Optics

- Improved signal-to-noise
- Excellent laser rejection solution

QUANTAMAX™ LASER EDGE LONGPASS FILTERS

QuantaMAX

Laser Edge Longpass Filters

Recent developments in sputter coatings have produced a series of QuantaMAX™ Laser Edge Longpass interference filters to attenuate, or block, scattered energy from reaching your detector, therefore improving critical signal-to-noise.

At the detector, both desired and unwanted scatter will be present, with the signal orders of magnitude lower than the scatter. Scatter is the result of minor irregularities and characteristic of the system optics and application, including uncontrolled light from the sample and filter holder. Combined with advances in laser and detector technology, our laser edge longpass filters are part of a revolution in Raman spectroscopy, expanding the use and applications of this analytical method.

QuantaMAX™ Laser Edge Longpass interference filters are an excellent laser rejection solution when used in a collimated light path on the detector side of the system. These filters attenuate shorter wavelengths to ~0.7 edge wavelength and transmit 95% of Stokes Raman or fluorescence signal and exhibit very high contrast between the Rayleigh and Raman transmission. Angle tuning is required for optimal performance.

QuantaMAX™ Laser Edge Longpass Filters

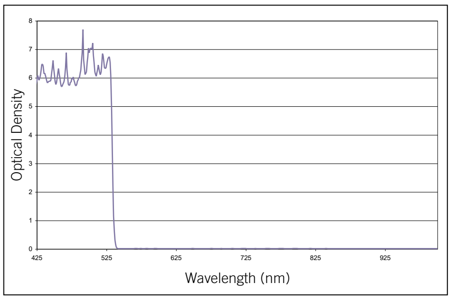
Laser Line (nm)	Transmission (Peak)	Product SKU	Description
441.6	95% average to 1100 nm	XRLP444	444QMLP
457.9	95% average to 1100 nm	XRLP463	463QMLP
473.0	95% average to 1100 nm	XRLP477	477QMLP
488.0	95% average to 1100 nm	XRLP492	492QMLP
514.5	95% average to 1100 nm	XRLP519	519QMLP
532.0	95% average to 1100 nm	XRLP537	537QMLP
568.2	95% average to 1100 nm	XRLP573	573QMLP
632.8	95% average to 1100 nm	XRLP638	638QMLP
647.1	95% average to 1100 nm	XRLP653	653QMLP
664.0	95% average to 1100 nm	XRLP670	670QMLP
780.0	95% average to 1800 nm	XRLP787	787QMLP
785.0	95% average to 1800 nm	XRLP792	792QMLP
808.0	95% average to 1800 nm	XRLP816	816QMLP
830.0	95% average to 1800 nm	XRLP838	838QMLP
980.0	95% average to 1800 nm	XRLP989	989QMLP
1064.0	95% average to 2000 nm	XRLP1076	1076QMLP
1319.0	95% average to 2000 nm	XRLP1335	1335QMLP

Product SKU denotes cut-on edge

Specifications

Physical	Size	Stock and custom sizes available
	Thickness	< 4.0 mm
Transmission Ripple	< +/- 1.5% typical	
Blocking	≥ OD 5 at laser wavelength	
Edge Slope	<1% from OD 0.3-OD 5	
Angle of Incidence	0.0° - 10.0° tunable	
Transmitted Wavefront Error	< 0.5 λ over the clear aperture at 633 nm	
Beam Deviation	< 15 arc seconds	
Surface Quality	E/E per MIL-C-48497A	
Filter Construction	Single substrate surface coated	

XLRP537 – actual representation



CUSTOM CONFIGURATIONS AVAILABLE UPON REQUEST

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LASER COMPONENTS®

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Angle Tuning Edge Filters

All edge filters can be angle tuned to achieve optimal signal to noise. Angle tuning the filter will blue shift the transmission curve and allow Raman signals closer to the laser line to pass through the filter, at some expense to blocking, at the laser line. The filter can be oriented up to about 15°, normal normal incidence.

At a 15° angle of incidence, the cut-on wavelength of the longpass edge filter will shift blue at approximately 1% of the cut on value at normal incidence. A filter that cuts on at 600nm with normal orientation will cut on at 594nm when tipped to 15°. A consequence of this blue shift is that the blocking at the laser line will decrease by approximately 2 levels of optical density.

A secondary feature of angle tuning is that reflected energy is redirected from the optical axis. For longpass edge filters, select a filter with an edge that is to the red of the desired cut off and adjust the filter angle until optimal performance is achieved.

For more than 40 years Omega Optical has been a leading manufacturer of high performance optical interference filters for a wide range of applications in Raman spectroscopy.

Raman Spectroscopy General Overview

Raman spectroscopy provides valuable structural information about materials. When laser light is incident upon a sample, a small percentage of the scattered light may be shifted in frequency. The frequency shift of the Raman scattered light is directly related to the structural properties of the material. A Raman spectrum provides a "fingerprint" that is unique to the material. Raman spectroscopy is employed in many applications including mineralogy, pharmacology, corrosion studies, analysis of semiconductors and catalysts, in situ measurements on biological systems, and even single molecule detection. Applications will continue to increase rapidly along with further improvements in the technology. A Raman signature provides positive material identification of unknown specimens to a degree that is unmatched by other spectroscopy's. Raman spectroscopy presents demanding requirements for the detection and resolution of narrow-bands of light with very low intensity and minimal frequency shift relative to the source. We are committed to supporting this science with optical coatings of the highest phase thickness and resulting superior performance.

Raman Scattering

When a probe beam of radiation described by an electric field **E** interacts with a material, it induces a dipole moment, **μ**, in the molecules that compose the material: **μ = a x E** where **a** is the polarizability of the molecule. The polarizability is a proportionality constant describing the deformability of the molecule. In order for a molecule to be Raman-active, it must possess a molecular bond with a polarizability that varies as a function of interatomic distance. Light striking a molecule with such a bond can be absorbed and then re-emitted at a different frequency (Raman-shifted), corresponding to the frequency of the vibrational mode of the bond. If the molecule is in its ground state upon interaction with the probe beam, the light can be absorbed and then re-emitted at a lower frequency, since energy from the light is channeled into the vibrational mode of the molecule. This is referred to as Stokes-shifted Raman scattering. If the molecule is in a vibrationally excited state when it interacts with the probe beam, the interaction can cause the molecule to give up its vibrational energy to the probe beam and drop to the ground state. In this case, the scattered light is higher in frequency (shorter wavelength than the probe beam). This is referred to as anti-Stokes Raman scattering, which under normal conditions is much less common than Stokes scattering. The most common occurrence is that light is absorbed and re-emitted at the same frequency. This is known as Rayleigh, or elastic scattering.

Both Rayleigh and Raman scattering are inefficient processes. Typically only one part in a thousand of the total intensity of incident light is Rayleigh scattered, while for Raman scattering this value drops to one part in a million. Thus, a major challenge in Raman spectroscopy is to attenuate the light that is elastically scattered in order to detect the inelastically scattered Raman light.

Blocking Rayleigh Scattering

In order to obtain high signal-to-noise in Raman measurements, it is necessary to block Rayleigh scattering from reaching the detector while transmitting the Raman signal. It's possible to use a double or triple grating spectrometer to accomplish rejection of the background signal. However, this results in low (~10%) throughput of the desired Raman signal. In many cases a better alternative is to use a Raman notch or Raman edge filter. Notch filters transmit both Stokes and anti-Stokes Raman signals while blocking the laser line. Edge filters (also known as barrier filters) transmit either Stokes (longpass) or anti-Stokes (shortpass).

Important considerations in the choice of an edge filter:

1. How well does the filter block out the Rayleigh scattering? Depending on the geometry of the experiment and the sample, blocking of > OD5 at the laser line is usually sufficient.

2. How steep is the edge, or transition from blocking to transmitting? The steepness of the edge required depends on the laser wavelength and the proximity of the Raman shifted signal of interest to the laser line. If the laser wavelength is 458nm, one would require > OD5 blocking at 458nm, and as high as possible transmission only 4nm away (at 462nm) in order to see a Stokes mode 200 cm-1 from the laser line. If the laser wavelength is 850nm, one would require blocking at 850nm and transmission at 865nm (15nm away from the laser line) in order to detect a signal at 200cm-1. Therefore, the slope of a filter that is required to look at a low frequency mode is steeper at bluer laser wavelengths.

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