

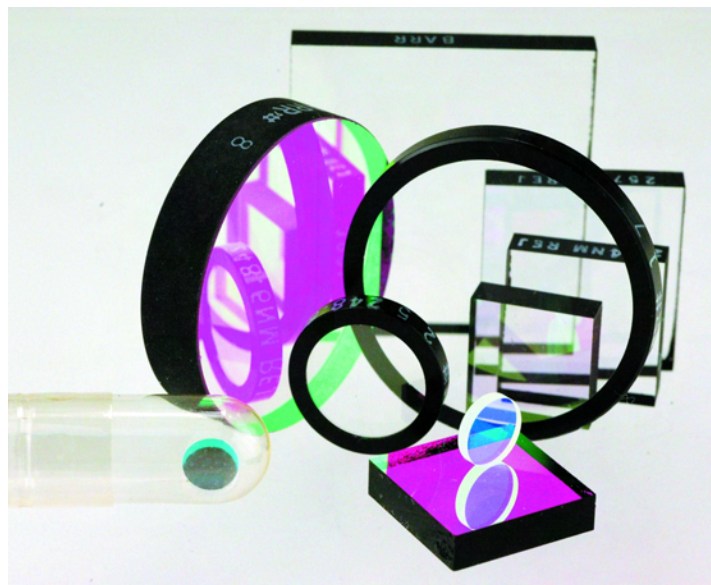
CUSTOM, PRECISION OPTICAL INTERFERENCE FILTERS FOR RAMAN SPECTROSCOPY APPLICATIONS

Overview:

Barr is a recognized industry leader in the design and manufacture of precision optical filters for Raman spectroscopic applications, supplying filters in small, prototype quantity as well as in large OEM volume. All filters are designed to customer specifications. With Barr's unique organizational structure you are placed in direct contact with Barr's filter engineering design team during the entire process of specifying, designing, and manufacturing the optical filter. In this way Barr can provide the best optical filter solution for any particular Raman spectroscopy application.

Barr's advanced coating deposition technologies have been applied to produce optical interference filters well suited for the most state-of-the-art Raman spectroscopic applications. Some related noteworthy filter technology innovations at Barr include:

- High performance optical filters (bandpass, dichroic mirror, laser rejection) for use in UV, visible, or near-IR spectral regions.
- Filters with ultra-steep slope which provide deep blocking at the laser line while providing high transmission close to the laser line (in some cases as close as 100 cm^{-1}).
- Miniature filters made with durable, hard oxide coatings ideal for use in fiber-optic-based Raman instruments.
- Filters made with superior environmental durability characteristics and showing low temperature coefficient, suitable use in Raman probes.
- Image quality filters exhibiting low wavefront distortion and superior surface quality.



Typical Raman-based applications where Barr optical filters are utilized:

- Raman Fiber Optic Probes
- Raman Process Analyzers
- Raman Imaging Spectrographs
- Raman Microscopes

Available Filter Types:

- Bandpass Filters (Plasma line rejection filters)
- Dichroic Beamsplitters
- Laser Rejection Filters
 - Steep Edge
 - Rugate Notch
 - Discrete-Layer Notch

Physical and Environmental Durability Properties:

Filter dimensions

- available in a wide range of sizes and shapes including miniature sizes with reduced thickness for use in fiberoptic systems
- supplied round with or without ring, or rectangular in shape
- conformance to tight dimensional tolerances

Environmental Durability

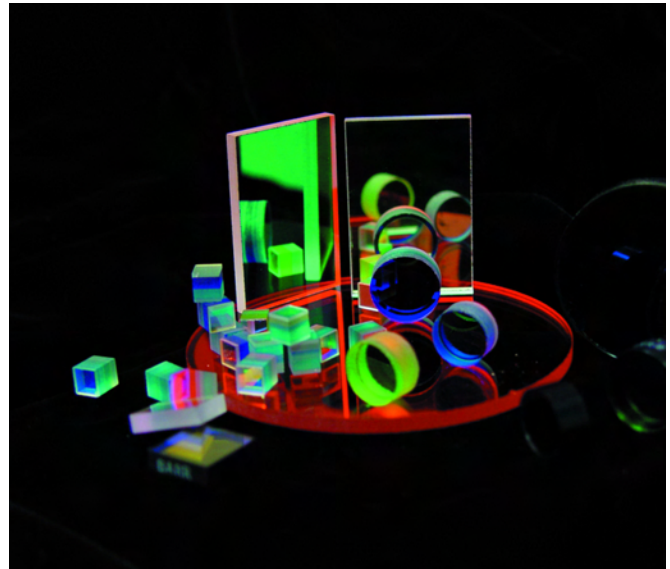
- filters constructed with durable oxide-type coatings
- coatings show low thermal shift: Thermal Coefficient typically $< [(4\text{ppm} \times \text{Center } \lambda)] / \text{deg C}$
- wide operating temperature range

Wavefront Control

- filters can be constructed to specified transmitted or reflected wavefront properties

Surface Quality

- Conformance to visual inspection standards routinely achieved for MIL-O-13830, MIL-F-48616
- 60/40 Scratch/Dig routinely supplied



Key Spectral Properties of Barr Optical Filters for Raman Applications:

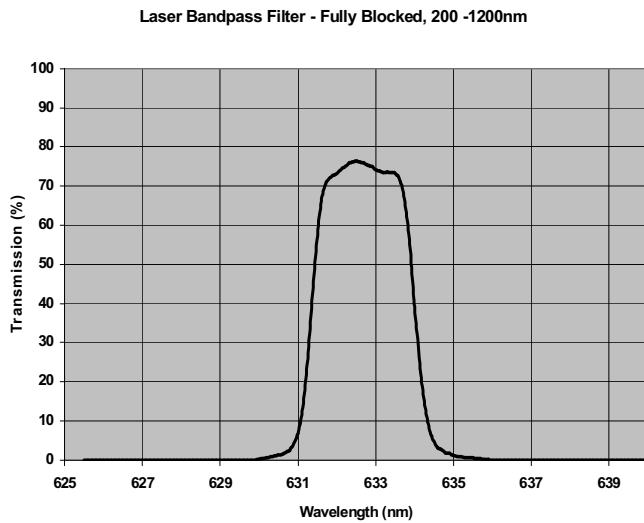
Wavelength range

Barr routinely produces custom optical interference filters for Raman spectroscopic applications over the broad wavelength range of 244nm to 1064nm. Also, depending upon requirements, developmental work can be done to produce specialized Raman filters for use outside of this wavelength range.

Key Spectral Properties of Barr Optical Filters for Raman Applications (continued):

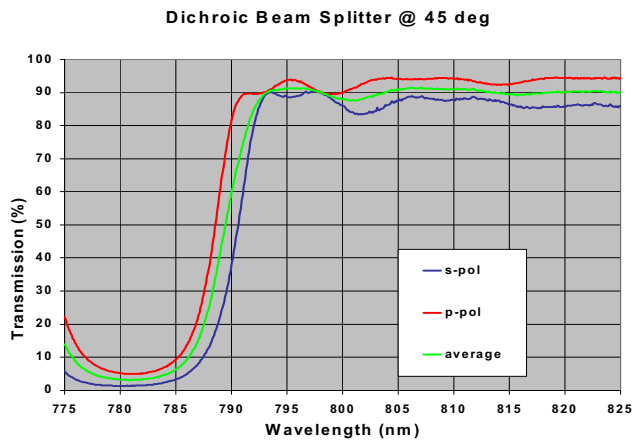
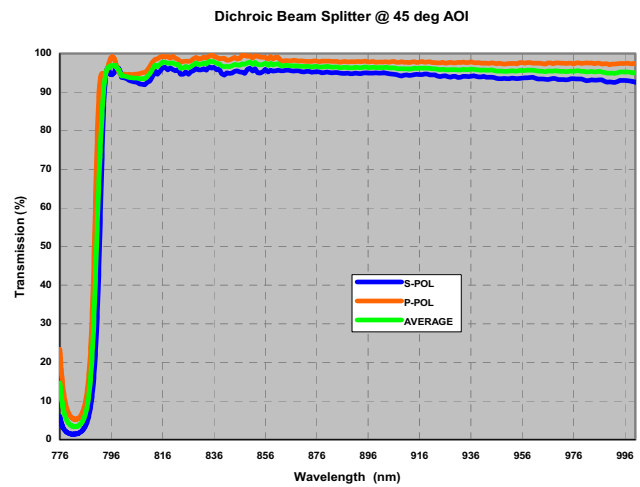
Bandpass filters

- high transmission
- effective blocking of laser plasma lines
- wide spectral blocking range
- designed for use at normal or non-normal incident angle
- image quality available
- low-to-no autofluorescence



Dichroic Beam Splitters

- transmit or reflect Raman scattering
- transmit or reflect laser excitation
- steep slope with low polarization splitting
- use at 45 deg AOI or at other angle
- low-to-no autofluorescence

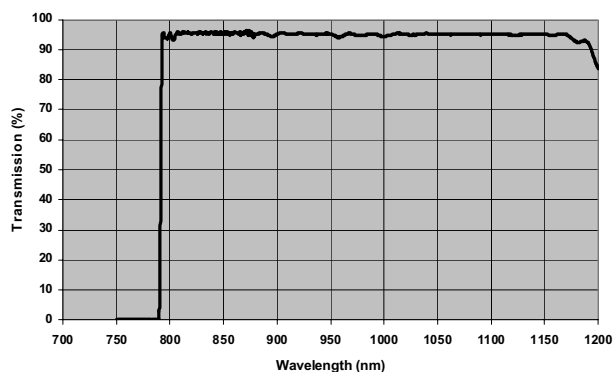


Key Spectral Properties of Barr Optical Filters for Raman Applications (continued):

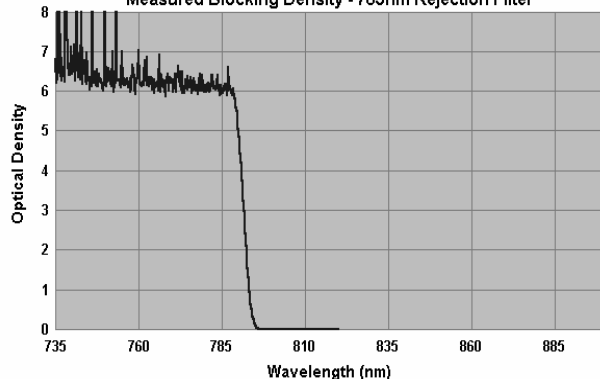
Laser Rejection (Steep Edge) Filters

- deep blocking at laser line (Measured OD6 +)
- steep slope (< 0.5% achievable, from OD 6 to 50% T)
- high transmission as close as 100cm^{-1} from laser line to 4000 cm^{-1} and beyond if required
- low ripple in transmission band
- designed for use at normal or non-normal incidence
- low-to-no autofluorescence

785nm Rejection Filter



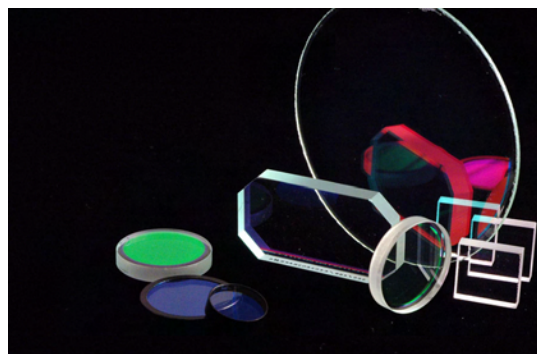
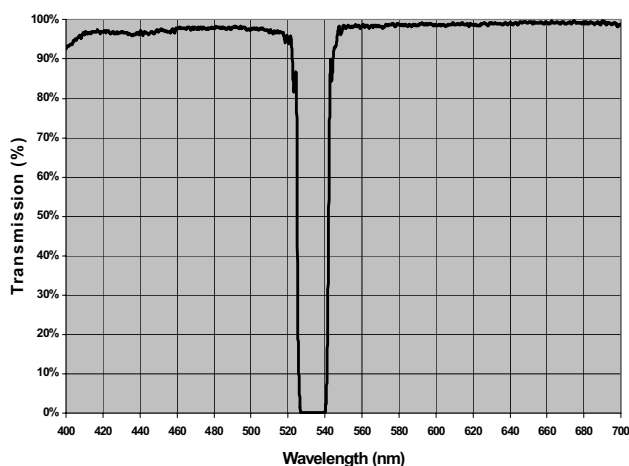
Measured Blocking Density - 785nm Rejection Filter



Laser Rejection Notch Filters

- deep blocking at laser line
- broad spectral transmission range
- single or multiple line rejection

532nm Rugate Notch Filter



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