engionic
Femto Gratings

FEMTOSECOND-LASER-WRITTEN FIBER BRAGG GRATINGS

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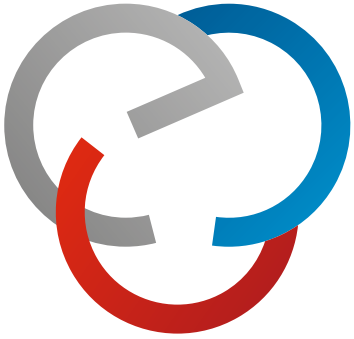
Widest range of Fiber Bragg Grating specifications. Broadest variety of fibers. Manufactured in the industry leading production process.



The engionic Femto Gratings GmbH was founded in 2013 and is the first commercial supplier of femtosecond-laser-written Fiber Bragg Gratings (FBG) worldwide. engionic Femto Gratings provides FBG, that open up completely new sensing possibilities for a wide range of industrial and medical sensing applications. Whether you are looking for individual sensing solutions or highly specialized applications, engionic Femto Gratings guarantees high customer value in terms of quality and cost efficiency.

In contrast to conventional FBG solutions, we can write FBG into all optical transparent fiber materials with a wide range of specifications and a broad variety of fiber coatings. Our available fibers cover high-end specialty fibers as well as low-cost commodity fibers. Our production process is highly automated for large quantities, but at the same time it is flexible enough to realize customized, single unit products. The manufacturing setup enables us to produce customer-specific FBG on short notice with minimum delivery times.

engionic Femto Gratings is part of the engionic Group.

PRODUCTS

The flexible fs-writing process of engionic Femto Gratings offers an outstanding variety of FBG specifications. Besides the standard FBG portfolio for sensing applications, engionic Femto Gratings offers highly customized FBG production for special applications.

In co-operation with our sister company engionic Fiber Optics GmbH, which is specialized in the assembly of fiber optic light guides and sensors, calibrated and assembled sensors and complete sensing solutions, including the sensor and interrogation system, can be provided.

ADVANTAGES

- **Highest specification variety** with a comprehensive portfolio of product specifications, the realization of customer individual requirements and the FBG inscription into customer specific fibers
- **Highest production capacity** based on a large volume production process with multiple-shift operation and an industry leading degree of automation
- **Highest efficiency** due to a high degree of automation and large scale production that results in a significantly higher efficiency compared to other FBG manufacturing technologies
- **Highest quality** with inline quality control, reporting and documentation, inline strain tests and industry leading delivery lead times

LEADING FS-LASER-WRITTEN FBG TECHNOLOGY

The FBG is an optical filtering device that reflects light on a specific wavelength and is located within the core of an optical fiber waveguide. Due to the wavelength dependence on temperature and strain, FBGs are widely used for optical sensing.

engionic Femto Gratings uses a special inscription technology for FBGs, based on infrared fs-laser technology. The laser is focused into the core of the fiber and induces local refractive index changes in a point-by-point writing process. The process is highly nonlinear and therefore basically independent of the fiber material, which means that doping the fiber is not required. The FBGs can be written in radiation insensitive fibers and special pure core fibers for harsh environments.
The gratings are type II gratings that withstand temperatures of up to 1,000°C.

As the process is applied through the coating of the fiber, no stripping and recoating is required, resulting in superior tensile strength of the FBGs.

BENEFITS

compared to conventional FBGs

- ✓ Type II gratings survive temperatures of up to 1,000°C, compared to UV-inscribed FBGs which fade-out at approx. 250°C
- ✓ Highly cost efficient multipoint/ sensor array production
- ✓ Immunity to humidity and radioactivity
- ✓ Significantly higher tensile strength compared to strip and recoat technology
- ✓ Low polarization (0-5pm) for high resolution measurements compared to draw tower gratings and very low scattering losses (< 0,2dB)
- ✓ Significantly higher reflectivity and lower fiber cost compared to draw tower technology
- ✓ Highest spatial resolution due to dense sensor spacing (minimum FBG distance 2mm)
- ✓ Direct writing process into customer specific fibers possible
- ✓ Industry leading specification variety

+

The fully automated manufacturing technology provides the highest possible flexibility in terms of customer individual FBG specifications and production volumes - from one up to thousands of units. Furthermore, customer orders are produced within shortest lead times in the industry.

BENEFITS
compared to other sensing technologies

✓ **Immunity to electromagnetic fields**
FBGs are completely immune to interference from electromagnetic, electrostatic or radio frequency sources. It is possible to install them in locations with severe electrical noise such as power generation and transmission plants. Furthermore, FGBs are 100% intrinsically safe and can be used in the most explosive environments.

✓ **Applicable in harsh environments**
Due to the completely passive nature of FBGs, without using any electronic components, they are capable of operating under extreme temperatures. They offer long-term stability in extreme environments where electronic sensors are unable to operate.

✓ **Multiplexing**
Several thousand FBGs can be written into one optical fiber and simultaneously interrogated by one multi-channel instrument. This provides a very low-cost mechanism compared with technologies where every sensor has a dedicated channel.

✓ **Small Size**
The fiber into which FBGs are written is very small and lightweight. That means that many sensors can be applied to a structure with very little intrusion. Uniquely, a fiber sensor array can be embedded inside a composite material in order to monitor internal strain, temperature and damage with no effect on the structural performance of the composite.

BROAD RANGE OF PRODUCTS AND SERVICES

SINGLE FBG AND FBG ARRAYS

Our Femto Gratings are of superior tensile strength, withstand temperatures of up to 1,000°C and can be immune to radioactivity and humidity. The product line of FemtoPlus® Gratings additionally provides extremely low polarization (0-5pm) for high resolution measurements and very low scattering loss (<0,2dB) for extra-long array configurations. Hundreds of FGBs can be integrated into one single sensor array to allow multipoint measurements along distances of many kilometers.

FIBER BRAGG GRATING SPECIALITIES

CHIRPED FIBER BRAGG GRATINGS

Due to a variation of the refractive index modulation within the FBG along the fiber, an optical chirp of the wavelength is generated. This FBGs have a broad bandwidth of several nm and a flat top profile instead of the typical Gaussian shape. Typical applications are WDM 1300/1550nm band rejection filter, ASE filtering, noise suppression or in-fiber mirrors.

WAVELENGTHLOCKER, LASER DIODE STABILIZERS (LDS)
A very common application of FBGs is the stabilization of DFB laser modules. They are applicable to pump lasers for EDFAs 980/1480nm as well as for WDM modules for the 1300/1550nm band. Typical applications include also in-fiber resonators for RAMAN fiber lasers or tunable laser modules.

WAVELENGTH SELECTIVE FILTERS FOR TELECOMMUNICATIONS
FBGs are widely used in optical communications as in-fiber narrow band filters, e.g. for DWDM technology for 2.5 Gbps and 10 Gbps systems, ASE filtering or Add/Drop-multiplexers for 100GHz and 50GHz channel spacing.

FABRY-PEROT-CAVITIES
The fiber Fabry-Perot Interferometer is a pair of matching FBGs. In this case an extremely small phase shift can be detected; for sensing purposes and to evaluate small vibrations or acoustic signals. By coating the fiber between the gratings with an electric, magnetic or acoustic enhancing coating small changes can be measured.

SPECIAL FIBERS
Special fibers show advantages for certain applications. Sapphire fibers for example have extreme temperature stability and therefore expand the sensing range above 1,000°C. Radiation hard fibers withstand high radiation and can be used in nuclear environments.

CUSTOMER INDIVIDUAL HIGH VOLUME PRODUCTION LINES

For recurring high volume FBG demands, we develop customer specific production processes to achieve the maximum of production efficiency. We agree on an investment and development program with defined efficiency targets and within 12 month we start production of your high volume production line with dedicated capacity at industry leading costs. This approach is ideally suited for applications that have successfully completed the development and proof-of-concept phase and are ready for capturing the high volume market. Even technically demanding FBG or FBG array specifications can be achieved and industrialized providing our customers with a strong and lasting competitive advantage, security of supply, since production capacity is exclusively secured and lowest possible FBG costs.

INDIVIDUAL SPECIFICATIONS

FBG SPECIFICATIONS

- Bragg wavelength 1460nm-1640nm (others on request)
- Wavelength tolerance <0.2 nm
- FWHM: 0.1nm to several nm
- Reflectivity: 10^{-4} to 99%
- Sideband suppression (apodized): up to 20dB
- FBG length: 0,06mm to 12mm
- Low polarization dependence option from 0-5pm
- Low scattering loss option of <0,2dB

ARRAY SPECIFICATIONS

Wavelength Division Multiplexed Arrays (WDM)

- For spectrometer, scanning laser, tunable filter or AWG interrogation systems
- Typically up to approx. 50 FBGs per array, depending on interrogation unit bandwidth and required measurement range
- Each FBG with individual wavelength and reflectivity typically between 30% and 70%
- Narrow FBG spacing starting from 1mm possible

Time Division Multiplexed Arrays (TDM)

- For OTDR and OFDR interrogation systems
- Number of sensors typically in the range of several thousand FBGs per sensing cable
- Each FBG with similar wavelength and reflectivity typically between -45dB and -35dB
- Narrow FBG spacing starting from 1mm possible

Combined WDM/TDM Arrays

- For special combined WDM/TDM interrogation units
- Number of sensors typically in the range of several 100 FBGs per sensing cable
- Repeated wavelength series of typically 2 to 50 different wavelengths in 10 to 100 repetitions
- FBG reflectivity typically between 1% and 50%
- Typical FBG spacing between 20mm and 2m

FIBER OPTIONS

- Standard single mode fiber (germanium doped fibers)
- Bend insensitive fiber (e.g. trench fibers)
- Pure silica core fiber
- Radiation hard fiber (e.g. fluorine doped fiber)
- Special fibers and materials like sapphire or laser fiber

FIBER COATINGS

- Acrylate coating (standard up to 85°C & high temperature acrylate up to 180°C)
- Polyimide (PI) coating for temperatures up to 300°C (400°C short term)
- Carbon coating for hermetic sealing
- Fiber ruggedization with extra buffers (e.g. PEEK)
- Custom coating options on request

STANDARD SPECIFICATIONS

Besides customer specific FBG solutions, engionic Femto Gratings offers an attractive range of standardized fs-written FBGs. Due to the worldwide leading, automated manufacturing technology, engionic Femto Gratings can provide high customer value in terms of quality and efficiency.

FEMTO Grating

- Standard fs-laser-written FBG

Item No.	Item Description	Wavelength	Reflectivity	FWHM	SLSR	Length
Femto.20.N.SMAC	Single FBG | Low Reflectivity | Narrow	1460-1640	20%	0,25 nm	>15 dB	7 mm
Femto.50.N.SMAC	Single FBG | Medium Reflectivity | Narrow	1460-1640	50%	0,25 nm	>15 dB	7 mm
Femto.70.N.SMAC	Single FBG | High Reflectivity | Narrow	1460-1640	70%	0,25 nm	>15 dB	7 mm
Femto.20.M.SMAC	Single FBG | Low Reflectivity | Mid	1460-1640	20%	0,40 nm	>15 dB	4 mm
Femto.50.M.SMAC	Single FBG |Medium Reflectivity | Mid	1460-1640	50%	0,40 nm	>15 dB	5 mm
Femto.70.M.SMAC	Single FBG | High Reflectivity | Mid	1460-1640	70%	0,40 nm	>15 dB	6 mm
Femto.20.W.SMAC	Single FBG | Low Reflectivity | Wide	1460-1640	20%	0,70 nm	>15 dB	2 mm
Femto.50.W.SMAC	Single FBG | Medium Reflectivity | Wide	1460-1640	50%	0,70 nm	>15 dB	2 mm

FEMTO*Plus*® Grating

- Low polarization dependence from 0-5pm
- Low scattering loss <0,2dB

Item No.	Item Description	Wavelength	Reflectivity	FWHM	SLSR	Length
FemtoPlus.05.N.SMAC	FemtoPlus | Ultra-low Reflectivity |Narrow	1460-1640	5%	0,30 nm	>12 dB	4 mm
FemtoPlus.20.N.SMAC	FemtoPlus | Low Reflectivity | Narrow	1460-1640	20%	0,25 nm	>15 dB	4 mm
FemtoPlus.40.N.SMAC	FemtoPlus | Medium Reflectivity | Narrow	1460-1640	40%	0,20 nm	>15 dB	8 mm

SMAC = Acrylate coated SM fiber

Other fiber and coating options: PI coated SM fiber (SMPI), PI coated pure core fiber (PCPI)

HIGHLY VERSATILE APPLICATIONS.

Our Fiber Bragg Gratings are used in an incredibly broad range of applications such as:

- High temperature sensing in stainless steel manufacturing, industrial process control, aerospace or oil and gas exploration
- Asset integrity monitoring of wind power plants and conventional power turbines
- Structural health monitoring of civil structures, such as bridges, dams and tunnels
- Temperature and structural health monitoring in nuclear environments
- Data acquisition during for example minimal-invasive surgery

HIGH TEMPERATURE SENSING

FBG based temperature sensors are superior against other technologies regarding measurement speed, cabling and the connection of a large number of sensors and thus they are widely used for example in stainless steel manufacturing, turbine monitoring, industrial process control or aerospace. Due to our specific fs-point-by-point FBG inscription technology, the manufactured Femto Gratings show extreme temperature stability. Using our FemtoPlus Gratings eliminates negative polarization effects on measurement accuracy that result from polarized light sources or from vibrations and movements within the sensing system. Hence, these enhanced sensors typically show no birefringence and are polarization independent. The technology also allows for using specific pure Silica core fibers, which themselves show highest temperature stability.

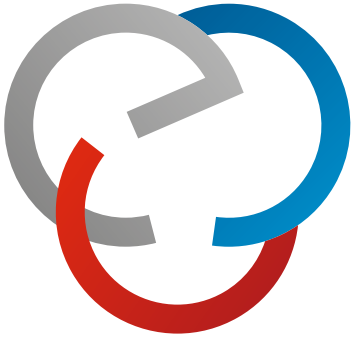
WIND ENERGY

Since FBG based measurements are immune to electromagnetic interference, they are especially well suited to monitor high power generators in wind turbines and are able to survive lightning strikes. High measurement speed and accuracy ensure an optimized and effective operation of the wind power plant. By mounting FBG based strain sensors to the rotor blades, turbine load can be measured. The precise knowledge of the actual loads on the blades prevents overloading and assures that the wind turbine is operated in a load-optimized manner. In particular, the bending moments of the individual rotor blades and the rotor moments represent important information. Furthermore, FBG based vibration sensors on the rotor blades can measure the individual ice deposition on the blades. This allows safe shut down and automated restart of turbines in case of ice events.

STRUCTURAL HEALTH MONITORING

The FBG technology is widely used for the surveillance of structural health parameters of civil structures, such as bridges, dams, tunnels and historical buildings during its construction, design validation and life time operation. The FBG technology is particularly cost effective when applied to large scale structures, deploying hundreds of sensors for long term measurement and surveillance. Since large numbers of sensors are included in one fiber, the deployment can be realized in a very efficient way. In addition, the comparably high costs of interrogation units for large scale sensing systems can be efficiently reduced through multiplexing technologies.

ABOUT ENGIONIC GROUP



The engionic group of companies focusses on the development and production of OEM specific products and components and covers the entire product life cycle, from prototyping to volume production. The group's technological focus lies on the design and production of fiber optic components and sensors, as well as the production of high quality precision CNC parts.

In 2022, we rebranded the engionic Group companies to create a joint brand identity. Loptek GmbH is now engionic Fiber Optics GmbH, FemtoFiberTec GmbH is now engionic Femto Gratings GmbH and KIESSIG CNC-Zerspanung GmbH is now engionic CNC GmbH.

Each company operates as an independent entity, while we maximize the synergies between the group companies to provide the best value proposition to our customers.

Within the group, engionic AG fulfills the function of a strategic investment holding company. All share holdings are bundled in this company. The main purpose of the holding company is the active further development of the business portfolio through organic growth and the selective acquisition of further businesses, as well as the identification of new technologies and products that are evolving on the market and can be scaled to industrial levels.

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Members of engionic Group

engionic Fiber Optics GmbH has been designing and manufacturing tailor-made fiber optic light guide solutions and fiber optic sensors since 1992.

engionic Femto Gratings GmbH is the first commercial manufacturer of Fiber Bragg Gratings based on a complex and highly automated fs-laser inscription process.

engionic CNC GmbH looks back on more than 20 years of experience in the production of CNC components, made with an exceptionally high level of precision and quality.

Locations

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