Diffraction Grating Selection Guide

As a leader in the design and manufacture of diffraction gratings, Newport offers precision components for analytical instruments, laser and telecommunications equipment manufacturers, and for researchers and astronomers. Presented here are standard, off-the-shelf gratings for a wide variety of applications. For additional sizes and coatings or customized gratings, please contact us or visit our gratings selection tool at www.newport.com.

There are two fundamental types of grating masters: ruled and holographic. Each can be manufactured on a flat (plane) or concave substrate, and each type has its own advantages:

Ruled Gratings

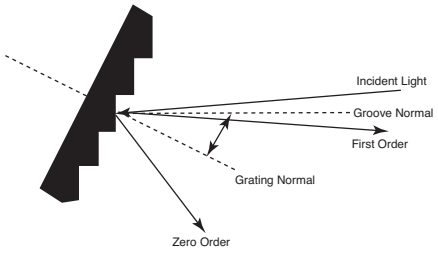
Can be blazed for specific wavelengths and generally have high efficiency. These gratings are often used in systems requiring high resolution.

Holographic Gratings

Will often have lower scatter since they are generated optically. These gratings can be designed to minimize aberrations and can have high efficiency in a single plane of polarization.

Plane Ruled Reflection Gratings

Designed for first order Littrow use, Newport's Plane Ruled Reflection Gratings are blazed for specific wavelengths and generally have high efficiency at those wavelengths. The groove spacing and blaze angle determine the distribution of energy. In Littrow use, light is diffracted from the grating back toward the source. Gratings used in the Littrow configuration have the advantage of maximum efficiency (or blaze) at specific wavelengths. Ruled gratings comprise the majority of diffraction gratings used in spectroscopic instrumentation. Typically used in systems with collimated, incident light, plane ruled gratings require auxiliary optics, such as lenses or mirrors, to collect and focus the energy. Ruled gratings are especially useful in systems requiring high resolution. At Newport, we have three ruling engines in full-time operation, each producing high-quality master gratings each year. These ruling engines provide gratings with triangular groove profiles, very low Rowland ghosts, and high resolving power. Mechanically ruled, individual grooves are burnished with a diamond tool against a thin coating of evaporated metal. Utilizing a high fidelity cast replication process, developed and enhanced through years of research and manufacturing experience, we have the ability to provide duplicates of master gratings that equal the quality and performance of the master grating.



Gratings used in first order near Littrow

Plane Holographic Reflection Gratings

Generated optically, Plane Holographic Reflection Gratings generally do not display periodic errors or ghosts often found in ruled gratings. They typically have a sinusoidal groove profile and are generated by the recording of an interference pattern onto a photoresist-coated substrate. Holographic gratings can provide excellent wavefront flatness and high efficiency in a single plane of polarization. Like their ruled counterparts, holographic gratings are most effective when used in the Littrow configuration. Newport offers a wide selection of holographic gratings with varying modulation depths (the ratio of groove depth to groove spacing). The lower the modulation, the shorter the wavelength limit to which the grating can be used, but the peak efficiency may be lowered as well. We have found that three modulation levels (high, medium, and low) are adequate for nearly all purposes. Since the grooves are symmetrical, they do not have a preferred blaze direction and hence, the gratings carry no blaze arrows.

Echelle Reflection Gratings

Unlike conventional ruled gratings, echelles are coarse, high-blaze angle gratings used in high diffraction orders. The virtue of an echelle lies in its high efficiency and low polarization effects over large spectral intervals. Providing very high dispersion and resolution, echelles enable compact system design. They are often used in or near Littrow configuration, in which the angle of incidence equals the angle of diffraction. Overlapping of diffraction orders is an important limitation of echelle gratings. Some type of order separation is essential, with cross-dispersion provided by another grating or a prism. The combination of grating and dispersing element leads to the ability to focus an image on a flat plane compatible with CCD or CID detectors. Common applications include atomic absorption spectroscopy, laser tuning, and astronomy. Since they operate in many diffraction orders, echelles are capable of wide wavelength coverage, being used from 100 nm into the infrared. Our echelle gratings have been used in several space spectrographs, including the Hubble Space Telescope. Newport's echelle gratings are subjected to careful testing. Resolution close to the theoretical limit can be verified by interferometric and Foucault wavefront tests, and also by observation of the hyperfine spectra of mercury. Efficiency is determined with mercury and laser light sources to ensure narrow spectral line widths.

Plane Transmission Gratings — Visible

Transmission gratings are designed to direct as much light as possible for a specific wavelength into lower orders. At Newport, we can replicate transmission gratings from almost any of our plane ruled gratings. Transmission gratings have special uses in spectrometry. Any optical imaging system, such as a camera or telescope, can be converted into a spectrograph by placing a transmission grating in the system, usually in front of the objective lens. Transmission gratings can also serve as convenient beamsplitters for monochromatic light sources, such as lasers. Geometrical optic considerations require relatively coarse

groove spacing (usually, no more than 600 grooves per mm). Finer grating pitches are possible, but at sharply reduced efficiencies. Unlike reflection gratings, the groove angle is much larger than the blaze angle for transmission gratings. The groove angle for transmission gratings is defined to be the angle at which a normally incident beam at the blaze wavelength is diffracted.

Concave Constant-Deviation Monochromator Gratings

Concave holographic gratings function as both a dispersing and focusing element for monochromators. These gratings contain two focusing elements: the substrate, and the groove curvature. As a result, an instrument designer can replace a lens system by using concave gratings, leading to a reduction of optics in a system, and thus, cost. Another advantage of a system based on concave gratings is decreased optical aberrations such as coma and astigmatism.

Handling Gratings

The grooved profile is typically etched into the front surface of diffration grating. This surface cannot be touched or otherwise come in contact with another object without damaging it and perhaps affecting its performance. Newport diffraction gratings are replicataed optics comprised of a number of layers - typically a substrate, resin layer, a reflective and a protective coating. Damage to the grating can take the form of contamination or distortion of the microscopic groove profile. Damage to this microscopic groove profile is, unfortunately, irreversible. The resin layer like modeling clay, will retain a permanent imprint. Contamination with finger oils, moisture, etc. is also often permanent. Because of the sensitive nature of the grating groove profile, it is imperative that the user take precautions in handling gratings.

Guidelines for Handling Gratings

- Never touch the grooved surface of a diffraction grating.
- Never allow any mount or cover to come in contact with the grooved surface of a diffraction grating.
- Do not talk or breathe over the grooved surface of a diffraction grating.

Specifications

Dimensions	Length & Width: ±0.1 mm Thickness: ±0.5 mm
Groove Spacing Tolerance	<0.05%
Alignment of grooves to side of substrate	±0.15°
Clear Aperture	Up to 1 mm from edge
Surface Figure	λ/4 at 632.8 nm over the clear aperture, typical (λ/2 for 25.4 x 50.8 mm, or 50.8 mm square sizes, typical)

Other Gratings

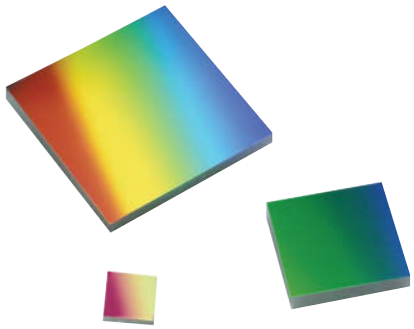
Newport also offers the widest selection of diffraction gratings beyond our standard, off-the-shelf products, such as:

- Concave Ruled Reflection Gratings
- Large Astronomical Reflection Gratings
- Plane Transmission Gratings – UV Spectrum
- Diode and Dye Laser Tuning Gratings
- Molecular Laser Tuning Gratings
- Other Concave Holographic Aberration-Reduced Reflection Gratings
- Pulse Compression Gratings
- Telecommunications Gratings

For more information about these gratings, please contact us to discuss your application or your OEM design requirements.

For more technical information about diffraction gratings, please see our *Diffraction Grating Handbook*.

Plane Ruled Reflection Gratings



Plane Holographic Reflection Gratings