OptiGrate Corp is a pioneer and world leader in volume Bragg gratings (VBG) technologies. For over a decade, OptiGrate has designed and manufactured a full range of Volume Bragg Gratings from inorganic photosensitive silicate glass. We supply custom built and volume orders of diffractive optical components to government contractors and industrial manufacturers. OptiGrate has an exclusive license for a full portfolio of unique VBG-based products deployed in optoelectronic, analytical, medical, defense, and semiconductor industries.

OptiGrate is located in Oviedo, FL where we design, develop, and make all of our products. Our unique facility includes a photosensitive glass production area, a holographic area, and a laser development facility.

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OUR PRODUCTS

BragGrate™ Mirror
BragGrate™ Pulse
BragGrate™ Notch Filter
BragGrate™ Bandpass Filter
BragGrate™ Spatial Filter
BragGrate™ Deflector
BragGrate™ Combiner

APPLICATIONS

Laserline Narrowing and Stabilization
Spectral and Spatial Filters
Raman Filters
Multiband Filters
Compressors for fs and ps-lasers
Spectral Beam Combining
Coherent Beam Combining
Wavelength Multiplexing
High Power Beam Splitting
Beam Steering and Deflection
Angular Magnifiers
Single Photon Counting
Wavelength Tunable Lasers

“Vertically integrated manufacturing: Reliable, fast, customer oriented.”
BragGrate™ - Mirror
Reflecting Bragg Grating (RBG) for laser mode selection

Product Description

The BragGrate™ Mirror is a reflecting volume Bragg grating recorded in a bulk of photosensitive silicate glass. BragGrate™ Mirrors are placed in a laser resonator which enables spectral and thermal management of the laser radiation. The laser mode structure is controlled by the longitudinal mode selection with the bandwidth down to 10 GHz and the customized central wavelengths with accuracy of 0.1–0.5 nm. BragGrate™ Mirrors have a record low absorption and scattering that allows them to withstand record high optical densities of up to 10 J/cm². This also yields a thermal laser wavelength shift reduction of up to 5 pm/K at 532 nm.

Standard Parameters

Center Wavelength: 405, 6XX, 7XX, 8XX, 9XX, 10XX, 15XX, 19XX nm
Spectral Bandwidth (FWHM): 0.1–0.3 nm
Diffraction Efficiency 10–35, 90, 99 %
Lateral Dimensions: 1.5×2, 1.5×12, 5×5, 8×8 mm²
Thickness 1, 2.5, 4.0 mm

Applications

• Longitudinal and transverse mode selection in laser resonators
• Solid-state lasers
• High–power diode lasers
• MM and SM diode lasers for spectroscopy
• Fiber lasers
• Laser radars, LIDARS, etc...

Specifications

Diffraction Efficiency (DE): 3–99.7%
Spectral Bandwidth: 20 pm to 0.5 nm
Wavelength Range: 350–2700 nm
Grating Thickness: 0.50–20 mm
Apertures: up to 35×35 mm²
Angular Selectivity: 1–100 mrad
Incident/Output Angles: 0–45 deg
Grating to Surface Tilt Angle: 0–10 deg
Absorption/Scattering Losses: <2%

Advantages & Features

• High power operations, over 1 kW
• High energy operations up to 5 J/cm²
• Low to No power penalty
• Unrestricted lifetime, no degradation of parameters has been detected for over 10 years
• Narrowing of laser line down to 20 pm with superior thermal stability
• Environmental stability
• No polarization dependence
• Unique solutions to achieve SFM oscillations
• Near–diffraction–limited beam quality

Schematics of LD bar stabilization with a BragGrate™ Mirror.

Normalized spectra of 2W free running LD and with BragGrate™ Mirror at different T. The narrowed linewidth was < 45 pm.
Insert: mode profile with a 10% DE BragGrate™ Mirror
**Product Description**

BragGrate™ Pulse is the first commercially available Chirped Bragg Grating (CBG) based product especially designed for the stretching and compression of femtosecond and picosecond laser pulses. It is a volume Bragg grating in reflecting geometry with a period that gradually varies along the direction of the beam propagation (CBG). It is the most compact and robust stretcher/compressor solution for high energy and high average power ultra-short pulsed laser systems.

**Product Features**

- Compact geometry and easy-to-align
- High power operation (up to 1 kW average power)
- High energy operation (up to 2 mJ pulse energy)
- Environmentally stable
- Robust, easy to handle and clean
- Preserves diffraction limited quality of femtosecond laser beam with diffraction efficiency exceeding 80%

**Applications**

BragGrate™ Pulse is for temporal stretching of a reflected ultrashort pulse and recompression of this pulse if launched from the opposite side of the grating. Most compact and robust compressors are ideal for industrial and scientific applications.

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**Specifications**

- Spectral bandwidth: 1–100 nm
- Operating range: 800–2500 nm
- Thickness: 10–50 mm
- Stretching time: 10–500 ps (FWHM)
- Efficiency: 70–95%
- Apertures: up to 8x10 mm²

**Typical Specs of BragGrate™ - Pulse for 1030 nm spectral range**

- Center wavelength: 1032 nm
- Spectral bandwidth: 5, 10, 25 nm
- Diffraction efficiency: > 85%
- Thickness: 20, 35 mm
- Stretching time (FWHM): ~ 150 ps
- Dispersion rate: ~ 6, 10, 25, 40, 60 ps/nm (linear)
- Compressed pulse duration: < 200 fs

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**Output beam shape after passing 30-mm-thick CBG in both directions**

**Compressed pulse profile theoretical vs measured data with 30 mm thick BragGrate™ Pulse**
Product Description

BragGrate™ Notch Filter (BNF) is a reflective volume Bragg grating recorded in a bulk of photosensitive silicate glass. Ultra-Narrow-Band Notch Filters reflect light with bandwidths as narrow as 5 cm⁻¹ while all other wavelength pass unaffected with up to 95% total transmission. BNF’s enable simultaneous measurements of Stokes and Anti-Stokes Raman bands down to 5 cm⁻¹ with a single stage spectrometer. Our Notch filters can withstand temperatures of up to 400°C and are fully environmentally stable with a practically unlimited life-time. Central wavelengths of the filters can be angle tuned by several nanometers without reduction of the filter optical density.

Standard Parameters

Center Wavelength: 488, 514, 532, 633, 785, 1064 nm (custom wavelengths available)
Spectral Bandwidth (FWHM): < 10 cm⁻¹
Attenuation: 99.9% and 99.99% (OD3; OD4)
Lateral Dimensions: 12.5x12.5, 11x11 mm² (90% clear aperture)
Thickness: 2–3 mm

Applications

Ultra-low frequency Raman spectroscopy

Specifications

Attenuation: 90–99.99% (OD1–4)
Spectral bandwidth (FWHM): < 10 cm⁻¹
Operating range: 400–2500 nm
BNF thickness: 2–4 mm
Apertures: up to 25×25 mm²
Angular selectivity: 0.1–0.2 deg
Incident/Diffracted Angles: 0–45 deg
Transmittance: up to 95%
Transmission ripple: <1% at ±0.5 nm from laser line (@ 633 nm)

Advantages & Features

- Ultra-narrow rejection bandwidth
- Measurements of both Stokes and anti-Stokes modes
- No degradation in high power light
- Environmentally stable: high temperature operation, no humidity effects
- No polarization dependence

Raman spectra of L-cysteine measured with a single-stage spectrometer and BragGrate™ Notch Filters at 3 different wavelengths. (Courtesy of HORIBA Jobin Yvon)
Product Description
BragGrate™ Bandpass Filter is a reflecting Bragg grating (RBG) recorded in a bulk of photosensitive silicate glass. These filters are used to clean up laser spectral noise with a bandwidth as narrow as 50 pm in visible and near IR regions. In Raman spectroscopy applications, combining these Filters with matching BragGrate™ Notch Filters enables Raman shift measurements down to 5 cm⁻¹ from the laser line. The widely used BragGrate™ filters have superior environmental stability and can handle high power optical radiation and high operations temperatures.

Advantages & Features
- High spectral selectivity
- Superior environmental stability, no degradation over lifetime
- High power operations over 1 kW
- High average power operations >20 W
- High energy operations up to 5 J/cm²
- No polarization dependence
- Near-diffraction-limited beam quality

Standard Parameters
Center Wavelength: 405, 488, 514, 532, 633, 785, 1064 nm (custom wavelengths available)
Spectral Bandwidth (FWHM): < 7 cm⁻¹
Diffraction Efficiency: > 90%
Lateral Dimensions: 5×5 mm²
Total Deflection Angle: 20 deg

Applications
- Spectral filtering and noise cleaning of laser beams
- ASE filters for Raman laser sources
- Spectral detection
- Tunable filters for high resolution spectroscopy

Specifications
Diffraction Efficiency (DE): >90%
Spectral Bandwidth: 0.1 to 0.5 nm
Operating Range λ: 400–2500 nm
Grating Thickness: 1.5–10 mm
Apertures: up to 10×10 mm²
Deflection Angles: 5–90 deg
Product Description

Imperfections in laser optics and variations in laser gain medium cause side fringes and spatially varying intensity. Our spatial filters are designed to “clean up” laser beams from these deficiencies. BragGrate™ Spatial Filters (BSF) provide a simple, compact, and cost effective solution for laser beam spatial filtering. BSF is based on reflecting volume Bragg grating with a narrow acceptance angle that enables filtering of laser beams with a single element, thus replacing pinhole assemblies in case of narrow line laser sources. In addition to spatial filtering, BSF’s provide ultra-narrow line spectral filtering and can be used for high-power/high-energy applications. BragGrate™ filters have superior environmental stability and can handle high power optical radiation and high operations temperatures.

Advantages & Features

- Spacial filtering without refocusing and pinhole assembly
- Highly cost effective and small footprint
- Easy alignment by angle tuning in standard kinematic mount
- Compatible with high-power operations over 1 kW
- Compatible with high-energy operations up to 5 J/cm²
- Simultanious spatial and spectral filtering (<5 cm⁻¹ to laser line)
- Supports operation at temperatures up to 400°C

Specifications

- Diffraction Efficiency (DE): 90–95%
- Spatial Noise Suppression: up to 30 dB
- Center Wavelength Range: 400–2300 nm
- Center Wavelength Tunability (angle tuning): up to 50 nm
- Filter Thickness: 2–5 mm
- Deflection Angles: 5–90 deg
- Lateral Dimensions: up to 25×25 mm²

Standard Parameters

- Center Wavelength: 405, 488, 514, 532, 633, 785, 1064 nm (custom wavelengths available)
- Lateral Dimensions: 5×5 mm²
- Thickness: ~3 mm
- Angular Acceptance (FWHM): < 5 mrad
- Deflection Angle: 20 deg
- Aluminum Housing with 0.5” or 1” Outer Diameter
BragGrate™ - Deflector
Transmitting Volume Bragg Grating for angular selection and magnification

Product Description
BragGrate™ Deflector is a transmitting volume Bragg grating recorded in a bulk of photosensitive silicate glass. The Deflector acts as a very narrow band mode selector in angular and spectral spaces and, therefore, enables spectrally selective beam steering and angular magnification. The spectral filtering is as narrow as 0.1 nm and can easily achieve deflection angles of up to 45 degrees. The grating is embedded inside the glass material and is stable to light powers exceeding 1 kW, temperatures >400°C, and is fully environmentally stable.

Standard Parameters
Center Wavelength: 532, 1064, 1550 nm
Spectral Bandwidth (FWHM): 1–10 nm
Diffraction Efficiency: > 97%
Lateral Dimensions: 12.5×12.5, 25×25, 35×35mm²

Applications
• 3D beam steering
• Angular magnification in fast switches
• Transmitting spectral and angular selector
• Beam combining
• Beam shaping and filtering

Specifications
Diffraction Efficiency (DE): 5–99%
Spectral Bandwidth: 0.5 nm to 100 nm
Operating Range λ: 400–2700 nm
Grating Thickness: 0.50–10 mm
Apertures: up to 50×50 mm²
Angular Selectivity: 0.1–100 mrad
Total Deflection Angles: <120 deg

Advantages & Features
• High power operations over 1 kW
• High energy operations up to 5 J/cm²
• No degradation over lifetime
• Superior environmental stability
• High angular selectivity
• No polarization dependence at small incident angles
• Near-diffraction-limited beam quality
• Possible multiplexing of different angular selectors in one volume
• Low wavefront aberrations

Schematics of a spectral and angular filters with BragGrate™ Deflector. Narrow spectral or angle selection is rejected from the incident beam.

BragGrate™ - Combiner
Transmitting or reflecting volume Bragg gratings for spectral beam combining

Product Description
BragGrate™ Combiner is a transmitting or reflecting volume Bragg grating (or set of gratings) enabling Spectral Beam Combining (SBC). It combines laser radiation from numerous sources into a single, nearly diffraction-limited beam with increased energy brightness. SBC by means of our BragGrate Combiners is a simple and robust technique for combining high-power laser radiation with a record spectral brightness. Excellent mechanical properties and a refractive index that is independent of temperature enables the Combiners to withstand high-power laser radiation, thus making them the ideal elements for high-powered SBC.

Specifications
- Diffraction Efficiency (DE): 90–99%
- Spectral Bandwidth: 50 pm to 20 nm
- Operating Range λ: 400–2700 nm
- Grating Thickness: 0.50–10 mm
- Apertures: up to 50×50 mm²
- Angular Selectivity: 0.5–10 mrad
- Deflection Angles: 5–45 deg

Advantages & Features
- High power operations up to 10 kW
- High energy operations up to 5 J/cm²
- Unrestricted lifetime, no degradation of parameters has been detected for over 10 years
- High angular selectivity (TBG)
- High spectral selectivity (RBG)
- Superior environmental stability
- No polarization dependence at small incident angles
- Near-diffraction-limited beam quality

Standard Parameters
- Center Wavelength: 930–980, 1030–1100 nm
- Spectral Bandwidth (FWHM): 0.2–0.5 nm
- Diffraction Efficiency 95–99%
- Lateral Dimensions: 15x15, 20x20 mm²

Applications
- High power spectral beam combining
- Wavelength multiplexing and demultiplexing
- Latest achievements: 5 beam combining with total output power of 780 W, combining efficiency of > 90%, channel spacing 0.25 nm

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- High energy operations up to 5 J/cm²
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Spectral beam combining scheme with 4 BragGrate™ Combiner gratings
Spectrum of spectrally–combined output beam with total power of 780 W and channel spacing of 0.5 nm
## HISTORY & MILESTONES

<table>
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<th>Year</th>
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| 2012 | Opened new manufacturing facility in Oviedo, FL  
Awarded “Small Manufacturer of the Year” from Manufacturers Association of Central Florida |
| 2011 | “50 Florida Companies to Watch” award winner  
World’s first monolithic lasers in Nd, Er, Yb doped PTR glass with Volume Bragg Gratings  
First kW-class DPAL pump unit with 10 GHz line width delivered |
| 2010 | New product line of ultra-narrow band BragGrate™ Raman Filters launched |
| 2009 | NASA and US Air Force awards to develop fiber laser technologies |
| 2008 | NAVY award to develop high-energy stretchers & compressors for ultra-short pulsed laser systems |
| 2007 | Volume Bragg Gratings pass 20 kW laser radiation test  
Launch of BragGrate™ Combiner product for kW-class spectral beam combining |
| 2006 | Absolute diffraction efficiency of 99.7% in Volume Bragg Grating achieved |
| 2005 | New holographic facility opened in Orlando, FL  
First volume order for Volume Bragg Grating production |
| 2004 | Grating with diffraction efficiency of 99.999% fabricated  
First Chirped Bragg Grating compressor for femtosecond lasers built |
| 2003 | Core patent issued for platform technology |
| 2002 | First commercial order for laser diode (LD) stabilization gratings |
| 2001 | Department of Defense award to develop spectral and angular narrowing and stabilization of lasers |
| 2000 | Exclusive license for platform technology obtained  
First U.S. Government contract received |
| 1999 | Light Processing and Technologies Inc. established (AKA OptiGrate) |
“BragGrate™ -
World records in volume Bragg gratings.”

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