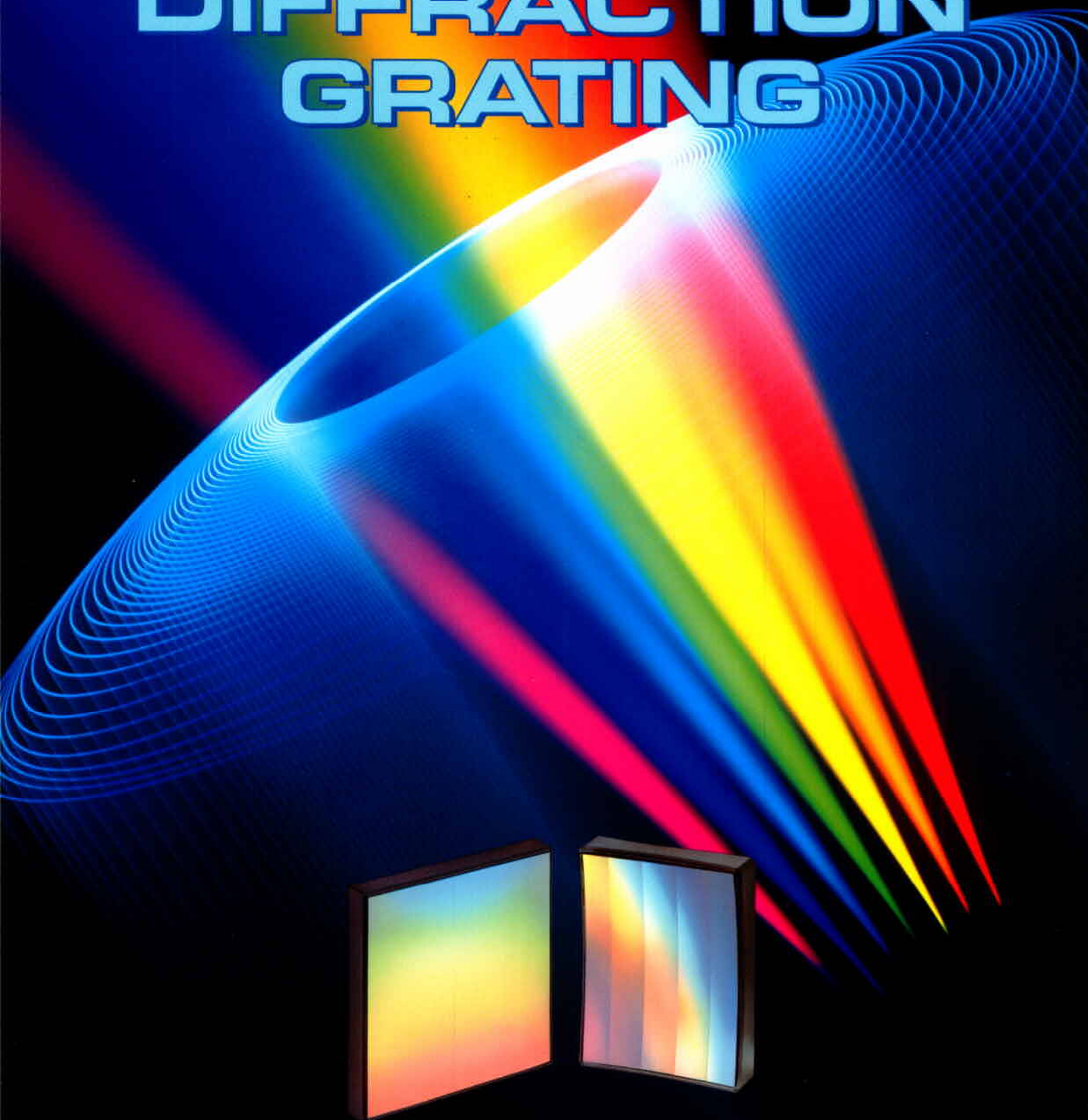


HITACHI

# HITACHI DIFFRACTION GRATING



# Hitachi Diffraction Gratings Analyze a Variety from X-rays to Infrared.

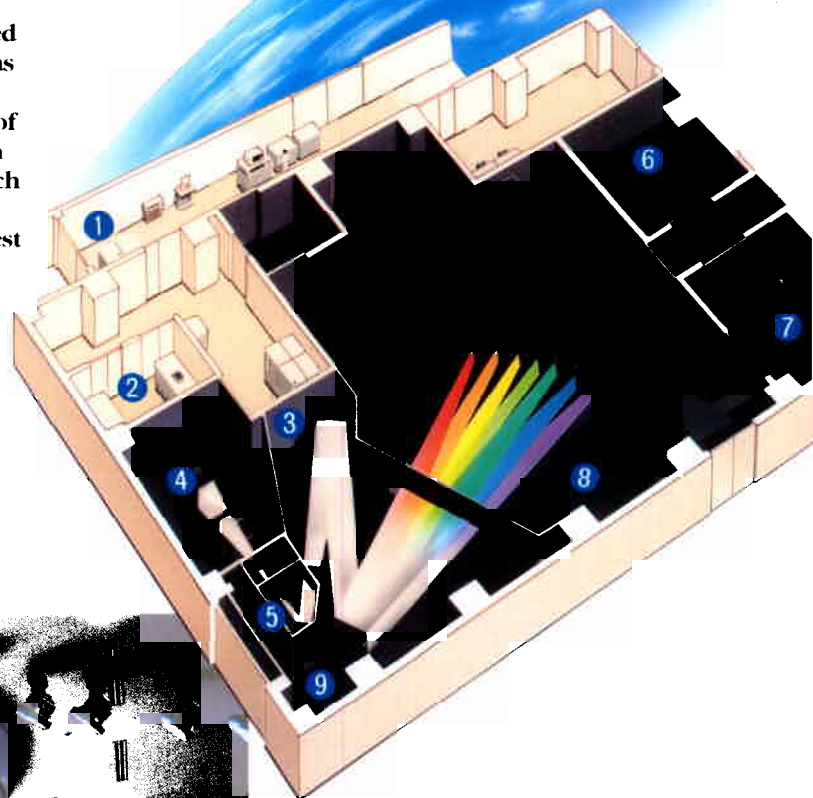
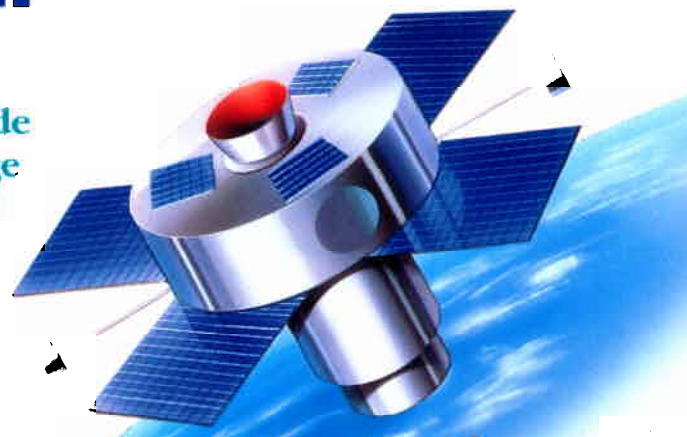
Hitachi diffraction gratings are adopted in a wide range of scientific and industrial fields, e.g. large spectrograph for photobiological research and spectrometer for extreme ultraviolet explorer.

The diffraction gratings capable of analyzing a variety of radiations ranging from soft X-rays to far infrared are now expanding their application areas as optical elements indispensable for spectroscopy.

The diffraction gratings developed by Hitachi have been used in various application areas, and are now highly evaluated as the world's foremost optical elements.

For example, a total of 36 diffraction gratings having a size of  $15 \times 15$  cm and arranged in a mosaic pattern, are adopted in the large spectrograph used in the Okazaki National Research Institutes, National Institute for Basic Biology.

The spectrograph has successfully realized the world's largest artificial rainbow whose intensity is 20 times the sunlight energy right above the equator. Furthermore, the Hitachi plane diffraction gratings consisting of varied space grooves have also been adopted in the spectrometer of the extreme ultraviolet explorer scheduled to be launched by NASA of the U.S.A. Hitachi has developed the reflection plane gratings and concave gratings to meet such most-advanced technological fields as exemplified above. These gratings are available in a wide variety of models to meet your diversified needs.



- Large spectrograph at the Institute for Basic Biology
- ① Control computer
- ② Power supply room
- ③ Condensing mirror
- ④ 30 kW xenon lamp
- ⑤ Deflection mirror
- ⑥ Optical fiber room
- ⑦ Operation room
- ⑧ Illumination room
- ⑨ Diffraction grating



◀ "Flying into the Rainbow" by Naoya Sakagami (In the arrival lobby of New Haneda Airport)  
An art object representing a rainbow under the dome, which was created using the Hitachi diffraction grating parts.

# ity of Radiations Ranging

## Reflection plane grating provided with 3,600 grooves per mm

Hitachi's highly reputed, precision ruling engine has now been combined with the laser interferometric technology. This permits arranging the grooves to a nanometer precision. Furthermore, a burnishing technique, making use of a diamond tool enables forming excellent grooves whose surfaces are far smoother than vacuum evaporated metal surface heretofore considered as the smoothest mirror surface. All these features serve to provide a highly-efficient diffraction grating with minimum stray light in UV-VIS region as well as in the soft X-ray and vacuum UV regions. The accurate blaze angle and the regularly-arranged groove-to-groove spacings can be observed clearly by scanning electron micrograph. This precision is shown in the figure to the right.



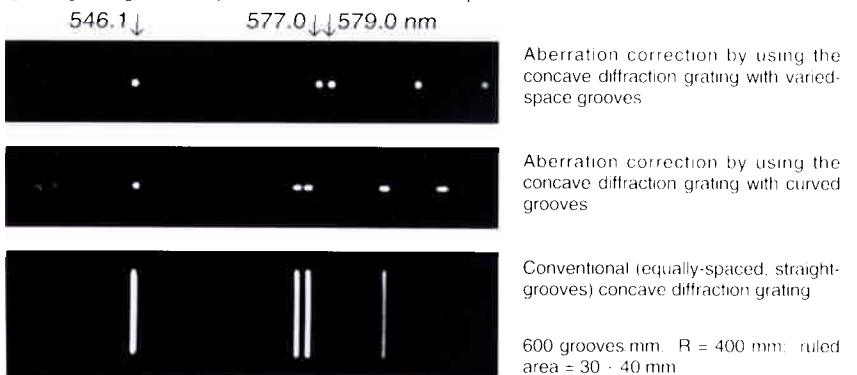
Magnification : 30,000x

## Stigmatic imaging of spectra by using an aberration-corrected concave diffraction grating

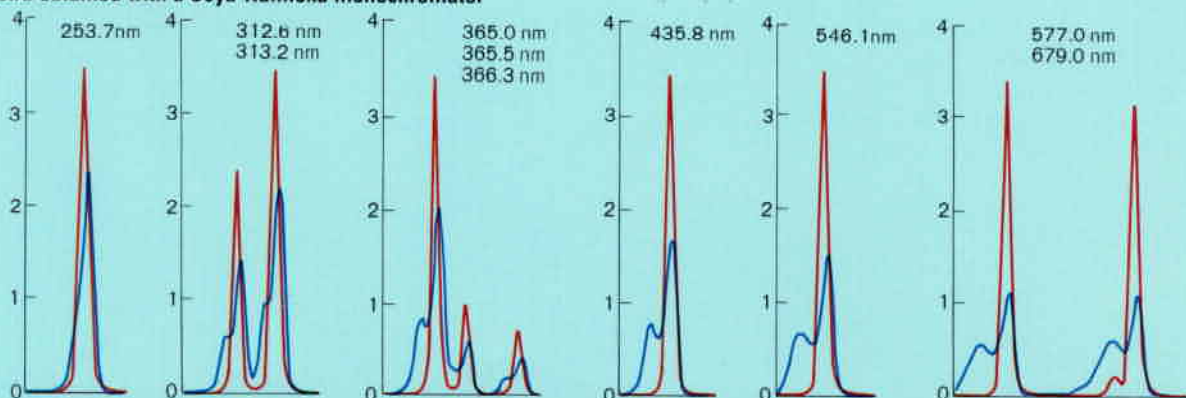
The variable spacing and curved groove ruling technology, developed solely by Hitachi, eliminates the aberrations inherent to the conventional concave diffraction gratings. This greatly enhances the spectral image focusing properties of concave gratings. The Hitachi aberration-corrected concave diffraction gratings include high resolution, reduced astigmatism, compact size, etc., which can be selected in accordance with the function of the equipment to which they are applied.

### ● Mercury line spectra

The conventional concave grating images the spectra emitted from a pinhole into vertical straight lines, while the newly developed aberration-corrected concave grating images the spectrum in the form of a point.



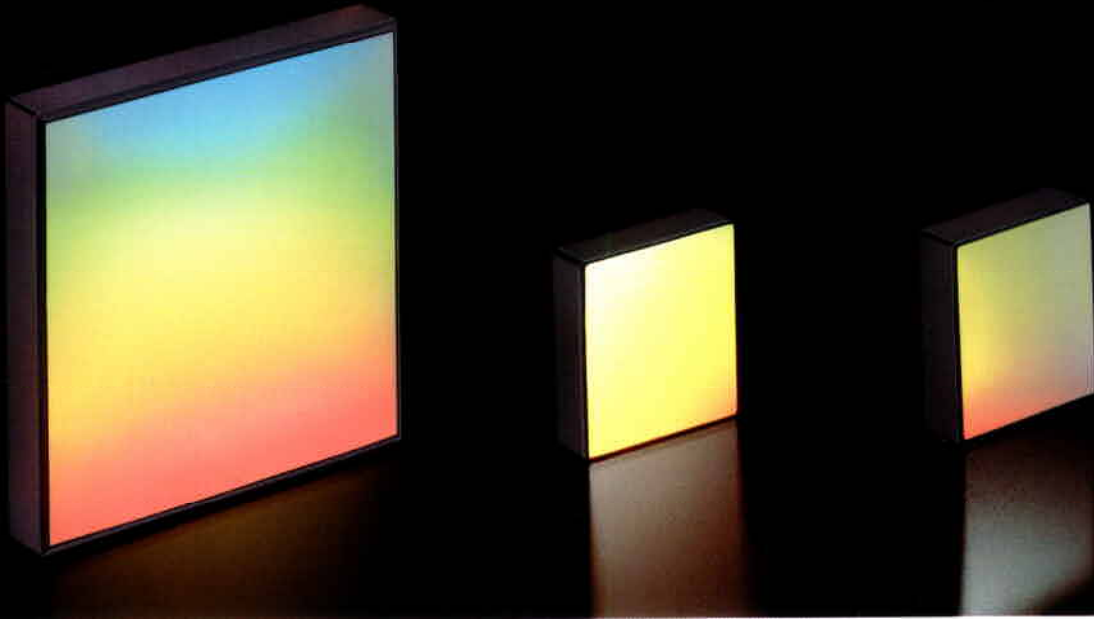
### Line spectra obtained with a Seya-Namioka monochromator



In the spectra obtained with the aberration-corrected grating, the peak does not have shoulder caused by the coma-type aberration.

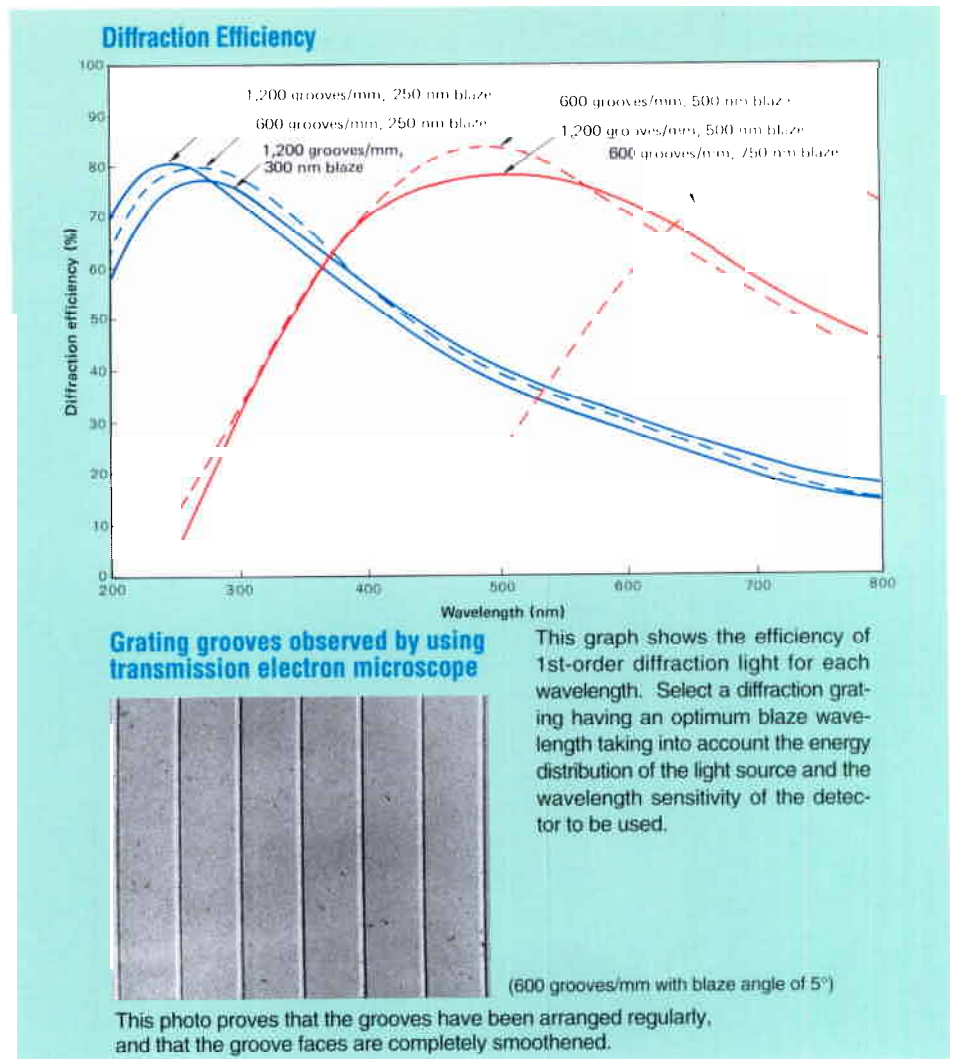
600 grooves/mm, R = 500 mm, ruled area 30 × 50 mm, slit 6 mm × 30 μm  
 — : Conventional type (equally-spaced, straight grooves)  
 — : Aberration-corrected type (optimized for 400 nm wavelength)

# Plane Diffraction Gratings



## A wide variety of high performance, mechanically-ruled diffraction gratings.

- The ruling engine equipped with a highly sensitive laser interferometer is able to rule grating grooves with ultrahigh accuracy, and realizes high resolution spectroscopic instruments.
- Burnishing process, by using a diamond tool, serves to form triangularly shaped echelette grooves whose surfaces are extremely smooth yielding minimum stray light.
- The grooves, having an exact blaze angle, can be formed by selecting an appropriate diamond tool and measuring the groove profiles with a scanning electron microscope. These processes allow the grating to provide a highly efficient diffraction efficiency in the designed wavelength region.
- Grating grooves having 2 or more different blaze angles can be combined on a single diffraction grating. This structure allows for broader wavelength coverage.
- A variety of diffraction gratings with variable spaced grooves and shapes are manufactured.



# Concave Diffraction Gratings



## From X-rays to Infrared! Gratings can now be designed to meet specific requirements.

- **Coma-type aberration-corrected concave grating for high resolution Seya-Namioka monochromator:**

This grating eliminates the coma-type aberration of the Seya-Namioka monochromator, which has been most widely used in monochromators with concave gratings that provide high resolution.

Hitachi is manufacturing a wide variety of aberration-corrected gratings for Seya-Namioka monochromator which cover a wavelength range from the vacuum ultra-violet to the near infrared region.

- **Diffraction gratings for compact, high efficiency monochromator:**

These gratings are designed for normal incidence mounting. They reduce aberrations and at the same time increase the efficiency of light intensity.

As a result, a high quality of image focusing of the concave grating is available.

- **Diffraction gratings for flat field spectrograph:**

Variable space grooves enable flat-field image focusing of concave grating spectrograph.

The spectrograph permits simultaneous measurement of multi-wavelength spectra when combined with a linear array detector. Gratings are designed optimally for the grazing-incidence optical system (for soft X-ray) and the normal-incidence optical system (for VIS-UV ray), respectively.

- **Diffraction gratings for multi-wavelength optical communication:**

A compact and efficient aberration-corrected concave grating is manufactured for transmitting multiple wavelength light beams through an optical fiber and acts to separate the beams at the receiving terminal.

- **Diffraction gratings for soft X-rays:**

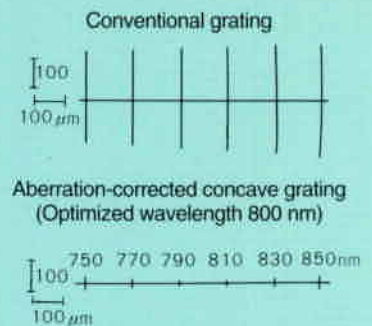
Highly dispersive concave gratings for grazing-incidence mounting are available especially used for synchrotron radiation and extreme ultra-violet applications. These gratings are very effective for the application of soft X-rays whose reflectance is extremely low on a metal surface.

### Demultiplexer for multi-wavelength fiber optics communication

The demultiplexer is required to focus the beams from the incident fiber efficiently onto the output fiber surface. In the aberration-corrected concave grating, astigmatism can be reduced at a specific wavelength range, so that highly efficient optical transmission can be achieved.

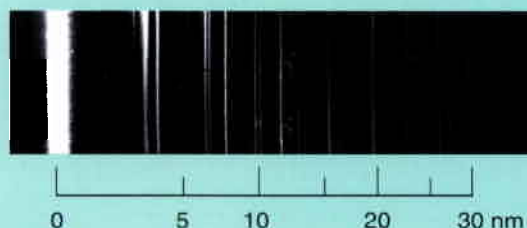
Ray-traced images of spectra emitted from a point light source.

In the conventional grating (300 grooves/mm,  $R = 50$  mm,  $15$  mm<sup>2</sup>), the spectral image is elongated in the vertical direction.



### Grazing-incidence soft X-ray spectrograph with flat-field image focusing

#### Line spectra of laser-induced plasma



Laser: 30 mJ YAG laser  
 Target: Carbon  
 Incidence angle: 87°  
 Diffraction grating: 1,200 grooves/mm,  
 $R = 5.6$  m,  
 30(H) × 50(W) mm,  
 aberration-corrected

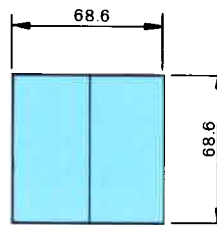
The spectra of soft X-ray region can be observed on a flat photographic plate when the grating is mounted at an incidence angle of 87°.

## List of Reflection Plane Diffraction Gratings

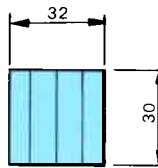
Part No.	Grooves per mm	Blaze wavelength (nm)	Blank size H x W x T (mm)	Blaze angle (degree)
001-0225	30	30,000	68.6 x 68.6 x 10	26.8
001-0226	66.6	3,000/10,000 <sup>1)</sup>	68.6 x 68.6 x 10	5.7/19.3
001-0227	120	3,000/10,000 <sup>1)</sup>	68.6 x 68.6 x 10	10.4/36.9
001-0228	120	6,000	68.6 x 68.6 x 10	21.1
001-0111	300	500	30 x 32 x 10	4.3
001-0126	300	500	58 x 58 x 10	4.3
001-0141	300	500	68.6 x 68.6 x 10	4.3
001-0156	300	500	76 x 85 x 16	4.3
001-0112	300	750	30 x 32 x 10	6.5
001-0127	300	750	58 x 58 x 10	6.5
001-0142	300	750	68.6 x 68.6 x 10	6.5
001-0157	300	750	76 x 85 x 16	6.5
001-0113	300	1,000	30 x 32 x 10	8.6
001-0128	300	1,000	58 x 58 x 10	8.6
001-0143	300	1,000	68.6 x 68.6 x 10	8.6
001-0158	300	1,000	76 x 85 x 16	8.6
001-0114	300	2,000	30 x 32 x 10	17.5
001-0129	300	2,000	58 x 58 x 10	17.5
001-0144	300	2,000	68.6 x 68.6 x 10	17.5
001-0159	300	2,000	76 x 85 x 16	17.5
001-0115	300	3,000	30 x 32 x 10	26.8
001-0130	300	3,000	58 x 58 x 10	26.8
001-0145	300	3,000	68.6 x 68.6 x 10	26.8
001-0160	300	3,000	76 x 85 x 16	26.8
001-0229	360	1,000	30 x 32 x 10	10.4
001-0116	600	200	30 x 32 x 10	3.4
001-0131	600	200	58 x 58 x 10	3.4
001-0146	600	200	68.6 x 68.6 x 10	3.4
001-0161	600	200	76 x 85 x 16	3.4
001-0117	600	250	30 x 32 x 10	4.3
001-0132	600	250	58 x 58 x 10	4.3
001-0147	600	250	68.6 x 68.6 x 10	4.3
001-0162	600	250	76 x 85 x 16	4.3
001-0118	600	300	30 x 32 x 10	5.2
001-0133	600	300	58 x 58 x 10	5.2
001-0148	600	300	68.6 x 68.6 x 10	5.2
001-0163	600	300	76 x 85 x 16	5.2
001-0119	600	500	30 x 32 x 10	8.6
001-0134	600	500	58 x 58 x 10	8.6
001-0149	600	500	68.6 x 68.6 x 10	8.6
001-0164	600	500	76 x 85 x 16	8.6
001-0120	600	750	30 x 32 x 10	13.0
001-0135	600	750	58 x 58 x 10	13.0
001-0150	600	750	68.6 x 68.6 x 10	13.0
001-0165	600	750	76 x 85 x 16	13.0
001-0230	600	950/1,900 <sup>2)</sup>	30 x 32 x 10	16.6/34.8
001-0121	600	1,000	30 x 32 x 10	17.5
001-0136	600	1,000	58 x 58 x 10	17.5
001-0151	600	1,000	68.6 x 68.6 x 10	17.5
001-0166	600	1,000	76 x 85 x 16	17.5
001-0122	1,200	200	30 x 32 x 10	6.9
001-0137	1,200	200	58 x 58 x 10	6.9
001-0152	1,200	200	68.6 x 68.6 x 10	6.9
001-0167	1,200	200	76 x 85 x 16	6.9
001-0232	1,200	230	58 x 58 x 10	7.9
001-0123	1,200	250	30 x 32 x 10	8.6
001-0138	1,200	250	58 x 58 x 10	8.6
001-0153	1,200	250	68.6 x 68.6 x 10	8.6
001-0168	1,200	250	76 x 85 x 16	8.6
001-0233	1,200	250	150 x 150 x 25	8.6
001-0234	1,200	250/500 <sup>3)</sup>	150 x 150 x 25	8.6/17.5
001-0124	1,200	300	30 x 32 x 10	10.4
001-0139	1,200	300	58 x 58 x 10	10.4
001-0154	1,200	300	68.6 x 68.6 x 10	10.4

Part No.	Grooves per mm	Blaze wavelength (nm)	Blank size H x W x T (mm)	Blaze angle (degree)
001-0169	1,200	300	76 x 85 x 16	10.4
001-0125	1,200	500	30 x 32 x 10	17.5
001-0140	1,200	500	58 x 58 x 10	17.5
001-0155	1,200	500	68.6 x 68.6 x 10	17.5
001-0170	1,200	500	76 x 85 x 16	17.5
001-0235	1,440	230	30 x 32 x 10	9.5
001-0236	1,440	230	40 x 40 x 10	9.5
001-0237	1,800	200	68.6 x 68.6 x 10	10.4
001-0238	2,400	200	90 x 90 x 16	13.9
001-0239	3,600	200	90 x 90 x 16	21.1

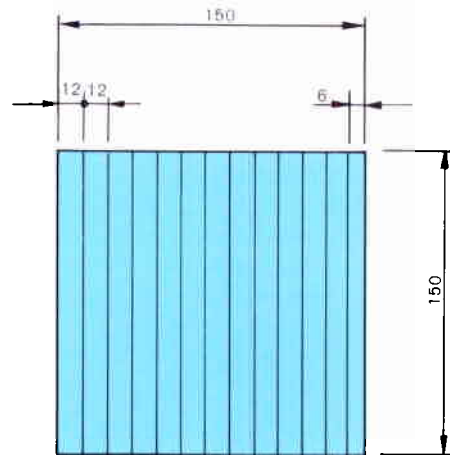
NOTE 1: Double blaze



NOTE 2: Double blaze



NOTE3: Double blaze



## Equally-Spaced, Straight Groove Concave Grating

Part No.	Grooves per mm	Radius of curvature (mm)	Blaze wavelength (nm)	Blank size H x W x T (mm)	Blaze angle (degree)
001-0448	2,400	2,000	25	40 x 36 x 10	1.8
001-0449	2,400	10,310	29	60 x 100 x 15	2.0
001-0438	1,200	10,310	38	60 x 98 x 15	1.3
001-0426	1,200	2,000	50	40 x 36 x 10	1.8
001-0277	600	200	250	25 x 20 x 5	4.3
001-0250	400	100	350	30 x 30 x 10	3.5
001-0249	350	100/67 <sup>1)</sup>	290	16 x 20 x 5	2.9
001-0451	600	200/134.7 <sup>1)</sup>	250	25 x 20 x 5	4.3

NOTE 1) Toroidal surface = (radius of curvature in horizontal direction)/(radius of curvature in vertical direction)

## Aberration-Corrected Concave Grating

### For Monochromator

#### ● Seya-Namioka Type

Part No.	Grooves per mm	Radius of curvature (mm)	Blaze wavelength (nm)	Blank size H x W x T (mm)	Blaze angle (degree)
001-0420	1,200	1,000	38	40 x 40 x 10	1.3
001-0261	1,200	1,000	38	50 x 40 x 10	1.3
001-0439	2,400	1,000	38	40 x 40 x 10	2.6
001-0440	2,400	1,000	38	40 x 50 x 10	2.6
001-0262	2,400	1,000	38	50 x 40 x 10	2.6
001-0441	2,400	1,000	38	68.6 x 68.6 x 10	2.6
001-0442	2,400	1,000	38	100 x 60 x 15	2.6
001-0422	1,200	1,000	96	40 x 40 x 10	3.3
001-0423	1,200	1,000	96	40 x 50 x 10	3.3
001-0424	1,200	1,000	96	50 x 40 x 10	3.3
001-0271	1,200	1,000	96	68.6 x 68.6 x 10	3.3
001-0425	1,200	1,000	96	76 x 80 x 15	3.3
001-0443	2,400	1,000	96	40 x 40 x 10	6.6
001-0444	2,400	1,000	96	40 x 50 x 10	6.6
001-0445	2,400	1,000	96	50 x 40 x 10	6.6
001-0446	2,400	1,000	96	60 x 70 x 15	6.6
001-0272	2,400	1,000	96	68.6 x 68.6 x 10	6.6
001-0447	2,400	1,000	96	100 x 60 x 15	6.6
001-0299	1,200	500	150	40 x 40 x 10	5.2
001-0265	1,200	500	150	40 x 50 x 10	5.2
001-0288	600	400	240	40 x 63 x 10	4.2
001-0278	600	200	250	25 x 20 x 5	4.3
001-0290	600	400	500	28 x 38 x 10	8.6

### For Monochromator

#### ● Normal-incidence Type

Part No.	Grooves per mm	Radius of curvature (mm)	Blaze wavelength (nm)	Blank size H x W x T (mm)	Blaze angle (degree)
001-0427	1,200	3,000	40	40 x 40 x 10	1.4
001-0428	1,200	3,000	40	40 x 50 x 10	1.4
001-0429	1,200	3,000	40	50 x 40 x 10	1.4
001-0430	1,200	3,000	40	68.6 x 68.6 x 10	1.4
001-0431	1,200	3,000	40	60 x 100 x 15	1.4
001-0432	1,200	3,000	150	40 x 40 x 10	5.2
001-0433	1,200	3,000	150	40 x 50 x 10	5.2
001-0434	1,200	3,000	150	50 x 40 x 10	5.2
001-0435	1,200	3,000	150	68.6 x 68.6 x 10	5.2
001-0436	1,200	3,000	150	60 x 100 x 15	5.2
001-0286	1,200	3,000	150	100 x 60 x 15	5.2
001-0256	600	100	200	20 x 20 x 5	3.4
001-0257	600	100	210	25 x 20 x 5	3.6
001-0260	600	150	230	30 x 30 x 10	4.0
001-0259	600	125	250	40 x 40 x 10	4.3
001-0279	600	200	250	25 x 25 x 5	4.3
001-0267	600	150	300	50 x 40 x 10	5.2
001-0452	900	150	300	50 x 40 x 10	7.8
001-0268	600	150	300	50 x 40 x 10	5.2
001-0255	600	80	400	28 x 28 x 5	6.9
001-0453	900	150	400	50 x 40 x 10	10.4
001-0274	600	150	450	50 x 40 x 10	7.8

### For Spectrograph

Part No.	Grooves per mm	Radius of curvature (mm)	Blaze wavelength (nm)	Blank size H x W x T (mm)	Blaze angle (degree)	Mounting standard incidence angle (degree)	Wavelength range with flat-field focusing (nm)
001-0450	2,400	15,920	15	30 x 50 x 10	1.9	88.7	1 ~ 5
001-0437	1,200	5,649	100	30 x 50 x 10	3.2	87	5 ~ 20
001-0253	500	100	210	20 x 18 x 5	3.0	-5.2	190 ~ 340
001-0280	600	200	250	25 x 25 x 5	4.3	0	200 ~ 300
001-0248	330	149.5	220	25 x 25 x 5	2.1	-1	200 ~ 520
001-0276	600	200	230	25 x 20 x 5	4.0	0.6	210 ~ 280
001-0245	300	50	250	9 x 9 x 5	2.2	-5.5	250 ~ 750
001-0269	600	150	450	18 x 18 x 5	7.8	0	440 ~ 700
001-0273	600	150	450	25 x 20 x 5	7.8	0	440 ~ 700
001-0242	150	20	520	7 x 7 x 5	2.2	2.2	500 ~ 600
001-0243	300	10	520	3 x 3 x 5	4.5	4.4	500 ~ 600
001-0246	300	50	520	15 x 15 x 5	4.5	4.4	500 ~ 600
001-0275	600	150	500	50 x 40 x 10	8.6	6	589 ~ 852
001-0247	300	50	800	15 x 15 x 5	6.9	7.3	700 ~ 900
001-0254	600	25	800	10 x 10 x 5	13.9	13.0	700 ~ 900
001-0295	600	400	770	28 x 38 x 10	13.4	19.1	720 ~ 820
001-0287	600	200	790	30 x 30 x 10	13.7	19.8	750 ~ 850
001-0296	600	400	790	28 x 38 x 10	13.7	19.1	750 ~ 850
001-0297	600	500	790	45 x 60 x 10	13.7	19.1	750 ~ 850
001-0244	300	25	1,250	10 x 10 x 5	10.8	10.1	1,200 ~ 1,400
001-0258	600	100	250	12 x 12 x 5	4.3	0	-
001-0298	600	710	500	64 x 78 x 15	8.6	-1	-

**Diffraction gratings of special specifications can also be manufactured on request.**

### 1) Material

Pyrex glass is used as a standard material. Hitachi is also prepared to use materials other than Pyrex glass when specified.

### 2) Coating

Diffraction gratings are coated with aluminum (Al) as a standard. Hitachi will coat the gratings with gold (Au) and platinum (Pt) as special specifications.

Diffraction gratings with Part No. 001-0450 and 001-0437 exceptionally are coated with gold (Au) as a standard.

### 3) Overcoating

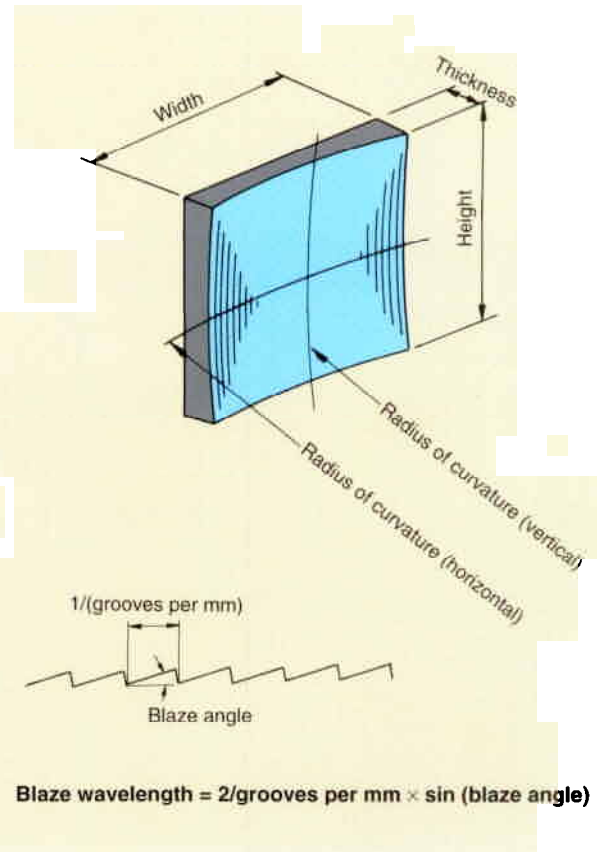
Diffraction gratings are overcoated with magnesium fluoride (MgF<sub>2</sub>) or lithium fluoride (LiF) as special specifications.

### 4) Dimensions

Diffraction gratings are manufactured to dimensions other than specified in this catalog. They can also be shaped round.

### 5) Certificate

For certifying the groove profile, an electron micrograph can be provided together with the manufactured diffraction grating at the expense of the customer.



**Reliable products and systems of proven quality for high customer satisfaction.**

Specifications in this catalog are subject to change with or without notice, as Hitachi continues to develop the latest technologies and products for our customers.

# HITACHI

*For further information, please contact your nearest sales representative.*



# GRATING SELECTION WORKSHEET

## Grating specification

Type of grating

- Plane
- Concave

Radius ..... mm

Line-space

- Constant (conventional grating)
- Varied (aberration-corrected grating)

Groove frequency ..... grooves/mm

Blaze wavelength ..... nm

Blaze angle ..... °

Blank size

- Rectangular

Ruled width (W) ..... mm  $\pm$  0.1 mm

Groove length (L) ..... mm  $\pm$  0.1 mm

Thickness ..... mm  $\pm$  0.2 mm

- Round

Diameter ..... mm  $\pm$  0.1 mm

Thickness ..... mm  $\pm$  0.2 mm

Blank material

- Pyrex
- Zero-dur
- Fused silica (SiO<sub>2</sub>)
- Other (specify) .....

Ruled area ..... (W) ..... (L) mm

Effective grating area ..... (W) ..... (L) mm

(around 2 ~ 4 mm smaller than ruled area)

Coating

- Al
- Au
- Pt
- Other (specify) .....

Overcoating

- Non
- MgF<sub>2</sub>
- LiF
- Other (specify)

Ambient temperature

- Lower than 40°C
- Lower than 200°C

## Optical system specification (if necessary)

Wavelength range ..... nm ..... nm

Reciprocal linear dispersion ..... nm/mm

Resolution ..... nm

System focal length ..... mm

F number .....

Mounting (append a sketch)

- Monochromator
- Spectrograph
- Other (specify)