and fiber lasers at 1060nm and 1550nm where stable management of high power optical powers is crucial

All Silica Double Clad Fiber:

The all silica double clad fiber gives the benefit of not requiring low index recoating at the strip point. The fiber can be stripped, cleaved and spliced like any standard optical fiber

Low Index Double Clad Passive Fiber



- High power handling capability
- 1060nm and 1550nm variants
- Splice compatible with Fibercore doped fibers
- Range of core NAs available

Typical applications:

- High power amplifiers
- Fiber lasers
- LIDAR
- Biomedical probes
- Beam delivery
- Pump combiners

Specifications

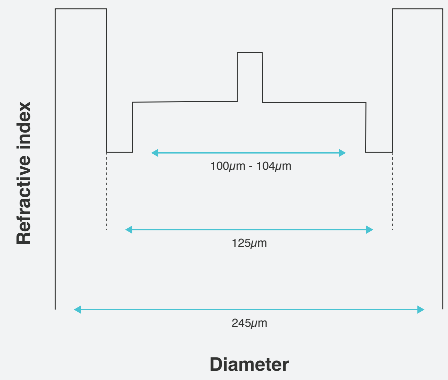
	DC1060(20/400) 0.065HD	DC1500(11/125) 0.12HD	DC1500(6/125) 0.21HD	DCSC (135/155/320)LI
Single-Mode Core				
Mode Field Diameter (µm)	-	9.5 - 11.5 @1550nm	5.6 - 6.5 @1550nm	-
Core Numerical Aperture	0.06 - 0.07	0.11 - 0.13	0.20 - 0.22	0.21 - 0.23
Cut-Off Wavelength (nm)	-	1360 - 1520	1290 - 1520	-
Core Attenuation (dB/km)	≤8 @1200nm	≤1 @1550nm		-
Core Concentricity (µm)	≤2.0	≤0.5		≤3
Core Diameter (µm)	18 - 22	9 (nominal)	5 (nominal)	134 - 137
Pump Guide				
Cladding Attenuation (dB/km)	≤15 @1095nm			-
Cladding Numerical Aperture	0.45 (nominal)			
Cladding Diameter (µm)	395 ± 5	125 ± 1		155 ± 1.5
General				
Operating Wavelength (nm)	1060	1550		800 - 1600
Coating Diameter (µm)	550 ± 15	245 ± 7		320 ± 20
Proof Test (%)	1 (100 kpsi)			
Coating Material	Low index fluoroacrylate			
Operating Temperature (°C)	-55 to +85			

LI - Low Index

SECTION 9 - PASSIVE CLADDING PUMPED FIBER

All Silica Double Clad Fiber

Double clad component fiber



- Designed for use with CP1500Y
- Combines both single-mode and multimode characteristics
- Compatible with SM980(4.5/125) and other 900/1500nm dual wavelength fibers

Typical applications:

- Pump combiners
- High power amplifiers (EDFA/YEDFA)
- Cable Television (CATV)
- Fiber lasers
- Biomedical probes

Specifications

	SMM900
Single-Mode Core	
Mode Field Diameter (µm)	6.5 - 8.2 @1550nm
Numerical Aperture	0.18 - 0.20
Cut-Off Wavelength (nm)	870 - 970
Attenuation (dB/km)	4 (nominal) @1550nm
Core Concentricity (µm)	≤0.75
Pump Guide	
Diameter (µm)	100 - 104
Numerical Aperture	0.24 - 0.28
General	
Cladding Diameter (µm)	125 ± 1
Proof Test (%)	1 (100 kpsi)
Coating Diameter (µm)	245 ± 7
Coating Type	Dual Layer Acrylate
Operating Temperature (°C)	-55 to +85

Multimode Fibers

Multimode fibers for sensing and telecommunications with specialized coatings for harsh environment

The multimode (MM) fibers are available in Graded Index (GRIN) variants with 50µm and 62.5µm germanium doped cores. In addition to these are pure silica core GRIN fibers specifically designed for long term use in downhole hydrogen environments as experienced in the Oil & Gas industry.

Products in this range:

Graded Index Multimode Fiber:

For high bandwidth sensing up to 150°C and 300°C

Graded Index Multimode Pure Silica Core Fiber:

For high bandwidth terrestrial sensing in hydrogen and/or radiation environments

Large Core Fiber:

Designed for pump power delivery

Graded Index Multimode Fiber

- High bandwidth
- Carbon coating options for reduced hydrogen sensitivity
- High temperature coatings for 150°C and 300°C
- 50µm and 62.5µm variants

Typical applications:

- DTS
- Telemetry
- Downhole monitoring

Specifications

	GIMM(50/125) *		GIMM(62.5/125)	
Operating Wavelength (nm)	800 - 1750			
Numerical Aperture	0.18 - 0.22		0.25 - 0.30	
Attenuation (dB/km)	@850nm	@1310nm	@850nm	@1310nm
High Temperature (HT)	≤3.2	≤1.0	≤3.2	≤1.0
Carbon High Temperature (CHT)	≤3.2	≤1.0	≤3.2	≤1.0
Polyimide (P)	≤4.0	≤2.0	≤4.0	≤2.0
Carbon Polyimide (CP)	≤4.0	≤2.0	≤4.0	≤2.0
Proof Test (%)	1 or 2 (100 or 200 kpsi)			
Bandwidth (MHz.km)	400/400 @850/1310nm		160/160 @850/1310nm	
Cladding Diameter (µm)	HT & P: 125 ± 1 CP & CHT: 125 ± 2			
Core Cladding Concentricity (µm)	≤2.0			
Coating Diameter (µm)	HT & CHT: 245 ± 15 P & CP: 155 ± 5			
Core Diameter (µm) (nominal)	50		62.5	
Coating Type	HT, P, CHT & CP			
Operating Temperature (°C)	HT & CHT: -50 to +150 P & CP: -50 to +300			

* Special easier to strip polyimide coating available for window stripping, for applications such as FBGs.

For Coatings Order Guide see pg. 36

SECTION 10 - MULTIMODE FIBER

Graded Index Multimode Pure Silica Core Fiber

- Coatings available for 150°C and 300°C
- Graded Index profile
- High bandwidth
- Hermetic coating option
- Hydrogen resistance

Typical applications:

- Distributed temperature sensing
- Pipeline monitoring
- Fire detection systems
- Production/injection monitoring
- DTS in hydrogen
- DTS in radiation

Specifications

	GIMMSC (50/125)HT	GIMMSC (50/125)CHT	GIMMSC (50/125)P	GIMMSC (50/125)CP *
Operating Wavelength (nm)	600 - 1750			
Numerical Aperture	0.18 - 0.22			
Attenuation (dB/km)	≤3.0 @850nm ≤1.2 @1310nm			
Proof Test (%)	1 or 2 (100 or 200 kpsi)			
Bandwidth (MHz.km)	300/300 @850/1310nm			
Cladding Diameter (µm)	125 ± 1	125 ± 2	125 ± 1	125 ± 2
Core Cladding Concentricity (µm)	≤2.0			
Core Diameter (µm) (nominal)	50			
Coating Diameter (µm)	245 ± 7		155 ± 5	
Coating Type	High Temperature Acrylate	Carbon High Temperature Acrylate	Polyimide	Carbon Polyimide
Operating Temperature (°C)	-50 to +150		-50 to +300	

* High Bandwidth / High NA variants available.

Large Core Fiber

- Wide range of coatings available
- High and low OH variants available, optimized for UV or visible/NIR applications
- Broad selection of core diameters for high power applications
- Highly customizable designs, alternative designs available by request
- ETFE and Nylon buffers available on request

Typical applications:

- Fiber laser beam delivery fiber
- Biomedical devices including optical power delivery within catheters
- Endoscopes
- Spectroscopy
- Pump diode pigtails

Specifications

	MMSC(102/125)0.26	MMSC(105/125)0.22	MMSC(106.5/125)0.22
Operating Wavelength (nm)	500 - 1600		
OH Level	Low (High OH for UV wavelengths also available)		
Numerical Aperture	0.22 - 0.26	0.20 - 0.24	0.20 - 0.24
Core Diameter (µm)	102 ± 2	105 ± 2	106 ± 2
Core Composition	Silica		
Proof Test (%)	1 (100 kpsi)		
Cladding Composition	Fluorosilicate		
Cladding Diameter (µm)	125 ± 1		
Coating Diameter (µm)	245 ± 7		
Coating Type	Acrylate		
Operating Temperature (°C)	-50 to +85		

Specifications continued

	MMSC (200/220)0.22	MMSC (300/330)0.22	MMSC (400/440)0.22	MMSC (600/660)0.22
Operating Wavelength (nm)	500 - 1600			
OH Level	Low (High OH for UV applications also available)			
Numerical Aperture	0.20 - 0.24			
Core Diameter (µm)	200 ± 4	300 ± 6	400 ± 8	600 ± 12
Core Composition	Silica			
Proof Test (%)	1 (100 kpsi)	0.7 (70 kpsi)		
Cladding Composition	Fluorosilicate			
Cladding Diameter (µm)	220 ± 2	330 ± 3	440 ± 4	660 ± 7
Coating Diameter (µm)	Acrylate: 330 Polyimide: 240	Acrylate: 450 Polyimide: 370	Acrylate: 560 Polyimide: 480	Acrylate: 840 Polyimide: 710
Operating Temperature (°C)	Acrylate: -55 to +150 Polyimide: -55 to +300			

Graded Index available upon request.
Polyimide is rated to cryogenic and high temperatures - contact Fibercore for further information.

FBGs

Fibercore offers two types of FBGs:

- **Femtosecond laser written FBGs for high mechanical strength and reduced hydrogen, radiation and UV photodarkening effects, suitable for use in harsh environments.**
- **Standard UV written FBGs for spectrally demanding applications, suitable for use in standard sensor and telecommunications environments.**

The femtosecond laser written FBGs are written through the coating, without the need to strip and recoat. This maintains the inherently high mechanical strength of the fiber, making FBGs ideal for high strain and high reliability applications. The femtosecond inscription method also allows FBGs to be written into non-photosensitive glass, allowing FBGs to be written into pure silica core fibers that have reduced attenuation sensitivity to hydrogen, radiation and UV. This allows the FBGs to be used in harsh environments that might be experienced in the Oil & Gas industry, nuclear environments and UV laser applications.

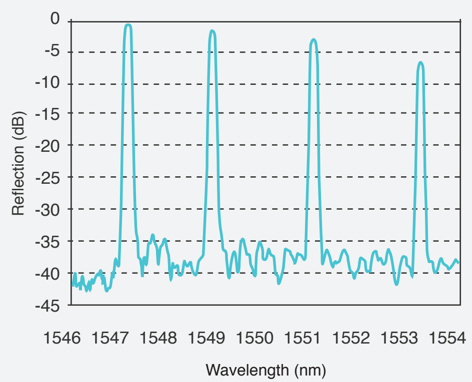
Standard UV written FBGs are available using the standard strip and recoat method. These FBGs offer a higher level of FBG specification with a greater flexibility on the spectral design, ideal for spectrally demanding applications in the sensing and telecommunications industries.

Typical applications:

- Temperature sensing
- Strain sensing
- Hydrophone and geophone acoustic sensing
- Laser wavelength locking
- Wavelength division multiplexing

FBGs

- High mechanical strength FBGs
- Hydrogen darkening resistant variants
- Radiation induced attenuation resistant variants
- UV photodarkening resistant variants
- Flexible spectral characteristics



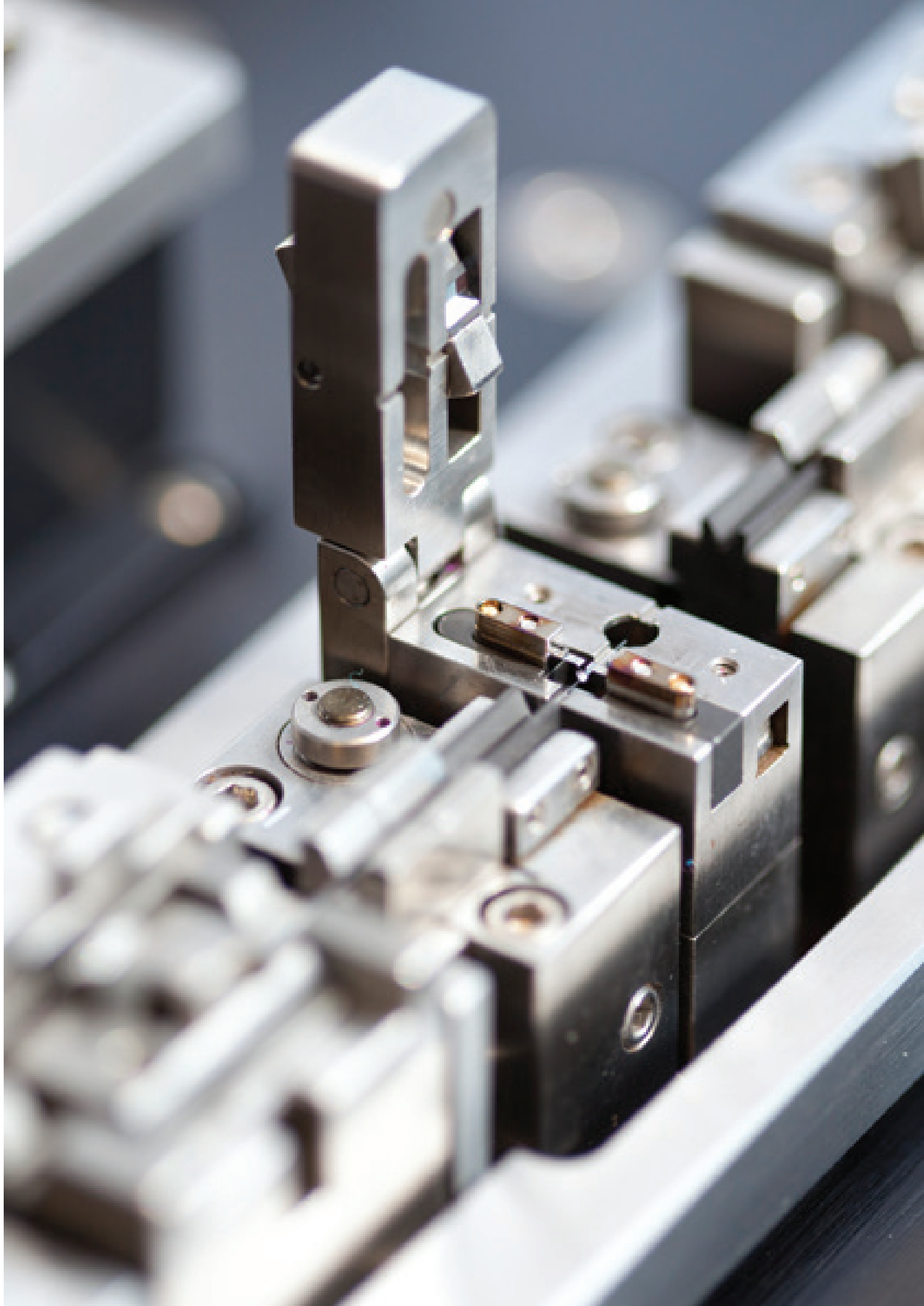
Typical applications:

- Temperature sensing
- Strain sensing
- Hydrophone and geophone acoustic sensing
- Laser wavelength locking
- Wavelength division multiplexing

Specifications

	Femtosecond FBG	UV Written FBG
Central Wavelength (nm)	790 - 850 1520 - 1590	970 - 1620
Wavelength Tolerance (nm)	±0.2 (standard) ±0.1 (optional)	±0.5 (standard) ±0.25 (optional)
Reflectivity (%)	<1 - >80	1 - 99
FWHM Bandwidth (nm)	0.3 - 1	0.1 - 3
FBG Length (mm)	≤150	1 - 25
FBG Profile	Uniform or Apodized	
Chirp	No	Not chirped (standard) Chirped (optional)
FBG Arrays	Optional	
Fiber Type	SM, MM	SM, PM
Fiber Cladding Diameters (μm)	125, 80	125, 80, 60, 50
Fiber Core Composition	Germanium Doped Pure Silica	Germanium Doped

Please note: Each parameter is inherently linked, therefore not all values are independently achievable.



At Fibercore, we understand you may require additional complementary products.

With this in mind we have put together a range of products to enhance the specialty optical fibers we offer. Should you need something else, simply ask and we will see what we can do.

There are six ranges of complementary products:

Fiber Optic Cables:

High performance cables engineered for harsh environments including Oil & Gas, Subsea and Avionics applications

- Downhole Fiber Optic Cable
- Slickline Fiber Optic Cable
- Wireline Fiber Optic Cable
- Fiber In Metal Tube
- Wire Armored Metal Tube

Ruggedized Sleeving and Buffering:

A range of sleeving options to ruggedize our specialty fibers for use in different environments

Pigtails and Patchcords:

All our fibers are available ruggedized and connectorized if required. Whether you wish to use SM, PM or MM Fiber, we can supply them as patchcords or pigtails to your specified length

Coreless Fiber:

For beam expanding and hermetic sealing

Quarter Wave Plate Fiber:

For manufacturing all-fiber quarter wave plates

Fiber Optic Cables

Specialty high performance cables engineered for harsh environments

In many applications, the optical fiber must be contained within a cable structure to ensure it survives the environment in which it is designed to be deployed. The best fiber in the World cannot overcome an improperly designed or manufactured cable. Fibercore brings over 20 years of cable design knowledge and manufacturing expertise to create cable designs that are customized to the rigors of specific environments. Fibercore specializes in the harshest of environments, ranging from cryogenic applications to the some of the hottest enhanced oil recovery wells. Fibercore extends to a network of manufacturing facilities, each with a particular strength and are not limited to in-house capabilities. For the most challenging applications, Fibercore delivers the best solution.

Goals in Designing Fiber Optic Cables

- Enable deployment of optical fiber
- Preserving optical transmission characteristics
- Optimizing the attribute to be measured
- Protecting from ecological/mechanical stress
- Providing reliable transmission throughout design life of cable

Cable Applications

Oil&Gas

Fiber optics are used for measuring a variety of attributes in an oil or gas well including: distributed temperature, distributed acoustic energy, and strain. This is also used alongside telemetry for fiber optic point sensors, such as pressure sensors and fiber Bragg gratings (FBGs). The types of cables used in the industry include: permanently installed fiber optic cables, logging cables (both wireline and slickline) and surface cables. With the information these types of cables can yield, the reservoir engineer can optimize the production from the oil or gas field thus improving the return on investment.

Industrial Sensing

There are many environments where knowledge of the temperature, strain, acoustic energy or other attributes is beneficial to the user. Applications such as pipelines, LNG facilities, waterways, industrial facilities, power cables, dams, power generation facilities like nuclear, coal or gas have used fiber optics successfully to gain insight into their operation. Each of these applications would use slightly different cable structures to provide not only the robustness necessary for long term use, but also to optimize the measurement of the attribute desired.

Products in this range:

Downhole Fiber Optic Cable
Slickline Fiber Optic Cable
Wireline Fiber Optic Cable
Fiber In Metal Tube
Wire Armored Metal Tube

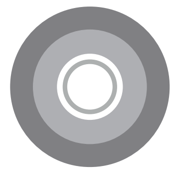
Downhole Fiber Optic Cable

Fibercore offers a range of designs for downhole fiber optic cable to meet the specific requirements of your oil or gas well. These types of cables are permanently installed either cemented in behind the casing or strapped to the production tubing. The optical fibers can be used to sense temperature and listen to well bore activities along the entire length of the cable and can be used for telemetry to point fiber optic sensors, such as pressure sensors and strain sensors.

This information provides key data to the reservoir engineer to better manage both the well and the reservoir. Design variables include type and number of optical fibers, metal types to deal with different corrosive environments, thicknesses of metal tubes to handle different pressure requirements and outer encapsulations for improved handling and abrasion resistance.

Typical Cable Cross Sections

Bare Downhole Cable



11mm Round Encapsulated Downhole Cable

11x11mm Square Encapsulated Downhole Cable

Specifications

Available options

Temperature Ratings (°C)	85 <150 <300 (Higher temperature ratings available upon request)
Outer Encapsulation Options (11mm round and 11x11mm square)	Polypropylene, Nylon, Santoprene, PVDF, ETFE, ECTFE, FEP

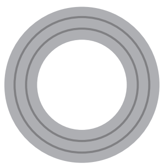
Tube Material	Outer Diameter (mm)	Inner Diameter (mm)	Wall Thickness (mm)
316L Stainless Steel	6.35 (0.250")	4.57 (0.180")	0.89 (0.035")
	6.35 (0.250")	3.86 (0.152")	1.245 (0.049")
Incoloy 825	6.35 (0.250")	4.57 (0.180")	0.89 (0.035")
	6.35 (0.250")	3.86 (0.152")	1.245 (0.049")

Slickline Fiber Optic Cable

Fibercore offers a range of slickline fiber optic cables suitable for logging wells directly or to be incorporated into a coiled tube. The portfolio utilizes a fiber in metal tube to house and protect the optical fibers and to ensure that the excess fiber length is controlled appropriately. As with the permanent downhole fiber optic cables, these fibers can be used to sense temperature and listen to well bore activities along the entire length of the cable and can be used for telemetry to point fiber optic sensors, such as pressure sensors and strain sensors that are incorporated into a tool. This information provides key information to the reservoir engineer to better manage the well and the reservoir. Design variables include: type and number of optical fibers, metal types to deal with different corrosive environments and thicknesses of metal tubes to handle different pressure requirements.

Typical Cable Cross Sections

Single Outer Tube Slickline



Multilayer Slickline

Specifications

Available options

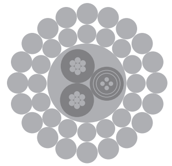
Temperature Ratings (ºC)	85 <150 <300

Tube Material	Outer Diameter (mm)	Inner Diameter (mm)	Wall Thickness (mm)
316L Stainless Steel	3.175 (0.125")	1.96 (0.077")	0.60 (0.024")
	4.000 (0.157")	2.50 (0.098")	0.75 (0.030")
Incoloy 825	3.175 (0.125")	1.96 (0.077")	0.60 (0.024")
	4.000 (0.157")	2.50 (0.098")	0.75 (0.030")

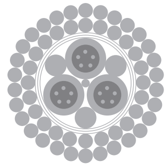
Wireline Fiber Optic Cable

Fibercore, in conjunction with selected partners, offer wireline logging cables that utilize Fibercore's hydrogen resistant, high temperature fibers. The optical fibers are be protected in a hermetic metal tube to provide the necessary protection for incorporation into the wireline cable. By working closely with our partners, Fibercore ensures that our designs meet the rigorous requirements of wireline logging cables in regards to temperature, corrosion resistance and strength. Optical fibers that are incorporated within these cables are used for telemetry to the tool, but can also be monitored for distributed temperature and acoustics, providing additional information for management of the well. In addition to the optical fibers, these cables can include insulated copper elements that can be used to power a tractor, components in the tool or for other sensors.

Typical Cable Cross Sections



Electro-Optic Wireline



All Optical Wireline

Specifications

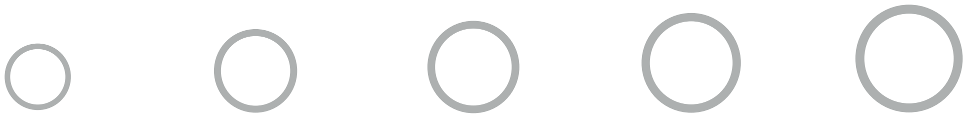
Available options

Temperature Ratings (ºC)	85 <150 <300 (Higher temperatures may be available upon request depending on application specifics)

Fiber In Metal Tube

Fibercore provides fiber in metal tubes (FIMTs) in different sizes, wall thickness and metal types. FIMTs are used in a variety of applications due to the hermeticity of the tube, strength, crush resistance, corrosion resistance and fiber density. Some of these applications include downhole fiber optic cables, logging cables, power cables, cryogenic applications, industrial monitoring, subsea cables and many more.

Typical Cable Cross Sections



0.84mm 2.4mm 3.2mm 4.0mm 6.35mm

Specifications

Available options

Temperature Ratings (°C)	85 <150 <300 (Higher temperature ratings available upon request)
Outer Tube Materials	304 Stainless Steel 316 Stainless Steel Incoloy 825 Inconel 625 (Other materials may be available upon request)
Diameter Range	0.84mm to 6.35mm (0.033” to 0.250”) (Diameters are available in 0.1mm increments)
Wall Thickness Range	0.127mm to 0.3mm (0.005” to 0.12”)

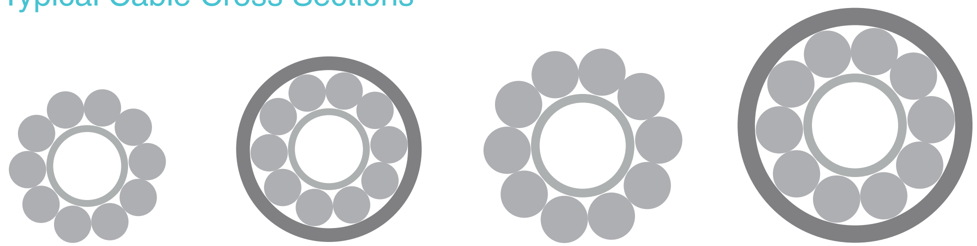
Outer buffering over the FIMT is available upon request.

Wire Armored Metal Tube

Fibercore provides fiber in wire armored metal tubes, enabling further robustness to the FIMT. FIMTs are prone to kinking and crushing, so are typically not used as a standalone product. With the addition of a high strength stranded wire layer over the FIMT, the handling characteristics improve tremendously along with crush performance and tensile strength.

The tube construction incorporates stainless steel components to provide improved corrosion resistance and an optional outer polymer jacket is also available upon request. Typical applications for wire armored metal tubes are for tactical applications (deploy/re-deploy), hydrological studies, industrial sensing, power cable monitoring and more applications.

Typical Cable Cross Sections



2.1mm 2.1mm Jacketed 2.8mm 2.8mm Jacketed

Specifications

Available options

Temperature Ratings (°C)	85 <150 <300 (Higher temperature ratings available upon request)
Construction	316L Stainless Steel tube 316L Stainless Steel wires Optional outer sheath (polyamide, other types upon request) Up to 8 optical fibers
Diameter Range	2.8mm to 4.8mm
Weight Range	18kg to 46kg
Maximum Operational Tension	750N to 2600N
Minimum Bend Radius	20xDiameter

Ruggedized Sleeving and Buffering

Protects valuable fiber

- Options available from 900µm tight buffer to 3mm diameter cable
- Available in blue (for PM fiber), orange (MM fiber) and yellow (for other fiber), or other colours by request
- Provide essential protection for indoor and outdoor applications
- Fully compatible with the Fibercore range of connectors

Enables rapid fabrication of short custom cables

- Furcation cable option
- Available without the fiber or connectors
- Nylon pull-cord allows ruggedization of virtually any fiber

Typical applications:

- Sensor cables
- Medical probes
- Beam delivery

Specifications

	900µm Hytrel®	LT3 (0.5/0.9)	LT3 (1.0/1.8)
Sheath Outer Coating (mm)	0.9	2.8	
Sheath Material	Hytrel®	PVC (blue)	
Loose Tube Outer Diameter (mm)	-	0.9	1.8
Loose Tube Inner Diameter (mm)	-	0.5	1.0
Loose Tube Material		Hytrel® (with fiber)	
Reinforcement	-	Aramid Yarn	
Pull Cord	No	Yes (Nylon filament)	

Pigtails and Patchcords

For specialty single-mode fiber, multicore fiber and polarization maintaining fiber

- Reliable, demountable connection for ease of fiber use
- Choice of Generic or Premium for optimum PM Fiber performance

Typical applications:

- Fiber laser beam delivery
- Oil & Gas sensor cables
- Medical probes
- High bit rate data transmission

Connector Specifications

Type	Single-Mode Connectors		Polarization Maintaining Connectors			
			Premium		Generic	
End Face Angle	0°	8°	0°	8°	0°	8°
Insertion Loss (dB)	0.2 Typical (0.4 Max)				0.4 Typical (0.5 Max)	
Return Loss (dB)	50	65	50	60	50	60
Repeatability (dB)	±0.2					
Service Life (Cycles)	500					
Extinction Ratio (dB)	Not applicable		28 typical (25 min)		25 typical (20 min)	22 typical (20 min)
Keyway Size	Narrow 1.95 ± 0.05mm Wide 2.15 ± 0.05mm Multicore Fiber 2.0 ± 0.02mm					
Temperature Range (°C)	-40 to +80					
Connector Types	DIN UPC, E2000 APC, E2000 UPC, FC UPC, FC APC, LC APC, LC UPC, SC UPC, SMA, ST UPC					

Contact Fibercore for options and characteristics for Multicore Fiber connectors.

For sleeving options and selection guide see data sheet www.fibercore.com/product/pigtails-and-patchcords

Coreless Fiber

For beam expanding and hermetic sealing

- Allows beam expansion at the end face of a small core fiber
- Larger MFD reduces end face power density
- Reduces power density related end effects
- Reduces Fresnel back reflection coupling efficiency
- Hermetically seals Photonic Crystal Fibers (PCF) and holey fibers

Typical applications:

- Fiber lasers
- Laser diodes
- Microscopy
- Distributed acoustic sensors (DAS)

Specifications

	MM125	MM125HT
Cladding Diameter (μm)	125 ± 1	
Coating Diameter (μm)	245 ± 15	
Proof Test (%)	1 (100 kpsi)	
Coating Type	Acrylate	High Temperature Acrylate
Temperature Range (°C)	-55 to +85	-55 to +150

Quarter Wave Plate Fiber

For manufacturing all-fiber quarter wave plates

- Capable of converting linear polarization to circular polarization
- Designed for optical compatibility with Spun HiBi current sensor fibers
- High splice compatibility with Fibercore sensor fibers

Typical applications:

- Current sensors
- Polarimetric systems
- Quarter wave plates

Specifications

	HB1250(7.3/125)QW	HB1500(8.9/125)QW
Operating Wavelength (nm)	1310	1550
Cut-Off Wavelength (nm)	≤1270	1200 - 1500
Numerical Aperture	0.13 - 0.17	
Mode Field Diameter (μm)	6.2 - 8.4 @1310nm	7.9 - 9.9 @1550nm
Attenuation (dB/km)	≤5 @1310nm	≤5 @1550nm
Beat-Length (mm) @633nm	3.0 - 4.3	
Proof Test (%)	1 (100 kpsi)	
Cladding Diameter (μm)	125 ± 1	
Coating Diameter (μm)	245 ± 15	
Core Concentricity (μm)	≤1	

Test, Measurement and Other Laboratory Services

As a leading manufacturer of specialty fiber, Fibercore maintains a state-of-the-art test and measurement laboratory

Fibercore have combined over 30 years' experience in the industry with an unsurpassed reputation for technical expertise and service. The facility enables Fibercore to provide a variety of services.

We offer multiple options in this group:

Hydrogen Testing:
Custom built facility to fully evaluate the performance of optical fibers

Qualification and Reliability Testing:
Full testing facilities available from our highly skilled team of experts using our dedicated T&M laboratory

Fiber Test and Measurement:
Detailed test facilities in accordance with ISO 10012-1 (BS5781) and our BS EN ISO9001(2008) Quality System, undertaken by our team of experts

Fusion Splicing:
For PM and rare-earth doped fibers

Development Projects and Custom Fiber:
If the success of your project relies on the availability of a custom single-mode optical fiber, provided that it is based on silica-glass. Fibercore has the capability to develop that fiber on your behalf

Custom and Multifiber Cables:
Fibercore can supply its range of specialty optical fibers, custom-cabled to suit highly complex deployments and demanding environments

Fibercore's commitment to...

Quality: ISO 9001:2015

Fibercore is dedicated to supplying customers with exceptional quality products, service, and support. Accredited to ISO9001, Fibercore maintains traceability to all critical elements and materials in the fiber that is manufactured. The unique identification of every length of fiber ensures that all test and manufacturing data can be easily accessed.

Fully documented procedures and instructions provide consistency and uniformity of products. Controlled test plans implemented through calibrated equipment guarantees the fiber is matched to your application.

Environment: ISO 14001:2015

Fibercore is committed to reducing its environmental impact, be this through the prevention of pollution or the reduction of resource and energy use.

An ISO14001 certified management system was installed by in-house staff to manage all aspects of Fibercore's environmental management including the permit under which Fibercore operates.

Health & Safety: OHSAS 18001:2007

Fibercore continues its commitment to quality by the addition of an Occupational Health & Safety Management System to our procedures.

RoHS 3 and REACH

Our products all comply with RoHS 2 requirements and with REACH

Conflict Minerals

Fibercore is committed to ensuring that neither its products or the processes involved in their manufacture contain or utilize minerals sourced from Conflict Regions. Fibercore will continue to review its position under Section 1502 of the US Dodd-Frank Wall Street Reform and Consumer Protection Act.

Copies of these certificates, as well as our policies can be downloaded from our website at **www.fibercore.com** or contact us at **info@fibercore.com**

A-Z of Acronyms

AOC	Active Optical Cable
ASE	Amplified Spontaneous Emission
C	Carbon and Acrylate
CATV	Cable Television
CHT	Carbon and High Temperature Acrylate
CP	Carbon and Polyimide
DAS	Distributed Acoustic Sensing
dB	Decibel
DPS	Distributed Pressure Sensing
DSS	Distributed Strain Sensing
DTS	Distributed Temperature Sensing
DWDM	Dense Wavelength Division Multiplexing
EDFA	Erbium Doped Fiber Amplifier
EFL	Excess Fiber Length
EMI	Electromagnetic Interference
FBG	Fiber Bragg Grating
FC/APC	Ferrule Connector / Angled Physical Contact
FIMT	Fiber In Metal Tube
FOG	Fiber Optic Gyroscope
FTTx	Fiber To The x
Ge	Germanium
GRIN	Graded Index
HI	High Index
HiBi	High Birefringence
HT	High Temperature Acrylate
IR	Infrared
IWDM	Isolating Wavelength Division Multiplexer
LCT	Laser Communications Terminals
LDA	Laser Doppler Anemometer
LIDAR	Light Detection and Ranging
MFD	Mode Field Diameter
MM	Multimode
NA	Numerical Aperture
nm	Nanometer
OBS	Ocean Bottom Seismic
OCT	Optical Coherence Tomography
OD	Outer Diameter
OEM	Original Equipment Manufacturer
P	Polyimide
PCF	Photonic Crystal Fibers
PER	Polarization Extinction Ratio
PM	Polarization Maintaining
PS	Photosensitive
RIA	Radiation Induced Attenuation
RIP	Refractive Index Profile
RLG	Ring Laser Gyroscope
RT	Radiation Tolerant
SAGD	Steam Assisted Gravity Drainage
SAP	Stress Applying Part
SB	Short Beat-Length
SC	Silica Core
SDM	Space Division Multiplexing
SHM	Structural Health Monitoring
SM	Single-Mode
SMF	Single-Mode Fiber
SM-SC	Single-Mode Pure Silica Core
µm	Micron
UV	Ultraviolet
VSP	Vertical Seismic Profiling
WDM	Wavelength Division Multiplexer
YEDFA	Ytterbium Erbium Doped Fiber Amplifier

Visit **fibercore.com/fiberpaedia** for our encyclopedia of industry terms/knowledge base.

Equations

NA, Cut-Off and MFD

$$NA = 2.405\left(\frac{\lambda_c}{\pi \times MFD}\right)\left[0.65 + \left(\frac{1.619}{2.405\left[\frac{\lambda_c}{\lambda_{op}}\right]^{3/2}}\right) + \left(\frac{2.879}{2.405\left[\frac{\lambda_c}{\lambda_{op}}\right]^{6}}\right)\right]$$

$$\lambda_c = \frac{2\pi a \times NA}{2.405}$$

$$MFD = a\left[0.65 + \left(\frac{1.619}{2.405\left[\frac{\lambda_c}{\lambda_{op}}\right]^{3/2}}\right) + \left(\frac{2.879}{2.405\left[\frac{\lambda_c}{\lambda_{op}}\right]^{6}}\right)\right]$$

Refractive Index and NA

$$\Delta n = n_{core} - n_{clad}$$

$$NA = \sqrt{n_{core}^2 - n_{clad}^2}$$

Birefringence and Beat-Length

$$B = n_{slow} - n_{fast}$$

$$B = \frac{\lambda}{L_p}$$

V-value

$$V = \frac{2\pi a \times NA}{\lambda_{op}}$$

$$V = 2.405\frac{\lambda_c}{\lambda_{op}}$$

Scale - mW vs. dBmW

$$\text{ratio [dB]} = 10 \times \log_{10}\left(\frac{P_A}{P_B}\right)$$

$$P\,[\text{dBmW}] = 10 \times \log_{10}\left(P\,[\text{mW}]\right)$$

Key

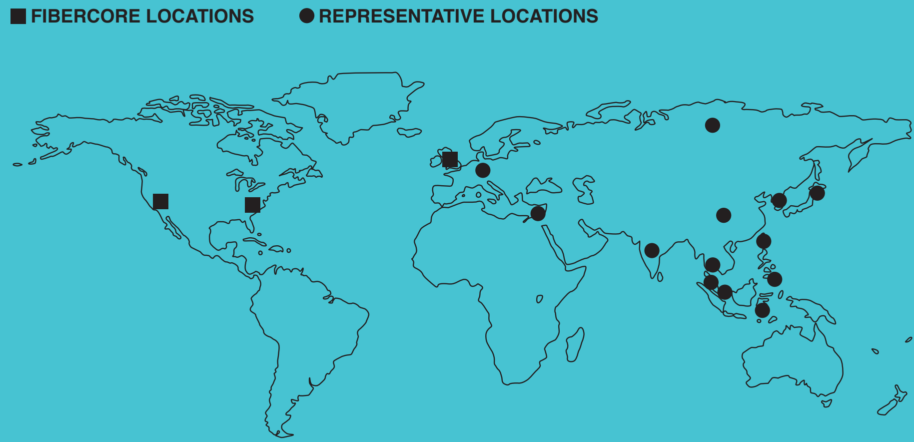
- a = core radius
- B = birefringence
- λ_c = 2nd order cut-off wavelength
- λ_{op} = operating wavelength
- n = refractive index
- L_p = beat-length
- P = power
- V = V-value

Notes

REPRESENTATIVES

We have representatives in the following countries. The most up to date information including contact details can be found on our website.
Fibercore.com/representatives

CHINA
GERMANY
INDIA
INDONESIA
ISRAEL
JAPAN
MALAYSIA
PHILIPPINES
RUSSIA
SINGAPORE
SOUTH KOREA
TAIWAN
THAILAND



UK AND WORLDWIDE

Fibercore House
University Parkway
Southampton Science Park
Southampton
Hampshire
SO16 7QQ
UK

T: +44 (0)23 8076 9893
F: +44 (0)23 8076 5356
sales@fibercore.com

NORTH AMERICA

Fibercore
T: +1 831 383 1028
salesus@fibercore.com

GLOBAL OIL & GAS

Fibercore
T: +1 607 483 3161
oilandgas@fibercore.com

Visit us at Fibercore.com