

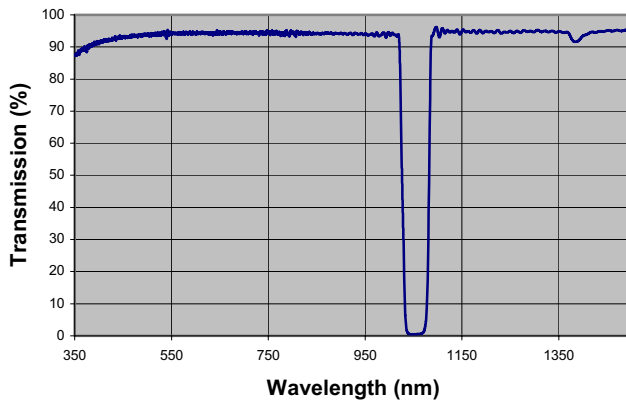
BARR CUSTOM RUGATE NOTCH FILTERS

Overview:

Custom-designed Rugate notch filters are available from Barr for use in a wide variety of spectroscopically-based and laser-based applications. In contrast to conventional notch filters made with dielectric-stack technology, Barr's Rugate notch filters offer effective optical reflection within the notch, while retaining high transmission over a broad spectral range. Rugate notch filters can be designed as single-line or multi-line notch filters. They can be designed for use at any incident angle and show extremely robust environmental durability characteristics.



1064nm Rugate Notch Filter



As optical interference devices Rugate filters show shift to shorter wavelength with increasing incident angle. The bandwidth of any interference device is proportional to the index contrast, and narrow notches can be produced by reducing index contrast. It is also possible to produce narrow

Rugate notch filters with high levels of rejection, but considerable coating thickness is required, and such coatings can have significant amounts of mechanical stress. Barr uses specialized processing methods, however, to mitigate this stress, thus maintaining a favorable surface flatness characteristic in the coated optic.

A Rugate filter has a continuous variation in refractive index following a prescribed profile. Adjusting the index profile places notches of independent optical density and bandwidth anywhere within the transmission region of the materials used in the fabrication of the filter.

Barr's capability to produce Rugate notch filters with a continuous variation in refractive index avoids material constraints imposed by use of more traditional thin film designs and may provide solutions to some of your more challenging optical requirements.

Rugate Notch Filter Features:

- Available as single-line or multi-line notch
- Wavelength position of notch or notches can be preset to user-specified values
- Can be designed for both normal incidence and non-normal incidence applications
- Either high reflectance (> 99.9%) within the notch or deep blocking, up to OD 6 achievable
- Suitable for use over wide operating temperature range (- 200°C to + 200°C)
- Can be constructed with minimal wavefront distortion to be suitable for imaging applications
- Can be fabricated in a wide variety of shapes and sizes
- Offer extremely robust environmental durability characteristics
- Custom Rugate notch filters can presently be fabricated within the spectral region from the UV to the near-IR



Representative Applications for Rugate Notch Filters:

- Fluorescence-based instruments for effective rejection or reflection of single- or multiple laser lines
- Eye-safe applications in Ophthalmic-related instrumentation, for providing effective laser attenuation at pre-selected laser lines while ensuring high, largely color-neutral transmission in the visible spectrum
- Raman Spectroscopy applications; for effective Rayleigh line rejection
- Image-quality Astronomy-related applications requiring high transmission over a broad spectral range ,with simultaneous rejection of a narrow wavelength band or bands.

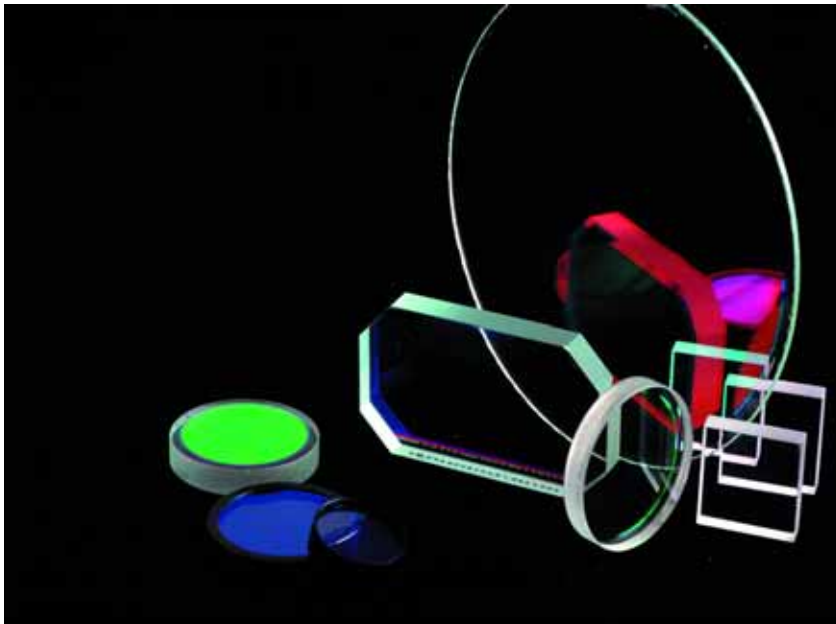
Representative Properties & Design Capabilities for Custom Rugate Notch Filters

Spectral Properties:

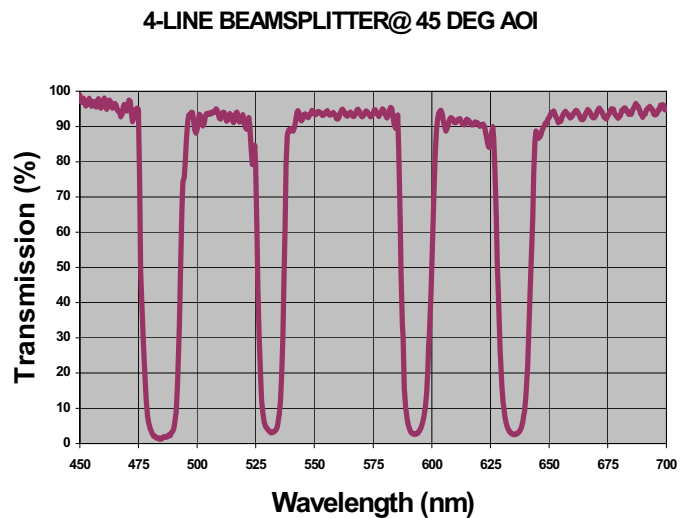
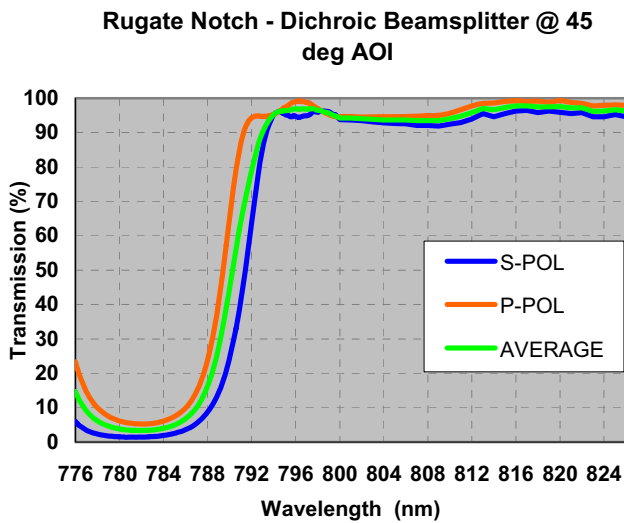
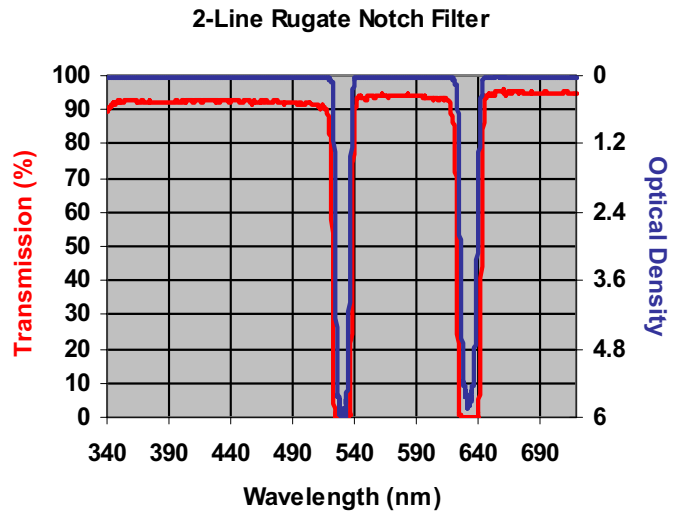
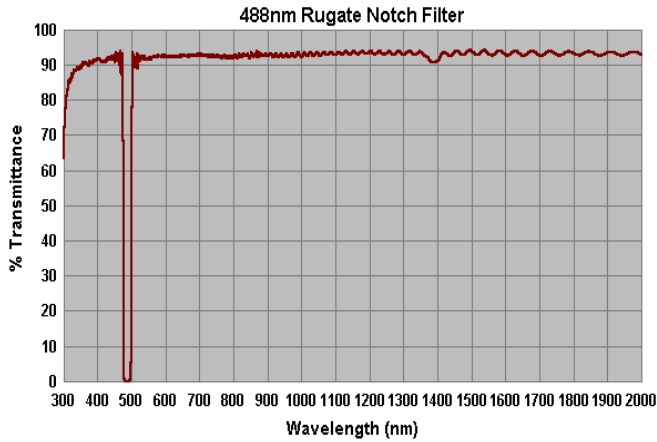
- Spectral Design range: 250nm to 2500nm
- Bandwidth (FWHM): > 2% of Center Wavelength
- Single or Multi-line reflection or rejection
- Rejection: up to OD 6 measured
- Reflection: > 99.9%R
- Transmission: > 95% (ignoring rear surface losses)
- Transmission Band Ripple: < +/- 2%
- Angle-of-Incidence: normal or oblique angles
- Autofluorescence: Low-to-no autofluorescence
- Surface Figure: Flatness and transmitted wavefront to 1/10 wave

Physical Properties:

- Thermal Shift: Thermal Coefficient typically < $[(4\text{ppm} \times \text{Center } \lambda)] / \text{deg C}$
- Operating Temperature Range: Can be designed for operation -200°C to $+200^{\circ}\text{C}$
- Environmental Durability: -MIL-STD-810C, MIL-F-48616, MIL-C-48497A, MIL-C-675, and MIL-STD-13508
- Tape, Abrasion, 10 day temperature-humidity cycling, Salt Fog, High and Low Temperature Storage
- Barr Rugate Notch filters have been exposed to 95%RH @ 65°C for 9 years with no sign of degradation in properties.
- Sizes/Shapes: Can be fabricated in a variety of shapes and sizes, either mounted or unmounted in holders, to match specific application requirements



Measured Spectral Data for Representative Custom-Designed Rugate Notch Filters



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