Optics

Optometrics
A Dynasil Company

LASER COMPONENTS®

Infrared and Laser Products

- Molecular Laser Gratings (ML Gratings)
- Ruled Wire Grid Polarizers
- Holographic Wire Grid Polarizers
- Grazing Incidence Gratings
- Gratings Ruled in Gold ***NEW!***

For Applications In:
Analytical Chemistry
Physics
Life Sciences
Engineering
Communications
FTIR - Spectroscopy, Microscopy

United Kingdom
Laser Components (UK) Ltd.
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LASER COMPONENTS®

Optometrics Corporation has, for more than thirty years, designed and manufactured optical components and instruments for university, industrial and government laboratories and the OEM markets.

Standard laser components include high damage threshold original and replicated gratings for molecular lasers (ML Gratings), holographic grazing incidence gratings for dye lasers, wire grid polarizers ruled in zinc selenide or calcium fluoride and holographic wire grid polarizers on ZnSe, CaF_2, BaF_2, KRS-5 and Ge.

Facilities

Optometrics' facility in Ayer, Massachusetts contains space for offices, engineering, R&D and production. Equipment that support our broad range of capabilities include:

- Four metal vacuum coating systems;
- Three thin-film soft coated filter vacuum coating systems;
- Two Ion-Assisted Deposition hard coat vacuum coating systems;
- Three grating ruling engines;
- Production holographic laboratory;
- R&D holographic laboratory;
- Full replication and lamination facilities;
- Full assembly, alignment and test facilities;
- Full complement of test equipment for spectral testing from the UV to the Far Infrared, for mechanical and flatness testing, for humidity and environmental testing;
- Extensive marking, packaging and bar coding equipment and capabilities

Products

- **Gratings**
  Originals and Replicated, Ruled and Holographic; Grazing Incidence, Echelles, Telecom and Transmission Gratings

- **Beamsplitters**
  Reflecting/Transmitting Beamsplitters, Transmission Grating Beamsplitters, Beam Dividers/Combiners

- **Optical Components**
  Mirrors, Lenses, Windows, Flats, Beamsplitters, Prisms

NEW

- **Filters**
  Hard and Soft Coated, Near Ultraviolet, Visible, Near Infrared, Dichroic and Laser Line Filters

- **Infrared & Laser Products**
  Laser Gratings, Holographic and Ruled Wire Grid Polarizers

- **Monochromators**
  Mini-Chrom Monochromators

- **Systems & Accessories**
  Monochromatic Light Modules, Sample Compartments, Detectors, Light Sources, Modular Recording Spectrophotometers

- **SPF-290S**
  Spectrophotometer for determining Sunscreen Protection Factors

Plus specialized packaging, bar coding and Kanban stocking arrangements for all OEM customers.

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LASER COMPONENTS®

Infrared and Laser Products

Goals

Optometrics goal is to provide advanced optical components and systems for use in wavelength selection applications in:

- Analytical Chemistry
- Life Sciences
- Telecom Applications
- Physics
- Education
- Space Sciences

and other applications where high quality optics are key.

In order to accomplish this, the Company has assembled state-of-the-art facilities and people to produce:

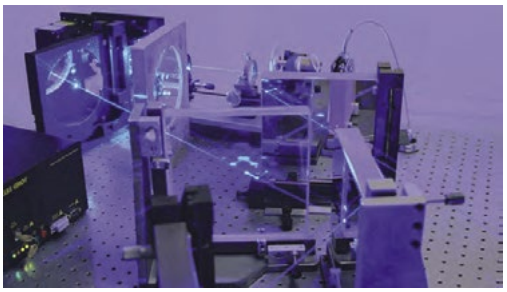
- diffraction gratings: ruled & holographic, original & replicated, reflection and transmission
- interference filters
- optical components
- laser gratings & products
- monochromators & accessories
- spectrophotometers
- wire grid polarizers: ruled & holographic

OEM Services

Optometrics caters, in particular, to the needs of its OEM customers by offering special services such as:

- Kanban stocking arrangements
- Custom packaging programs
- Bar coding capabilities
- Code names for complete confidentiality
- Higher level pre-aligned optical assemblies

The company is also proud of its ability to support customers in all phases of the product development cycle.



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Infrared and Laser Products

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LASER COMPONENTS®

Infrared and Laser Products | Wire Grid Polarizers

Optometrics Manufactures Wire Grid Polarizers Using Two Methods:

1- Ruling precisely spaced grooves directly into a highly polished Calcium Fluoride (CaF_2) or Zinc Selenide (ZnSe) substrate and then aluminizing the substrate, allowing the use of the polarizers with relatively high power lasers.

2- Holographic method of producing grooves, allowing the use of a wider array of infrared materials such as BaF_2, KRS-5 and Ge, as well as the traditional CaF_2 and ZnSe. The finer grid spacing improves short wavelength performance.

PERFORMANCE

Optometrics manufactures ruled wire grid polarizers on CaF_2 and ZnSe substrates, together covering a wavelength range from 2 to 20 microns and holographic wire grid polarizers on ZnSe, CaF_2, BaF_2, KRS-5 and Ge, covering a wavelength region from 2 to 30 microns. Wire grid polarizers are commonly used to polarize radiation from an unpolarized molecular laser, attenuate radiation from a polarized laser or, using two in series, to both polarize and attenuate a laser beam. A second polarizer can be inserted in the reflected beam for applications requiring a polarizing beam splitter. Wire grid polarizers are also used in reflectance accessories for dispersive and FT-IR spectrophotometers. Applications include the investigation of metal surfaces and crystal structures at grazing incidence, where polarization of the incident radiation is required.

Wire grid polarizers transmit radiation when the “E” vector is perpendicular to the wire (E ⊥). Radiation with the “E” vector parallel to the wire (E II) is reflected. Due to surface reflections, the reflected beam contains both polarizations.

The extinction ratio of a polarizer is a measure of its ability to attenuate a plane polarized beam. Two principle transmissions are necessary to calculate an extinction ratio, T_1 and T_2. Assuming a perfectly plane polarized beam, T_1 is defined as the maximum transmission for which the polarizer can be oriented. Minimum transmission (T_2) is the transmission through the polarizer when it is rotated 90 degrees from T_1. The extinction ratio is given as $E = T_2/T_1$ and expressed as a decimal or percentage. The inverse of E, expressed as a ratio (R = 100: 1), is used in our specifications. Wire grid polarizers can also be characterized by the degree of polarization, defined as $P = (T_1 - T_2)/(T_1 + T_2)$.

Extinction ratios greater than 40,000:1 can be achieved by the use of two wire grid polarizers in series with their grids parallel (the overall extinction ratio is the product of the extinction ratio of the individual polarizers).

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RULED WIRE GRID POLARIZERS

Optometrics manufactures wire grid polarizers by ruling precisely spaced grooves directly into a highly polished CaF_2 or ZnSe substrate. The ruling process forms sharp, well defined peaks which are then coated with aluminum by vacuum deposition at an oblique angle. The direct ruling and coating process results in a series of closely spaced, highly conductive wires with a high extinction ratio and an inherently high damage threshold. No intermediate absorbing materials are required between the substrate and aluminum coating, minimizing localized heating and allowing the use of the polarizers with relatively high power lasers.

Wire grid polarizers can be used at angles of incidence up to 45 degrees with collimated, diverging or converging beams without loss of efficiency and little lateral displacement of the transmitted beam.

NOMINAL EXTINCTION RATIOS

The extinction ratios listed below are typical and are usually exceeded:

SUBSTRATE MATERIAL	EXTINCTION RATIOS @ 3.0µ	5.0µ	10.6µ
CaF_2	50	80	NA
ZnSe	50	75	100

TYPICAL TRANSMISSION

%T IN POLARIZED LIGHT OF ZnSe WIRE GRID POLARIZER @ 10.6 µ

Uncoated .....≥ 64%
AR, one side.....≥76%
AR, two sides .....≥85%

CALCIUM FLUORIDE (CaF2)

3.0µ .....≥65%
5.0µ .....≥85%
8.0µ .....≥88%

STANDARD SIZES AND OPTIONS

Ruled wire grid polarizers are available in five standard sizes (15 mm square,15, 25, 38 and 50 mm diameter). Ruled polarizers are available unmounted, mounted in a double protective ring or installed in a bench mountable stage which allows 360° rotation.

If your application requires a different size or shape, please contact us for price and delivery. OEM inquiries are welcome.

SPECIFICATIONS

RULED WIRE GRID POLARIZERS

- Wire Grid Spacing ..... 1200 g/mm nominal
- Parallelism ..... ≤ 3 arc min.
- Surface Flatness....λ/20 @ 10.6µ up to 25 mm C.A.
  λ/10 @ 10.6µ > 25 mm C.A.
- Groove Parallelism to Edge (Squares)..... ± 0.5°
- Dimensional Tolerance .....± 0.5 mm
- Substrate Thickness .....2 mm ± .5 mm
- Damage Threshold:
  CW Laser..... 100 W/cm²
  Pulsed Laser (100 nsec. pulse).....2 J/cm²

CAUTION

The surface of a wire grid polarizer, like a diffraction grating, is extremely delicate. Nothing should ever be allowed to touch the surface of the polarizer. Handling, when necessary, should be by the edge only and with protected fingers. Careful removal of dust by gentle air flow is the only cleaning procedure recommended by Optometrics.

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LASER COMPONENTS®

Infrared and Laser Products | Ruled Wire Grid Polarizers

Diameters - Ruled Wire Grid Polarizers Unmounted*

CATALOG NO.	SUBSTRATE	CLEAR APERTURE	SUBSTRATE DIAMETER	
5-2615	ZnSe	13.5 mm	15 mm	
5-2625	ZnSe	22.5 mm	25 mm	
5-2638	ZnSe	34.0 mm	38 mm	
5-2650	ZnSe	45.0 mm	50 mm	
5-2815	CaF_2	13.5 mm	15 mm	
5-2825	CaF_2	22.5 mm	25 mm	
5-2838	CaF_2	34.0 mm	38 mm	
5-2850	CaF_2	45.0 mm	50 mm	

Mounted In Protective Double Ring*

CATALOG NO.	SUBSTRATE	CLEAR APERTURE	OUTSIDE DIAMETER	RING THICKNESS	
5-2626	ZnSe	18 mm	25 mm	5.0	
5-2639	ZnSe	34 mm	50 mm	6.0	
5-2651	ZnSe	43 mm	50 mm	6.0	
5-2826	CaF_2	18 mm	25 mm	5.0	
5-2839	CaF_2	34 mm	50 mm	6.0	
5-2851	CaF_2	43 mm	50 mm	6.0	

*** See page 10 for rotary stage accessories**

Squares - Unmounted

CATALOG NO.	SUBSTRATE	CLEAR APERTURE	SUBSTRATE SIZE	
5-2617	ZnSe	13.5 mm sq.	15 mm sq.	
5-2817	CaF_2	13.5 mm sq.	15 mm sq.	

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LASER COMPONENTS®

Holographic Wire Grid Polarizers | Infrared and Laser Products

HOLOGRAPHIC WIRE GRID POLARIZERS

Working with experts in the field, Optometrics has developed a special holographic technique to produce infrared polarizers with sub-micron grid spacing. In the company's holographic laboratory, an interferometrically generated pattern is produced from monochromatic light and exposed onto a photo-resist coated substrate. Once developed, the resist has a regular sinusoidal profile which is vacuum aluminized at an oblique angle to create the array of parallel conductors.

The fabrication of holographic wire grid polarizers permits the use of a wide variety of infrared materials that do not lend themselves to the ruling process. They are available with a spacing of 2700 grooves/mm for optimum short-wavelength efficiency.

OVERCOATINGS

Calcium Fluoride and Barium Fluoride have low refractive index (high Tx) values and do not require anti-reflective (AR) coatings.

Zinc Selenide has a high refractive index and transmission at specific wavelength regions which can be enhanced by an AR coating on the rear surface only. Zinc Selenide is usually optimized for transmission at specific laser lines, typically from 9 to 11 microns.

KRS-5 is not normally AR coated, because this would limit its broad transmission range, which is its primary advantage.

Germanium is AR/AR coated to maximize transmission @10.6µ.

STANDARD SIZES AND OPTIONS

Holographic wire grid polarizers are currently available in several standard sizes from 25 mm diameter up to 50 mm diameter, both mounted and unmounted.

HIGHLIGHTS

- 2700 grooves/mm for improved short wavelength performance
- Calcium Fluoride (CaF_2)
  Barium Fluoride (BaF_2)
  Zinc Selenide (ZnSe)
  KRS-5
  Germanium (Ge)
- Extended infrared range
- High transmission
- High extinction ratios
- 360° bench mountable, rotary stage for FTIR spectrometers
- All polarizers can be mounted in a double protective ring

SPECIFICATIONS

- Wire grid spacing 2700 grooves/mm (nominal)
- Parallelism ..... ≤ 3 arc minutes
- Surface Flatness* ..... λ/20 @ 10.6µ up to 25 mm C.A.
  λ/10 @ 10.6µ > 25 mm C.A.
- Substrate thickness:
  for sizes under 30 mm ..... 2 mm
  for sizes 30-49 mm ..... 3 mm
  for sizes ≥49 mm ..... 5 mm
- Dimensional Tolerance (unmounted) ..... ±0.5 mm

* Excludes KRS-5

Nominal Extinction Ratios

Material	Wavelength (microns)	Typical Extinction Ratio
CaF_2	3 8	150 300
BaF_2	3 10	150 300
ZnSe	3 10	150 300
KRS-5	3 15	150 300
Ge (AR/AR)	10.6	300

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LASER COMPONENTS®

Infrared and Laser Products | Holographic Wire Grid Polarizers

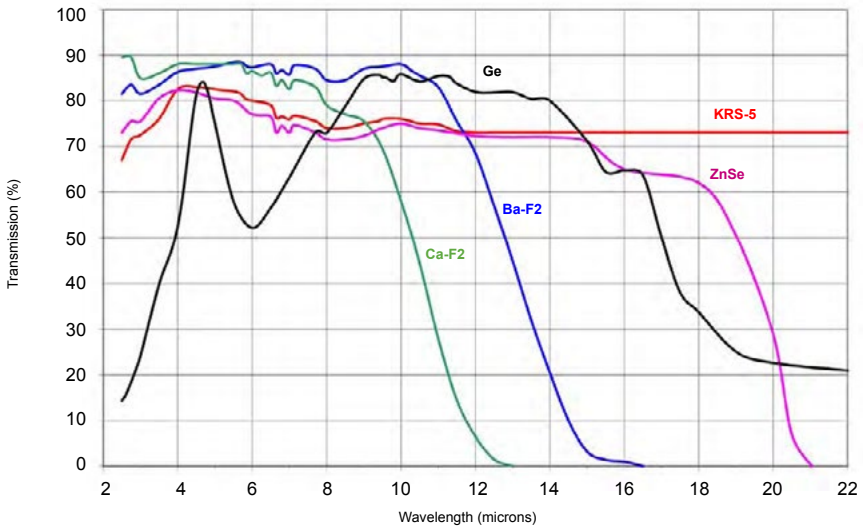

Figure 1 - Typical transmission in linearly polarized light with wire grid polarizers oriented for maximum transmission.

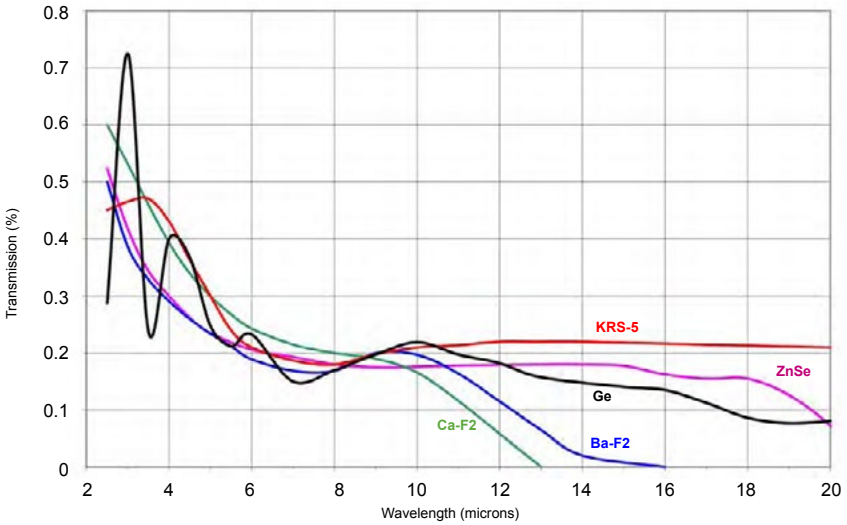

Figure 2 - Typical transmission in linearly polarized light with wire grid oriented for minimum transmission.

CAUTION

The surface of a wire grid polarizer, like a diffraction grating, is extremely delicate. Nothing should ever be allowed to touch the surface of the polarizer. Handling, when necessary, should be by the edge only and with protected fingers. Careful removal of dust by gentle air flow is the only cleaning procedure recommended by Optometrics. Particular care should be used when handling KRS-5.

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LASER COMPONENTS®

Holographic Wire Polarizers - Unmounted*

CATALOG NO.	SUBSTRATE	CLEAR APERTURE	OUTSIDE DIMENSION	
5-8003	ZnSe	22.5 mm	25 mm dia.	
5-8103	CaF_2	22.5 mm	25 mm dia.	
5-8203	BaF_2	22.5 mm	25 mm dia.	
5-8303	KRS-5	22.5 mm	25 mm dia.	
5-8403	GE (AR/AR)	22.5 mm	25 mm dia.	
5-8004	ZnSe	25 mm	29 mm dia.	
5-8104	CaF_2	25 mm	29 mm dia.	
5-8204	BaF_2	25 mm	29 mm dia.	
5-8304	KRS-5	25 mm	29 mm dia.	
5-8404	GE (AR/AR)	25 mm	29 mm dia.	
5-8011	ZnSe	34 mm	38 mm dia.	
5-8111	CaF_2	34 mm	38 mm dia.	
5-8211	BaF_2	34 mm	38 mm dia.	
5-8311	KRS-5	34 mm	38 mm dia.	
5-8411	GE (AR/AR)	34 mm	38 mm dia.	
5-8015	ZnSe	45 mm	50 mm dia.	
5-8115	CaF_2	45 mm	50 mm dia.	
5-8215	BaF_2	45 mm	50 mm dia.	
5-8315	KRS-5	45 mm	50 mm dia.	
5-8415	GE (AR/AR)	45 mm	50 mm dia.	

Mounted* (Protective Double Ring)

CATALOG NO.	SUBSTRATE	CLEAR APERTURE	OUTSIDE DIMENSION	RING THICKNESS mm	
5-8001	ZnSe	18 mm	25 mm dia.	5.0	
5-8101	CaF_2	18 mm	25 mm dia.	5.0	
5-8201	BaF_2	18 mm	25 mm dia.	5.0	
5-8301	KRS-5	18 mm	25 mm dia.	5.0	
5-8401	GE (AR/AR)	18 mm	25 mm dia.	5.0	
5-8031	ZnSe	25 mm	35 mm dia.	5.0	
5-8131	CaF_2	25 mm	35 mm dia.	5.0	
5-8231	BaF_2	25 mm	35 mm dia.	5.0	
5-8331	KRS-5	25 mm	35 mm dia.	5.0	
5-8431	GE (AR/AR)	25 mm	35 mm dia.	5.0	
5-8021	ZnSe	34 mm	50 mm dia.	6.0	
5-8121	CaF_2	34 mm	50 mm dia.	6.0	
5-8221	BaF_2	34 mm	50 mm dia.	6.0	
5-8321	KRS-5	34 mm	50 mm dia.	6.0	
5-8421	GE (AR/AR)	34 mm	50 mm dia.	6.0	

*** See page 10 for rotary stage accessories**

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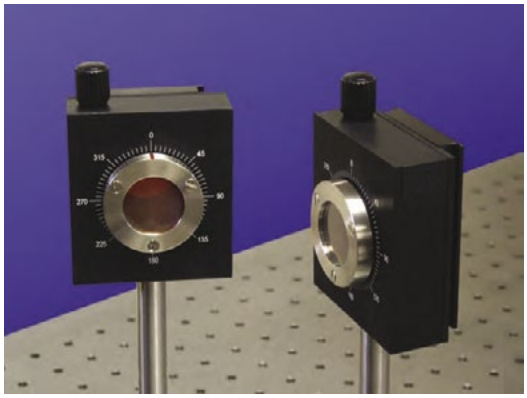
LASER COMPONENTS®

Infrared and Laser Products | Holographic Wire Grid Polarizers

Mounted in 360⁰ Rotary Mount

With adapter, post and breadboard screws suitable for breadboards, bench mounting and IR spectrometer applications.
Available for Holographic Wire Grid Polarizers only.

CATALOG NO.	SUBSTRATE	CLEAR APERTURE	
5-8005	ZnSe	25 mm	
5-8105	CaF_2	25 mm	
5-8205	BaF_2	25 mm	
5-8305	KRS-5	25 mm	
5-8405	GE (AR/AR)	25 mm	



5-8305 (Includes Holographic Wire Grid Polarizer and mount)

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LASER COMPONENTS®

Holographic Wire Grid Polarizers | **Infrared and Laser Products**

Accessories

Rotary stage for wire grid polarizers with 2° per division scale and holes for mounting on an optical bench or post. All rotary stages and adapters include mounting and aligning of your selected polarizer. Available for all mounted wire grid polarizers with a 25 mm or 50 mm outside diameter.

CATALOG NO.	
5-2146	Rotary stage. Bench mountable stage allows 360° rotation of wire grid polarizer in 25 mm diameter protective ring.
5-2147	Rotary stage. Bench mountable stage allows 360° rotation of wire grid polarizer in 50 mm diameter protective ring.
5-2148	Adapter. Allows 15 mm square wire grid polarizers to be used in 5-2146 rotary stage.

5-8021 Wire Grid Polarizer, mounted in a rotary stage, 5-2147

5-8301 Wire Grid Polarizer, mounted in a rotary stage, 5-2146

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LASER COMPONENTS®

Infrared and Laser Products | Molecular Laser (ML) Gratings

ML GRATINGS

ML gratings are original rulings or replicas that are normally used as end reflectors for tuning molecular lasers. Original gratings are ruled directly into an aluminum coating deposited on a kanigen coated copper substrate, resulting in an inherently higher damage threshold and are recommended for use with high powered molecular lasers.

The output wavelength of a molecular or dye laser can be tuned by rotating a Littrow mounted grating around an axis parallel to the grooves. The grating equation:

$$n\lambda = d(\sin i + \sin i')$$

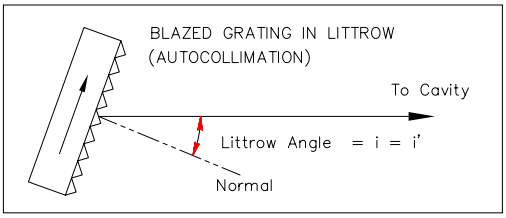
where n is the order of diffraction, λ is the diffracted wavelength, d is the grating constant (the distance between successive grooves), i is the angle of incidence measured from the normal and i' is the angle of diffraction measured from the normal, reduces to $n\lambda = 2d \sin i$ for the Littrow configuration.

The angle of incidence (i) is adjusted to select the output wavelength while creating a narrow gain profile.

BLAZE ANGLE AND ALIGNMENT

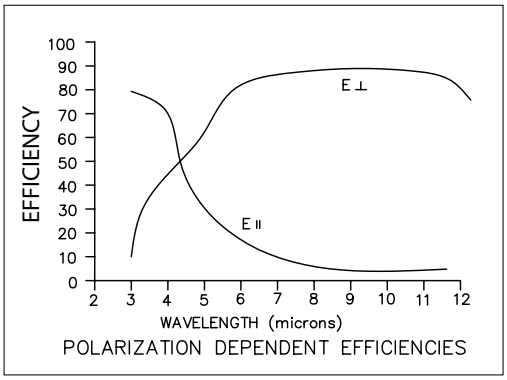
Because the ML series of gratings are designed for peak polarized efficiency, the groove angle is not equivalent to the Littrow blaze angle of the grating. As a result, when using a He-Ne laser for preliminary grating alignment, the brightest He-Ne order will not correspond to the blaze wavelength of the grating. The grating must be aligned using the calculated He-Ne order that corresponds to the wavelength of interest, regardless of its relative intensity.

The blaze arrow marked on the side or back of the grating should be oriented as shown below.



POLARIZATION

Typical efficiency curves illustrate that, in all cases, orienting the polarization of the E vector (P-Plane) perpendicular to the grooves (E ⊥) increases the efficiency over a specific wavelength region. This should be considered when optimizing the figure of merit (Q) of a cavity, particularly when it is polarized by auxiliary components such as Brewster angle windows.



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LASER COMPONENTS®

Molecular Laser (ML) Gratings | **Infrared and Laser Products**

COATING

ML gratings can be overcoated with gold, increasing the reflectivity at 10.6 microns by approximately 1%, (single pass) but the damage threshold in high power applications may be reduced. No damage threshold minimums apply for overcoated gratings.

SPECIFICATIONS

Clear Aperture.....≥90%
Groove Parallelism to Edge .....± 0.5°
Dimensional Tolerances..... ± 0.5 mm
Thickness:
  Originals .....10 mm ± 0.5 mm
  Replicas .....9.5 mm ± 0.5 mm
Damage Threshold:
  Original Gratings:
    CW Laser ..... 1 KW/cm²
    Pulsed Laser (100 nsec pulse) ..... 7 J/cm²
  Replicated Gratings:
    CW Laser .....250 W/cm²
    Pulsed Laser (200 nsec pulse) ..... 3.5 J/cm²

Summary ML Grating Specifications

MODEL NO.	GROOVES/ mm	MIN. POLARIZED ABS. EFFICIENCY	OPTIMUM RANGE (µ)	LITTROW ANGULAR DISPERSION (nm/mr)
ML-301	75	≥ 88%	9.0 - 11.0	12.3
ML-302	100	≥ 88%	9.0 - 11.0	8.5
ML-303	150	≥ 88%	9.0 - 11.0	4.2
ML-304	135	≥ 88%	9.0 - 11.0	5.2
ML-401	150	≥ 88%	5.0 - 6.0	6.1
ML-402	300	≥ 82%	5.0 - 6.0	2.0
ML-501	300	≥ 80%	2.5 - 3.0	3.0
ML-502	450	≥ 85%	2.0 - 4.0	1.6
ML-601	300	≥ 80%	2.5 - 4.0	0.35
ML-701	90	≥ 88%	16.0 - 20.0	7.7

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LASER COMPONENTS®

Infrared and Laser Products | Molecular Laser (ML) Gratings

ML Series Gratings - Original And Replicated

ML gratings are normally used as end reflectors for tuning molecular lasers. Original gratings are ruled directly into an aluminum coating deposited on a kanigen coated copper substrate, resulting in an inherently higher damage threshold than the replicas which are replicated onto a Pyrex® substrate.

Squares

SIZE	25 x 25 mm		30 x 30 mm		50 x 50 mm		58 x 58 mm	
MODEL NO.	ORIGINAL CAT. NO.	REPLICA CAT. NO.	ORIGINAL CAT. NO.	REPLICA CAT. NO.	ORIGINAL CAT. NO.	REPLICA CAT. NO.	ORIGINAL CAT. NO.	REPLICA CAT. NO.
ML-301	5-3012	5-3112	5-3019	5-3119	5-3015	5-3115	5-3016	5-3116
ML-302	5-3022	5-3122	5-3029	5-3129	5-3025	5-3125	5-3026	5-3126
ML-303	5-3032	5-3132	5-3039	5-3139	5-3035	5-3135	5-3036	5-3136
ML-304	5-3042	5-3142	5-3049	5-3149	5-3045	5-3145	5-3046	5-3146
ML-401	5-4012	5-4112	5-4019	5-4119	5-4015	5-4115	5-4016	5-4116
ML-402	5-4022	5-4122	5-4029	5-4129	5-4025	5-4125	5-4026	5-4126
ML-501	5-5012	5-5112	5-5019	5-5119	5-5015	5-5115	5-5016	5-5116
ML-502	5-5022	5-5122	5-5029	5-5129	5-5025	5-5125	5-5026	5-5126
ML-601	5-6012	5-6112	5-6019	5-6119	5-6015	5-6115	5-6016	5-6116
ML-701	5-7012	5-7112	5-7019	5-7119	5-7015	5-7115	5-7016	5-7116

Rectangles

SIZE	12.5 x 25 mm		25 x 50 mm		1" x .825"	
MODEL NO.	ORIGINAL CAT. NO.	REPLICA CAT. NO.	ORIGINAL CAT. NO.	REPLICA CAT. NO.	ORIGINAL CAT. NO.	REPLICA CAT. NO.
ML-301	5-3610	5-3810	5-3013	5-3113	5-3018	5-3118
ML-302	5-3620	5-3820	5-3023	5-3123	5-3028	5-3128
ML-303	5-3630	5-3830	5-3033	5-3133	5-3038	5-3138
ML-304	5-3640	5-3840	5-3043	5-3143	5-3048	5-3148
ML-401	5-4610	5-4810	5-4013	5-4113	5-4018	5-4118
ML-402	5-4620	5-4820	5-4023	5-4123	5-4028	5-4128
ML-501	5-5610	5-5810	5-5013	5-5113	5-5018	5-5118
ML-502	5-5620	5-5820	5-5023	5-5123	5-5028	5-5128
ML-601	5-6610	5-6810	5-6013	5-6113	5-6018	5-6118
ML-701	5-7610	5-7810	5-7013	5-7113	5-7018	5-7118

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ML Series Gratings - Original And Replicated

ML gratings are normally used as end reflectors for tuning molecular lasers. Original gratings are ruled directly into an aluminum coating deposited on a kanigen coated copper substrate, resulting in an inherently higher damage threshold than the replicas which are replicated onto a Pyrex® substrate.

Diameters

SIZE MODEL NO.	25 mm DIA. ORIGINAL CAT. NO.	25 mm DIA. REPLICA CAT. NO.	38 mm DIA. ORIGINAL CAT. NO.	38 mm DIA. REPLICA CAT. NO.	50 mm DIA. ORIGINAL CAT. NO.	50 mm DIA. REPLICA CAT. NO.
ML-301	5-3011	5-3111	5-3017	5-3117	5-3014	5-3114
ML-302	5-3021	5-3121	5-3027	5-3127	5-3024	5-3124
ML-303	5-3031	5-3131	5-3037	5-3137	5-3034	5-3134
ML-304	5-3041	5-3141	5-3047	5-3147	5-3044	5-3144
ML-401	5-4011	5-4111	5-4017	5-4117	5-4014	5-4114
ML-402	5-4021	5-4121	5-4027	5-4127	5-4024	5-4124
ML-501	5-5011	5-5111	5-5017	5-5117	5-5014	5-5114
ML-502	5-5021	5-5121	5-5027	5-5127	5-5024	5-5124
ML-601	5-6011	5-6111	5-6017	5-6117	5-6014	5-6114
ML-701	5-7011	5-7111	5-7017	5-7117	5-7014	5-7114

COATINGS

Gold overcoat that enhances reflectivity in the IR is available for an additional charge. No damage threshold minimums apply for overcoated gratings.

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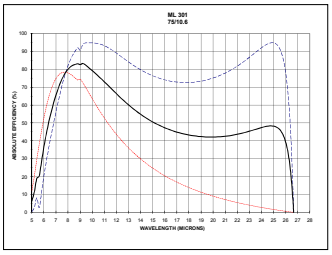
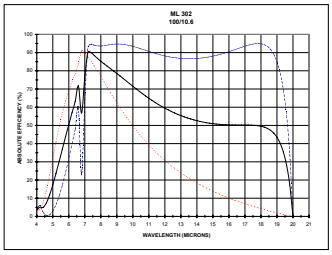
Infrared and Laser Products | Molecular Laser (ML) Gratings

Typical Efficiency Curves-ML Gratings

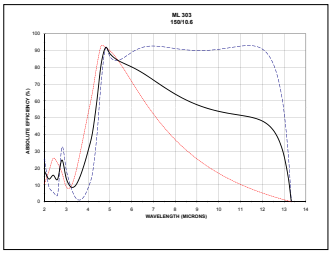
Larger graphs can be viewed from the Optometrics web site at:
http://www.optometrics.com



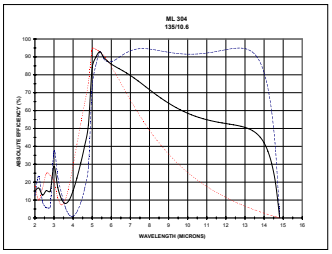
ML-301: 75 g/mm, Blazed at 10.6 μ(E⊥)
Angular Dispersion 12.3 nm/mr



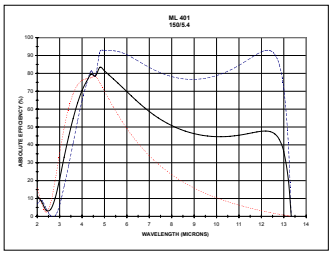
ML-302: 100 g/mm, Blazed at 10.6 μ(E⊥)
Angular Dispersion 8.5 nm/mr



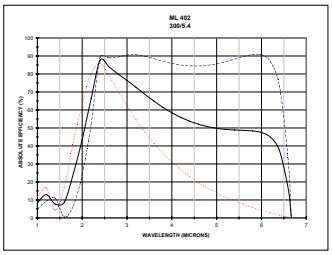
ML-303: 150 g/mm, Blazed at 10.6 μ(E⊥)
Angular Dispersion 2.0 nm/mr



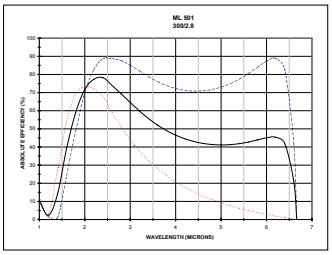
ML-304: 135 g/mm, Blazed at 10.6 μ(E⊥)
Angular Dispersion 3.0 nm/mr



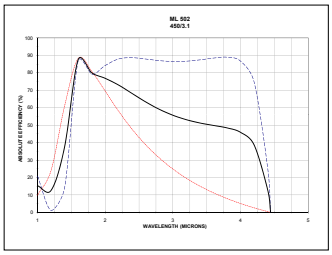
ML-401: 150 g/mm, Blazed at 5.4 μ(E⊥)
Angular Dispersion 6.1 nm/mr



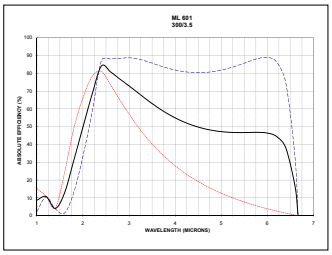
ML-402: 300 g/mm, Blazed at 5.4 μ(E⊥)
Angular Dispersion 2.0 nm/mr



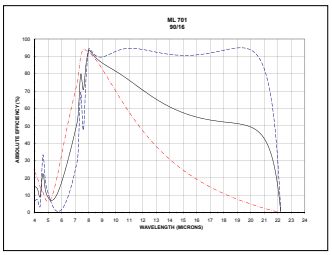
ML-501: 300 g/mm, Blazed at 2.8 μ(E⊥)
Angular Dispersion 3.0 nm/mr



ML-502: 450 g/mm, Blazed at 3.1 μ(E⊥)
Angular Dispersion 1.6 nm/mr



ML-601: 300 g/mm, Blazed at 3.5 μ(E⊥)
Angular Dispersion 0.35 nm/mr



ML-701: 90 g/mm, Blazed at 16.0 μ(E⊥)
Angular Dispersion 7.7 nm/mr

Legend

Perpendicular Polarization
Parallel Polarization
Average

* All gratings are measured in the Littrow mounting configuration
* All gratings utilize an aluminum (Al) reflective coat

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Gratings Ruled In Gold

Gold gratings for high power, high efficiency IR Laser Applications

GOLD GRATINGS

We design and rule custom Gratings directly in gold for IR (4 to 12 microns) laser applications. Gold gratings are particularly important to IR lasers since their increased efficiency allows more of the generated light to be used. Their resistance to degradation allows them to be used in high power applications that might damage gratings having a thin gold coating over aluminum, for example.

These gratings are available on both INVAR and ceramic substrates - if you are interested in working with other materials please contact us for more information.

CAPABILITIES

- Custom gratings ruled directly in gold on special substrates in various materials and mediums for 4-12 micron laser applications
- Standard molecular laser gratings on aluminized copper substrates. (See standard ML Gratings on pages 12 - 16)

SPECIFICATIONS

Grooves/mm	70 - 450
Optimum Range (µ)	4.0-12.0
Substrate Materials	Copper, Invar, Ceramic or Silicon
Clear Aperture	90%
Groove Parallelism to Edge	± 0.5°
Dimensional Tolerance	± 0.5 mm
Thickness Tolerance	± 0.5 mm
Typical Peak Efficiency (Polarized)	≥ 95%

Custom sizes, rulings and substrates are available on request.

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LASER COMPONENTS®

Infrared and Laser Products | Grating End Reflectors for Dye Lasers

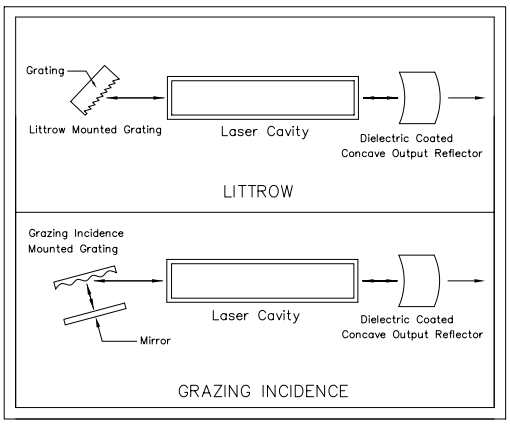
LITTROW GRATING END REFLECTORS FOR DYE LASERS

The output wavelength of the dye laser can be tuned by turning the Littrow-mounted diffraction grating end reflector about an axis parallel to the grooves. The equation relating wavelength to angle of incidence on the grating is $n\lambda = 2d \sin i$. Using this relationship, one can calibrate the mirror mount micrometer to i and, using a grating as one of the reflectors in a dye laser, cause the spectral line width of the output to be reduced to a narrow region around the Littrow wavelength. Maximum reduction is attained by increasing dispersion to the practical limit. The equation for angular dispersion is:

$$\left(\frac{d\,\lambda}{d\,i} = \frac{\lambda}{2\,\tan i}\right)$$

Even greater selectivity can be attained by adding a Fabry-Perot etalon to the grating-mirror cavity. The efficiency of the spectral condensation in organic dye lasers is quite high, with figures of 70% being typical.

Gratings are normally used in one of two configurations: Littrow or grazing incidence (see figure below).



Typical Cavity Configurations
of TF and UTF Gratings

GRAZING INCIDENCE GRATINGS

Grazing incidence is a simple and inexpensive optical configuration that can tune and increase the resolution of a dye laser. A holographic grating, functioning as an end reflector in a dye laser cavity, is positioned so that laser radiation strikes the grating almost perpendicular to the grating normal. As the angle of incidence approaches 89 degrees, a relatively large area of the grating is illuminated by the laser beam, increasing angular dispersion and resolving power significantly. The sizes of the grating and mirror (12.7 x 50.8 mm) are optimized for grazing incidence. The grazing angle is fixed and tuning is achieved by rotation of the mirror. The laser beam is diffracted twice in grazing incidence, resulting in a two-fold increase in resolution. Low grating efficiency is characteristic of the grazing incidence configuration but is compensated for by the high gain of the dyes used.

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LASER COMPONENTS®

Littrow Series Gratings

SPECIFICATIONS

Dimensional tolerances ..... ± 0.5 mm
Thickness tolerances ..... ± 0.5 mm
Efficiencies:
Ruled ..... 60 - 80% at blaze λ
Holographic ..... 45 - 65% at peak λ
Clear aperture 90%
Groove parallelism to edge ..... ±0.5°

All dimensions in millimeters.

GROOVES PER mm	BLAZE ANGLE	BLAZE λ (nm)	DISPERSION (nm/mr) @ 500 nm	12.5 x 25 x 6 CAT. NO.	25 x 25 x 9.5 CAT. NO.	30 x 30 x 9.5 CAT. NO.	50 x 50 x 9.5 CAT. NO.
1200	10° 22'	300	0.82	3-4131	3-2131	3-3131	3-5131
1200	17° 26'	500	0.79	3-4151	3-2151	3-3151	3-5151
1200	26° 45'	750	0.74	3-4171	3-2171	3-3171	3-5171
1200	36° 52'	1000	0.67	3-4111	3-2111	3-3111	3-5111
1800	26° 45'	500	0.50	3-4851	3-2851	3-3851	3-5851

All gratings are available with higher damage thresholds. Contact sales for more information.

Grazing Incidence Gratings And Mirror

SPECIFICATIONS

Grating:
Thickness ..... 9.5 mm ±0.5 mm
Resolution ..... 90% of theoretical
Efficiency at Grazing Incidence:
Single Pass ..... Approx. 24%
Double Pass ..... Approx. 4%
Mirror:
Coating ..... AlSiO
Thickness ..... 9.5 mm ±0.5 mm

REPLICATED HOLOGRAPHIC GRATING (12.7 x 50.8 mm)		
GROOVES/mm	BLAZE	CAT. NO.
1200	VIS	5-2401
1800	VIS	5-2402
2400	VIS	5-2403
3600	VIS	5-2404

MIRROR: Used in conjunction with grazing incidence gratings (above) for double pass high resolution tuning of dye lasers.		
SIZE	CATALOG NO.	
12.7 x 50.8 mm	5-2405	

Rev: 6/23/10

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