

Optics & Coatings

120nm - 1064nm



Excimer Laser Optics

VUV/UV Optical Filters

Nd:YAG Laser Optics

VUV/UV Broadband Mirrors

 **ACTON**
RESEARCH CORPORATION

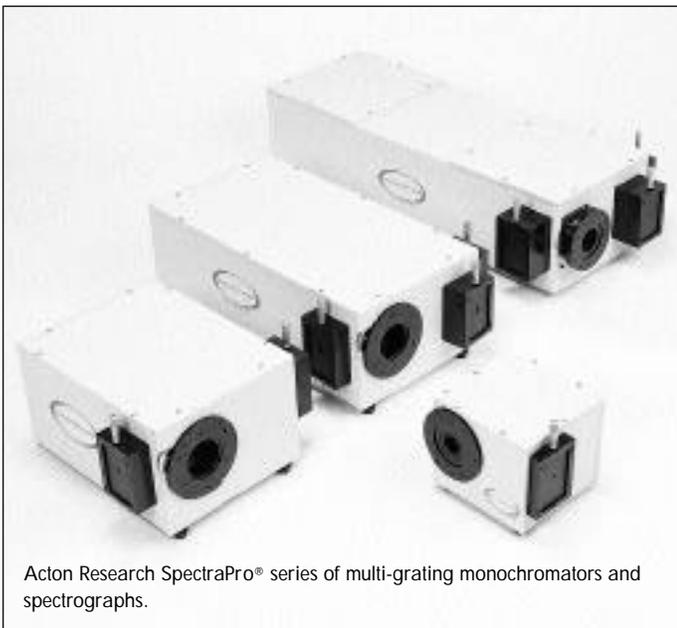
Acton Research Corporation, a leading manufacturer of high performance optical coatings, finished optics and spectroscopic instrumentation, is proud to be celebrating over 40 years of superior quality and service!

Optics & Coatings - Acton Research has a rich history of innovative design and manufacturing including optics and coatings for cutting-edge applications such as semiconductor laser systems and excimer laser vision-correction instruments (LASIK). We have also provided optics for a number of space missions, including the first Apollo missions, the Hubble Space Telescope and the recent TRACE mission (Transition Region and Coronal Explorer).

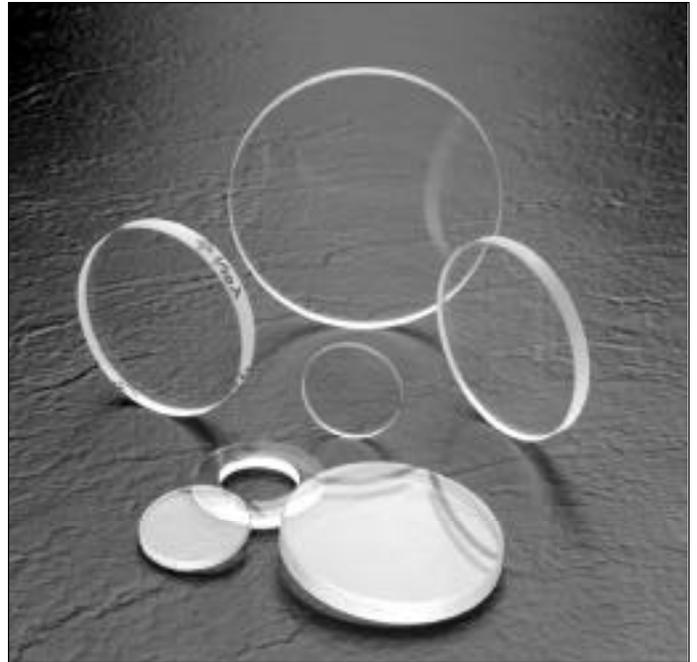
Our success is based on extensive coating experience and the continued emphasis on coating development. Acton Research state-of-the-art coating methods assure that each customer receives high-quality optics designed for their specific application.

Our commitment is to offer the highest performance and longest lifetime optics available.

Spectroscopy Products - Acton Research also produces the industry standard SpectraPro® series of multi-grating monochromators and spectrographs, the new InSpectrum integrated CCD spectrometer, vacuum spectrometers, as well as complete spectroscopic measurement systems. These instruments include integrated data acquisition and analysis hardware with software for research and industrial spectroscopy applications.



Acton Research SpectraPro® series of multi-grating monochromators and spectrographs.



Markets - Acton Research products are used in nearly every major industry incorporating optical or electro-optical technologies including:

**Laser • Semiconductor • Telecom • Medical
Environmental • Analytical Chemistry • Spectroscopy
Aerospace • Physics • Basic & Applied Research**

We are pleased to provide you with Acton Research's Optics and Coatings catalog. Enclosed you will find information on our standard optical components and coatings; including long-lifetime excimer and Nd:YAG laser optics as well as VUV/UV broadband mirrors and VUV/UV optical filters for demanding commercial and research applications.

Acton Research routinely provides large OEM quantities as well as single pieces. We would be pleased to discuss any custom requirements you might have for optics or coatings. Our technical engineers and optics sales staff understand, anticipate, and respond to your needs, enabling you to utilize our innovative coatings and optics technology to achieve your goals.

**Call 978.263.3584 today or visit our
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High Power Excimer Laser Mirrors

Acton Research high power excimer laser mirrors are multi-layer dielectric coated mirrors designed for use with high energy excimer lasers. These coatings have yielded superior high damage thresholds. Representative reflectance / transmittance curves for these mirrors are shown on the following page.

Acton Research maintains a stock supply of these beam-turning and normal incidence mirrors for fast delivery to your facility. Mirrors and coatings on Acton mirror blanks or customer supplied material can be produced and supplied in volume, keeping the price very competitive.

We also provide excimer laser beam attenuators that allow variation in the amount of laser energy transmitted. Please note that coatings and mirrors for other UV laser wavelengths are also available. Please contact the Optics Sales department for details and pricing.



Standard Mirror Blank Specifications

Material: UV Laser Grade Fused Silica (VUV Grade Calcium Fluoride for 157nm mirrors)

Parallelism: 3 arc minutes

• **Chamfer:** 0.5mm x 45° nominal

• **Clear Aperture:** Central 80%

Surface Figure: 1/10 wave at 632.8nm

• **Surface Finish:** 20-10 scratch-dig

Sizes: 1.0" Dia. x 0.250" thick • 1.5" Dia. x 5mm thick • 2.0" Dia. x 0.375" thick

High Power Excimer Laser Mirrors - Normal Incidence

Excimer Laser Wavelength	Reflectance at N.I.	Mirror Part Numbers		
		1.0" Dia. (25.4mm)	1.5" Dia. (38.1mm)	2.0" Dia. (50.8mm)
157nm (F ₂)	91%	157-FR-1D-FLC	157-FR-1.5D-FLC	157-FR-2D-FLC
193nm (ArF)	97%	193-FRE-1D-MB	193-FRE-1.5D-MB	193-FRE-2D-MB
248nm (KrF)	98%	248-FR-1D-MB	248-FR-1.5D-MB	248-FR-2D-MB
308nm (XeCl)	98%	308-FR-1D-MB	308-FR-1.5D-MB	308-FR-2D-MB
353nm (XeF)	99%	353-FR-1D-MB	353-FR-1.5D-MB	353-FR-2D-MB

High Power Excimer Laser Mirrors - 45° Angle of Incidence

Excimer Laser Wavelength	Reflectance at 45°	Mirror Part Numbers		
		1.0" Dia. (25.4mm)	1.5" Dia. (38.1mm)	2.0" Dia. (50.8mm)
157nm (F ₂)	89%	157-FR45-1D-FLC	157-FR45-1.5D-FLC	157-FR45-2D-FLC
193nm (ArF)	97%	193-FR45E-1D-MB	193-FR45E-1.5D-MB	193-FR45E-2D-MB
248nm (KrF)	97%	248-FR45-1D-MB	248-FR45-1.5D-MB	248-FR45-2D-MB
308nm (XeCl)	97%	308-FR45-1D-MB	308-FR45-1.5D-MB	308-FR45-2D-MB
353nm (XeF)	98%	353-FR45-1D-MB	353-FR45-1.5D-MB	353-FR45-2D-MB



High Power Excimer Laser Mirrors

Damage Threshold Information

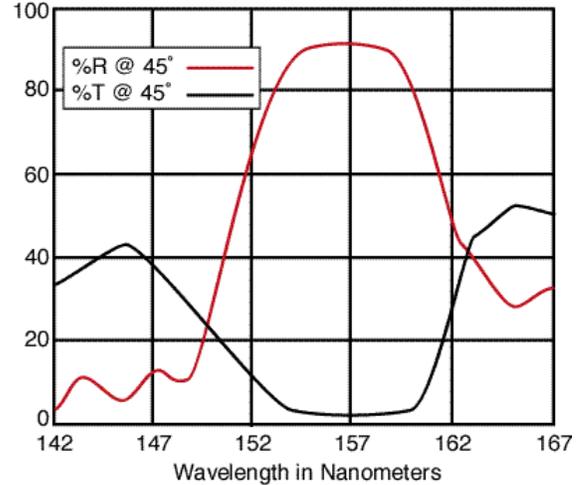
Damage thresholds for these excimer laser mirrors were tested with a pulse duration of 15-20ns, on clean, uncontaminated coatings. Repetition rates in some tests were as high as 100hz, and coatings were applied to UV fused silica substrates.

Coating Type (N.I.)	Coating Type (45°)	Damage Threshold
157-FR	157-FR45	0.3-0.75 J/cm ²
193-FR	193-FR45E*	1 - 2 J/cm ²
248-FR	248-FR45	4-7 J/cm ²
308-FR	308-FR45	4-7 J/cm ²
353-FR	353-FR45	4-7 J/cm ²

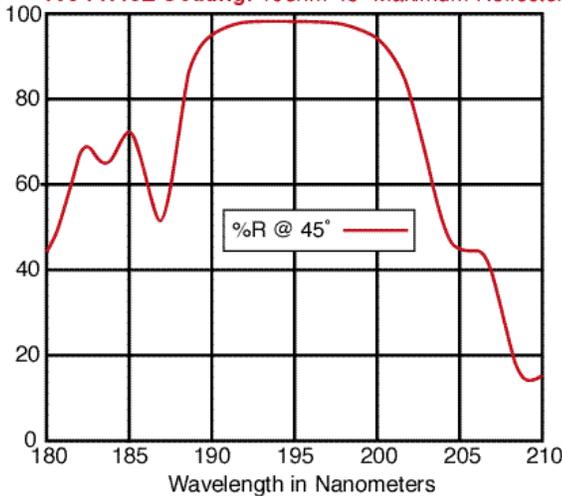
* Due to the superior reflectance and laser damage resistance of our 193-FR45E coating, we have now made it the standard 193nm front-surface coating.

157-FR45 Coating:

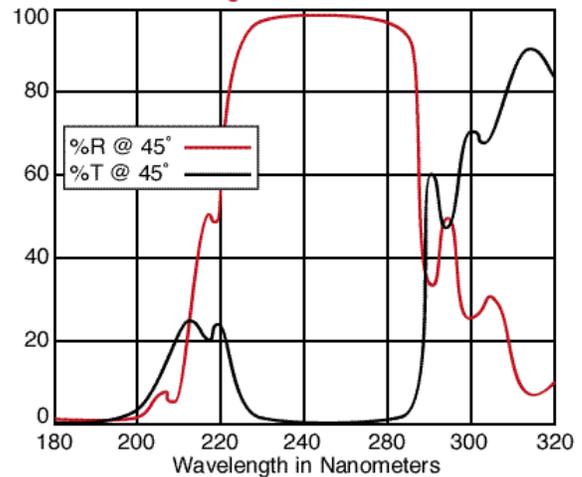
157nm 45° Maximum Reflector on CaF₂ Substrate



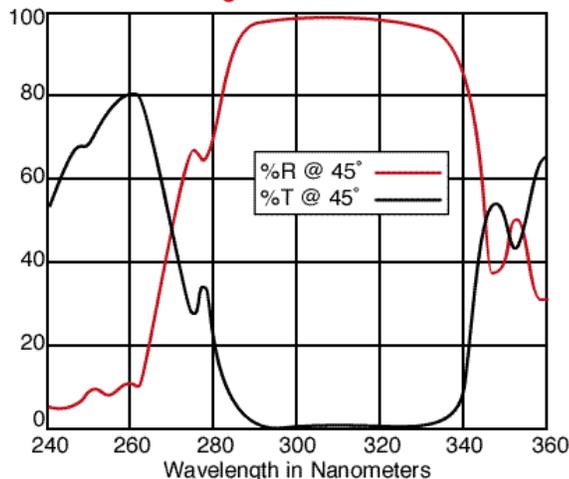
193-FR45E Coating: 193nm 45° Maximum Reflector



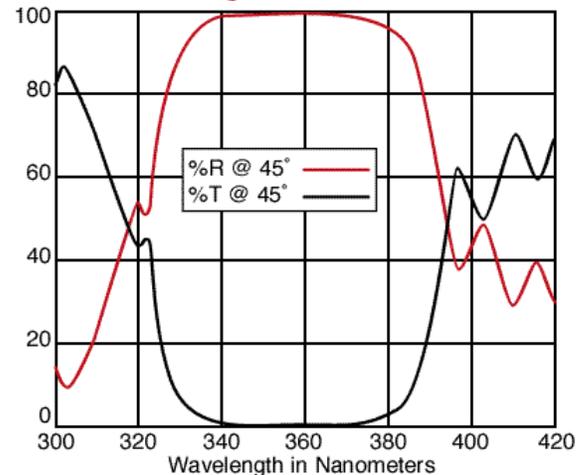
248-FR45 Coating: 248nm 45° Maximum Reflector



308-FR45 Coating: 308nm 45° Maximum Reflector



353-FR45 Coating: 353nm 45° Maximum Reflector



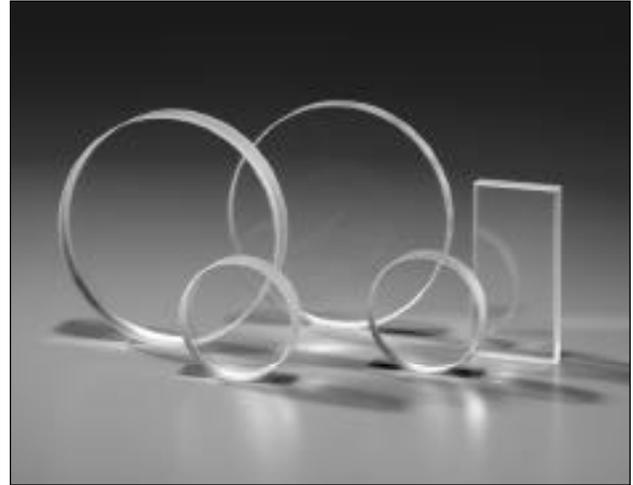


“ HDT ” Nd:YAG Laser Mirrors

Acton Research “HDT” series of optics and coatings for Nd:YAG lasers are optimized for high damage threshold and high durability tolerance. The new 266-FR45 HDT mirrors, for example, provide 98% reflectance and laser induced damage threshold of 4 - 7 J/cm² (dependent on specific conditions).

Our standard mirrors, listed below, are available for fast delivery to laser manufacturers, system integrators and laser end users. High performance anti-reflection coatings are available for all the Nd:YAG wavelengths listed below. See pages 8-9 for more information.

Multi-wavelength mirrors and coatings are also available to enhance transmission at specified wavelengths. Contact the Optics Sales department with your custom requirements.



Standard Mirror Substrate Specifications

Material: UV Laser Grade Fused Silica

Parallelism: 3 arc minutes

Surface Figure: 1/10 wave at 632.8nm

Chamfer: 0.5mm x 45° nominal

Surface Finish: 20-10 scratch - dig

Clear Aperture: Central 80%

Sizes: 1.0" Dia. x 0.250" thick • 1.5" Dia. x 5mm thick • 2.0" Dia. x 0.375" thick

Nd:YAG Laser Mirrors - Normal Incidence

Laser Wavelength	Laser Type	Reflectance at N.I.	Mirror Part Numbers		
			1.0" Dia. (25.4mm)	1.5" Dia. (38.1mm)	2.0" Dia. (50.8mm)
212nm	Nd:YAG (5th)	95%	212-FR-1D-MB	212-FR-1.5D-MB	212-FR-2D-MB
266nm	Nd:YAG (4th)	98%	266-FR-1D-MB	266-FR-1.5D-MB	266-FR-2D-MB
355nm	Nd:YAG (3rd)	99%	355-FR-1D-MB	355-FR-1.5D-MB	355-FR-2D-MB
532nm	Nd:YAG (2nd)	99%	532-FR-1D-MB	532-FR-1.5D-MB	532-FR-2D-MB
1064nm	Nd:YAG	99%	1064-FR-1D-MB	1064-FR-1.5D-MB	1064-FR-2D-MB

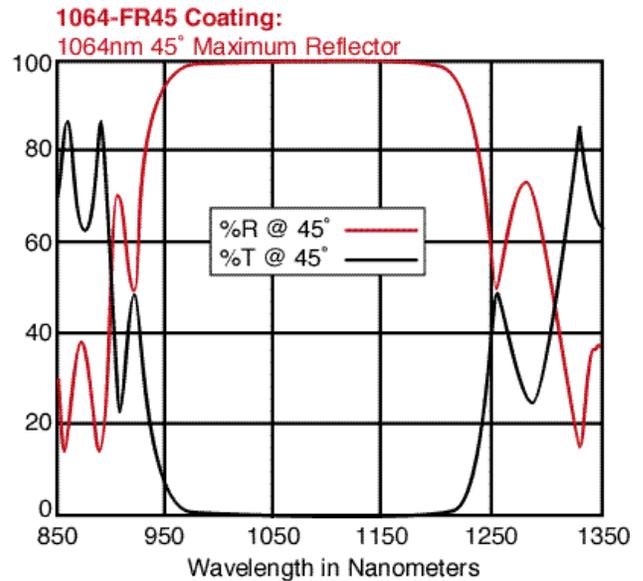
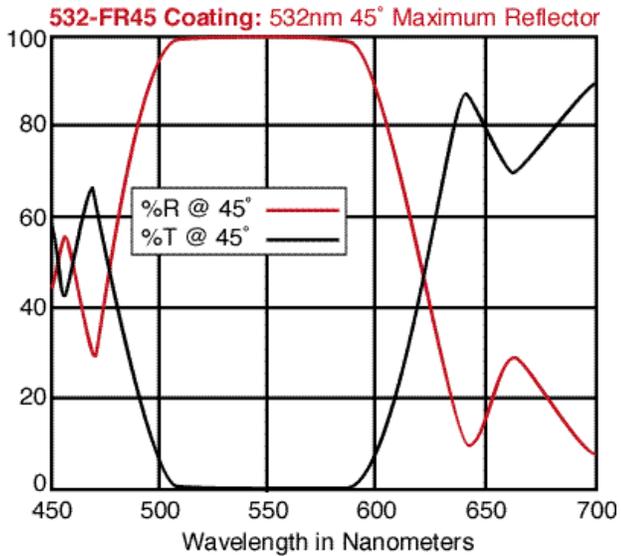
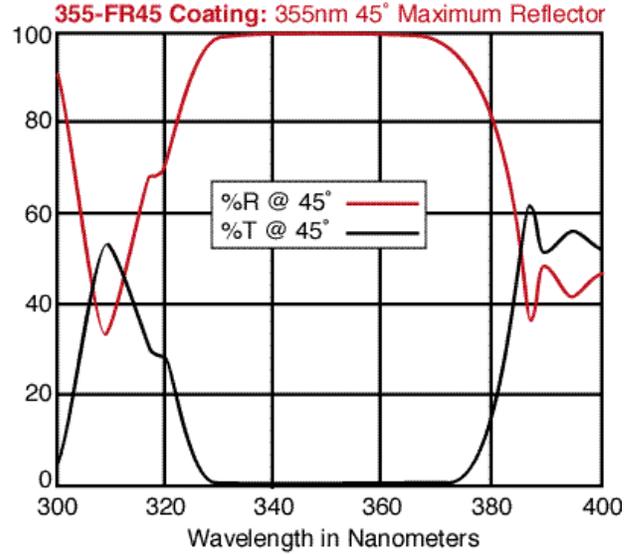
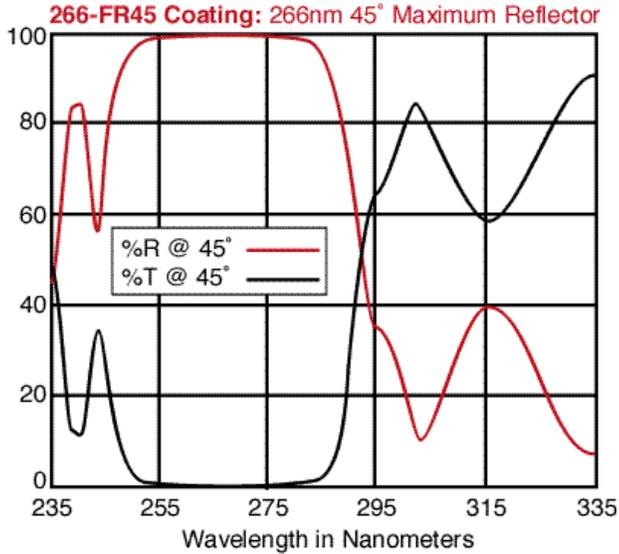
Nd:YAG Laser Mirrors - 45° Angle of Incidence

Laser Wavelength	Laser Type	Reflectance at 45°	Mirror Part Numbers		
			1.0" Dia. (25.4mm)	1.5" Dia. (38.1mm)	2.0" Dia. (50.8mm)
212nm	Nd:YAG (5th)	92%	212-FR45-1D-MB	212-FR45-1.5D-MB	212-FR45-2D-MB
266nm	Nd:YAG (4th)	98%	266-FR45-1D-MB	266-FR45-1.5D-MB	266-FR45-2D-MB
355nm	Nd:YAG (3rd)	98%	355-FR45-1D-MB	355-FR45-1.5D-MB	355-FR45-2D-MB
532nm	Nd:YAG (2nd)	99%	532-FR45-1D-MB	532-FR45-1.5D-MB	532-FR45-2D-MB
1064nm	Nd:YAG	99%	1064-FR45-1D-MB	1064-FR45-1.5D-MB	1064-FR45-2D-MB



"HDT" Nd:YAG Laser Mirrors

Below are representative reflectance and transmission curves for Nd:YAG Laser Mirrors. Actual coating performance may vary slightly.



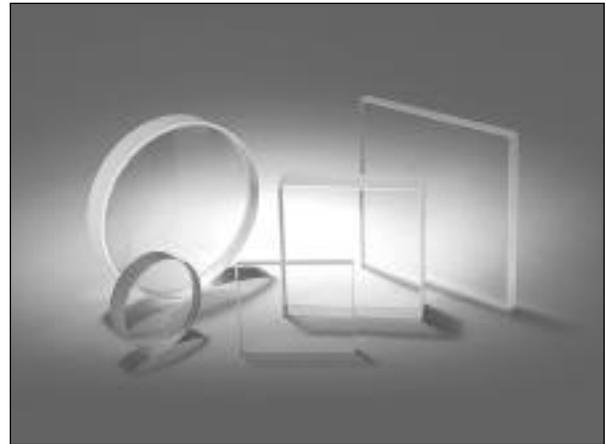


Anti-Reflection Coatings

Acton Research anti-reflection coatings are durable, electron beam deposited dielectrics designed to minimize reflections that normally occur from uncoated surfaces of substrates. These low absorption coatings are ideal for increasing the transmittance properties of lenses, and for reducing the second surface reflections of beam-splitters. Anti-reflection coatings offer excellent resistance to laser damage, and are suitable for high power use.

Standard Anti-reflection Coatings

Standard "V-type" anti-reflection coating designs are available for specific wavelengths from 157nm to 1064nm. Part numbers listed below are for normal incidence coatings. Please contact the Optics Sales Department if you require other angles of incidence.



Standard Anti-Reflection Coatings

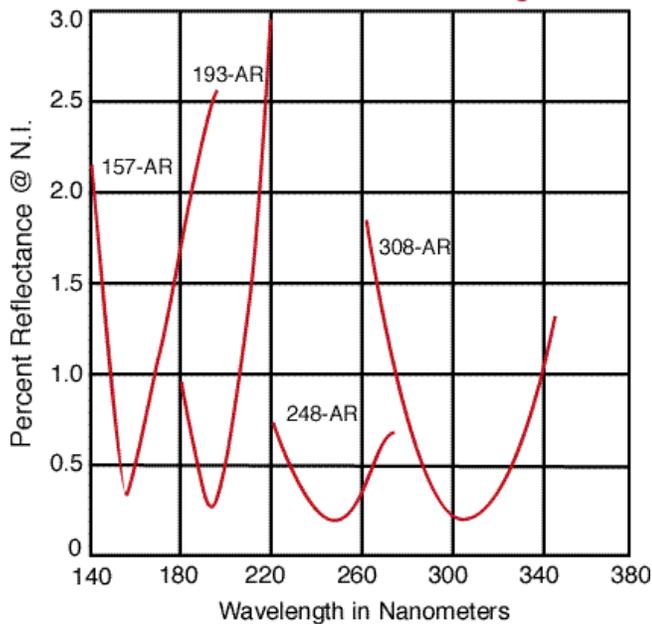
Laser Wavelength	Coating Part Number	Reflectance at Normal Incidence*
157nm (F ₂)	157-AR	0.5%
193nm (ArF)	193-AR	0.5%
212nm (Nd:YAG)	212-AR	0.5%
222nm (KrCl)	222-AR	0.5%
244nm (Argon-Ion)	244-AR	0.3%
248nm (KrF)	248-AR	0.3%
266nm (Nd:YAG)	266-AR	0.3%
282nm (XeBr)	282-AR	0.3%

NOTE: Reflectance of uncoated fused silica is 4.8% per surface at 193nm and 4.1% per surface at 248nm.

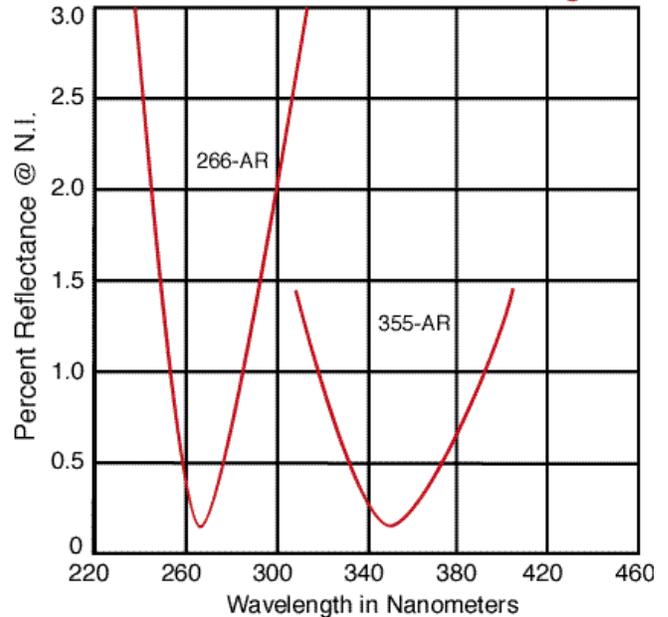
Laser Wavelength	Coating Part Number	Reflectance at Normal Incidence*
308nm (XeCl)	308-AR	0.3%
325nm (HeCd)	325-AR	0.3%
337nm (N ₂)	337-AR	0.5%
353nm (XeF)	353-AR	0.3%
355nm (Nd:YAG)	355-AR	0.3%
532nm (Nd:YAG)	532-AR	0.25%
633nm (HeNe)	633-AR	0.25%
1064nm (Nd:YAG)	1064-AR	0.25%

*Reflectance per coated surface

Excimer Laser Anti-Reflection Coatings

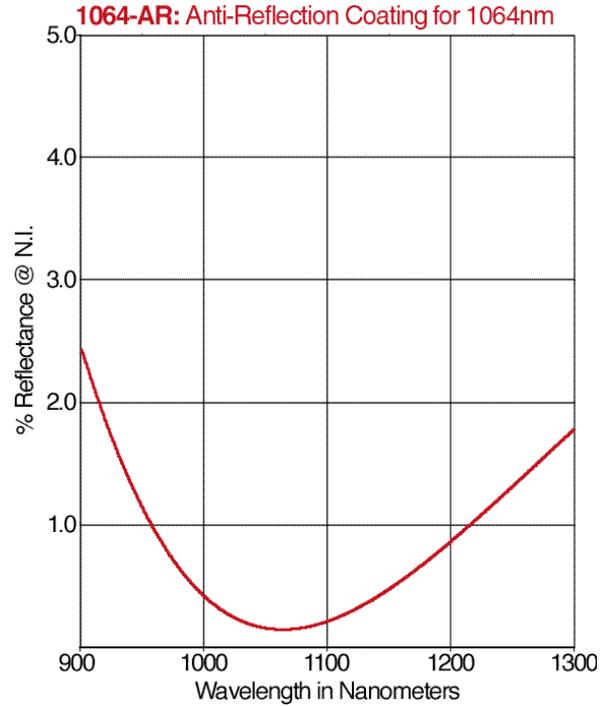
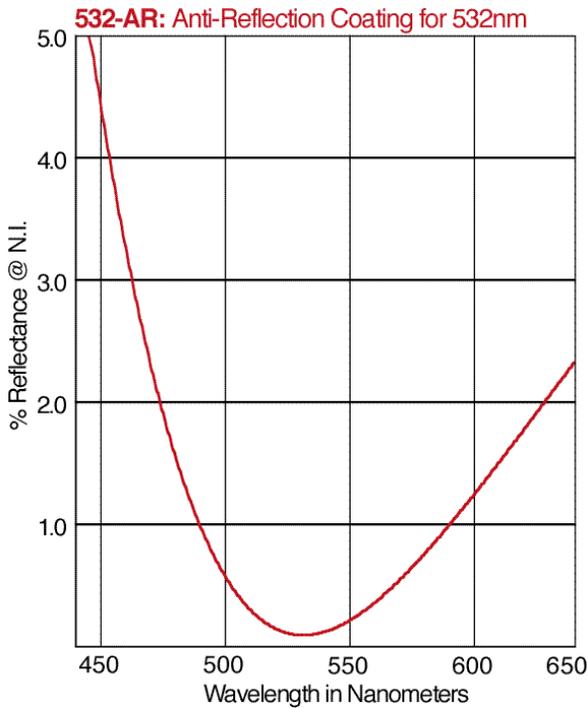


Nd:YAG Harmonic Anti-Reflection Coatings





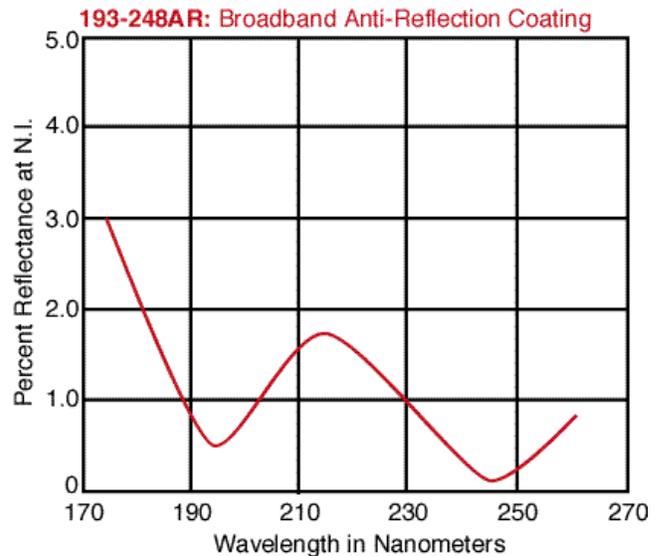
Anti-Reflection Coatings



Broadband UV Anti-Reflection Coatings

Acton Research broadband UV anti-reflection coatings are optimized for low reflectance and maximum transmittance for the wavelength ranges 193-248nm and 248-355nm. Using these overlapping anti-reflection coatings, the entire wavelength range from 193-355nm can be transmitted efficiently using only two optical elements.

Multi-wavelength anti-reflection coatings are available up to 1064nm. Contact the Optics Sales Department for more information.



UV Broadband Anti-reflection Coatings		
Wavelength Range	Average Reflectance*	Part Number
193-248nm	0.4 - 0.8%	193-248-BBAR
248-355nm	0.2 - 0.6%	248-355-BBAR

*Average reflectance @ normal incidence per coated surface on fused silica substrate.



Dichroic Mirrors

UV/VIS and UV/IR Designs

UV/VIS Dichroic Mirrors

UV/VIS dichroic mirrors are special multi-layer dielectric coatings which enable reflectance of a primary UV laser wavelength with good broadband VIS/Near IR transmittance. Dichroic mirrors are typically used for beam combining or beam separation. The standard dichroic mirrors listed below have UV laser grade fused silica substrates and are optimized for use at 45 degrees, with other angles available on request.

Other UV reflecting wavelengths from 145nm to approximately 355nm are also available. Contact the optics sales department for further information.

UV/IR Dichroic Mirrors

UV/IR dichroic mirrors are designed to reflect a UV laser wavelength while transmitting wavelengths into the infrared. These coatings are specially modified multi-layer dielectric designs, electron beam deposited onto high quality CaF₂ substrates. Acton Research UV/IR dichroic mirrors reflect a UV wavelength specified below with usable transmittance out to approximately 8µm.

Substrate Specifications

Surface Figure: 1/10 wave both surfaces at 632.8nm

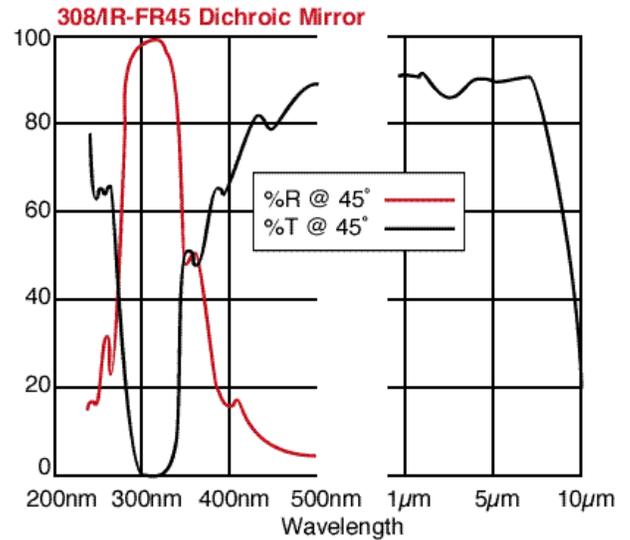
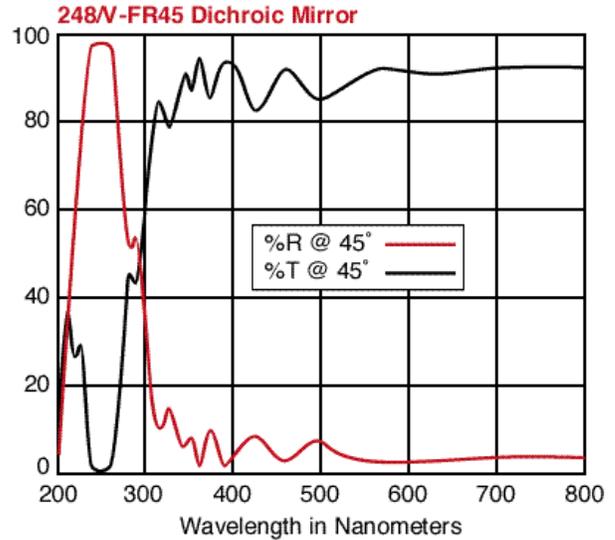
Surface Finish: 20-10 scratch - dig both surfaces

Clear Aperture: Central 80%

Chamfer: 0.5mm x 45° nominal

Sizes: 1.0" Dia. x 0.250" thick • 1.5" Dia. x 5mm thick
2.0" Dia. x 0.375" thick

These coatings are also available on Customer Supplied Material (CSM). Contact Acton Research for details.



Dichroic Mirrors

UV/VIS Dichroic Mirrors - Laser Grade Fused Silica Substrates

Part Numbers

UV	45° Reflectance	1.0" Diameter (25.4mm)	1.5" Diameter (38.1mm)	2.0" Diameter (50.8 mm)
193nm	94%	193/V-FR45-1D-FL	193/V-FR45-1.5D-FL	193/V-FR45-2D-FL
212nm	95%	212/V-FR45-1D-FL	212/V-FR45-1.5D-FL	212/V-FR45-2D-FL
248nm	96%	248/V-FR45-1D-FL	248/V-FR45-1.5D-FL	248/V-FR45-2D-FL
266nm	96%	266/V-FR45-1D-FL	266/V-FR45-1.5D-FL	266/V-FR45-2D-FL
308nm	96%	308/V-FR45-1D-FL	308/V-FR45-1.5D-FL	308/V-FR45-2D-FL
353nm	98%	353/V-FR45-1D-FL	353/V-FR45-1.5D-FL	353/V-FR45-2D-FL

UV/IR Dichroic Mirrors - CaF₂ Substrates

Part Numbers

UV	45° Reflectance	1.0" Diameter (25.4mm)	1.5" Diameter (38.1mm)	2.0" Diameter (50.8 mm)
193nm	94%	193/IR-FR45-1D-FLC	193/IR-FR45-1.5D-FLC	193/IR-FR45-2D-FLC
212nm	95%	212/IR-FR45-1D-FLC	212/IR-FR45-1.5D-FLC	212/IR-FR45-2D-FLC
248nm	96%	248/IR-FR45-1D-FLC	248/IR-FR45-1.5D-FLC	248/IR-FR45-2D-FLC
266nm	96%	266/IR-FR45-1D-FLC	266/IR-FR45-1.5D-FLC	266/IR-FR45-2D-FLC
308nm	96%	308/IR-FR45-1D-FLC	308/IR-FR45-1.5D-FLC	308/IR-FR45-2D-FLC
353nm	98%	353/IR-FR45-1D-FLC	353/IR-FR45-1.5D-FLC	353/IR-FR45-2D-FLC



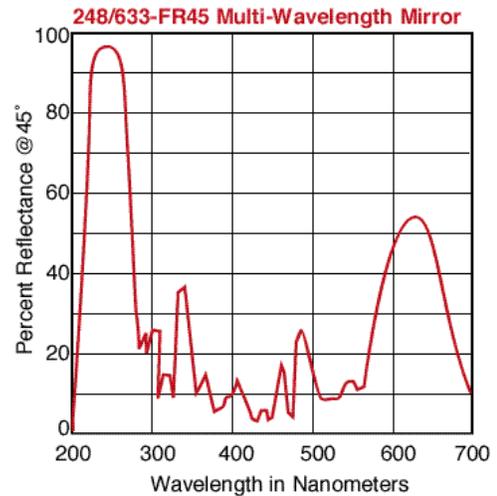
Multi-Wavelength Laser Mirrors

All Dielectric & Metal / Dielectric

All Dielectric 45° Mirrors

Specially designed multi-layer dielectric coatings, electron beam deposited onto laser grade substrates enable maximum reflectance of high energy excimer & UV laser wavelengths plus > 50% reflectance at a specific visible laser wavelength from the same mirror. Standard mirrors are designed as Nd:YAG laser harmonic and excimer/HeNe laser reflectors. These mirrors permit dual wavelength reflection for laser harmonic generation and excimer alignment applications.

Acton Research has standard 45° mirrors for 248nm, 308nm, and 353nm excimer wavelengths as well as 212nm and 266nm, as listed below. Other UV and visible laser wavelengths, and angles of incidence are available on request.



All Dielectric Dual Wavelength Mirrors

UV	%R for UV at 45°	VIS	Part Numbers		
			1.0" Diameter* (25.4mm)	1.5" Diameter* (38.1mm)	2.0" Diameter* (50.8mm)
212nm	90%	532nm	212/532-FR45-1D-MB	212/532-FR45-1.5D-MB	212/532-FR45-2D-MB
248nm	97%	633nm	248/633-FR45-1D-MB	248/633-FR45-1.5D-MB	248/633-FR45-2D-MB
266nm	97%	532nm	266/532-FR45-1D-MB	266/532-FR45-1.5D-MB	266/532-FR45-2D-MB
308nm	97%	633nm	308/633-FR45-1D-MB	308/633-FR45-1.5D-MB	308/633-FR45-2D-MB
353nm	98%	633nm	353/633-FR45-1D-MB	353/633-FR45-1.5D-MB	353/633-FR45-2D-MB

Substrate Specifications

Material: UV Grade Fused Silica
Surface Finish: 20-10 scratch-dig

Clear Aperture: Central 80%
Thickness: 1.0" dia. = 0.250" thick

Chamfer: 0.5mm x 45° nominal

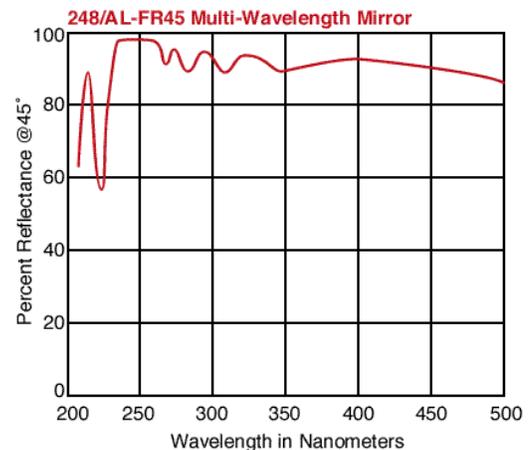
Surface Figure: 1/10 wave at 632.8nm

• 1.5" dia. = 5mm thick • 2.0" dia. = 0.375" thick

NOTE: Part numbers listed on this page are for complete mirrors. Acton Research multi-wavelength coatings can be applied to customer supplied material. Please contact the Optics Sales Department for details.

Metal / Dielectric 45° Mirrors

Standard Acton Research high power multi-layer dielectric Excimer laser mirror coatings, combined with an undercoat of aluminum, enable maximum reflectance of single excimer laser wavelengths with broadband visible through IR reflectance. Mirrors of this type permit visual alignment of excimer-based optical systems by means of a visible laser or conventional visible light source. The standard angle of incidence is 45°, with other angles available on request. Average visible reflectance is 85-90%. Normal incidence coatings of this type are typically used in microscope objective applications.



Metal / Dielectric Multi-Wavelength Mirrors

UV	45° Reflectance	Part Numbers		
		1.0" Diameter* (25.4mm)	1.5" Diameter* (38.1mm)	2.0" Diameter* (50.8mm)
157nm	94%	157/AL-FR45-1D-MB	157/AL-FR45-1.5D-MB	157/AL-FR45-2D-MB
193nm	94%	193/AL-FR45-1D-MB	193/AL-FR45-1.5D-MB	193/AL-FR45-2D-MB
248nm	97%	248/AL-FR45-1D-MB	248/AL-FR45-1.5D-MB	248/AL-FR45-2D-MB
308nm	97%	308/AL-FR45-1D-MB	308/AL-FR45-1.5D-MB	308/AL-FR45-2D-MB
353nm	98%	353/AL-FR45-1D-MB	353/AL-FR45-1.5D-MB	353/AL-FR45-2D-MB



UV Laser Beamsplitter Coatings

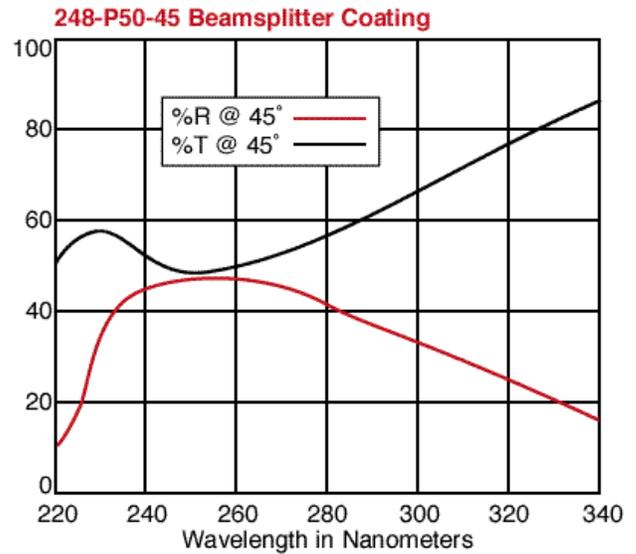
Multi-Layer Dielectric Design

UV Laser Beamsplitter Coatings

Acton Research's multi-layer dielectric coatings are ideal for beamsplitting applications, laser cavity output couplers, and beam attenuators. These beamsplitter coatings are manufactured with extremely low absorption characteristics, and calibrated for reflectance and transmittance at the laser wavelength and angle of incidence specified to insure excellent performance in high power laser applications.

Standard beamsplitters are designed for random polarization. Beamsplitters can be optimized for horizontal "P" polarization or vertical "S" polarization if required. Contact the Optics Sales Department for ordering information.

Acton Research offers anti-reflection coatings for the rear surface of beamsplitters, if required. See pages 8-9.



UV Laser Beamsplitter Coatings

Multi-Layer Dielectric Design - 45° Angle of Incidence

Laser Wavelength	10%±2% T* Part Number	30%±5% T* Part Number	50%±5% T* Part Number	70%±5% T* Part Number	90%±5% T* Part Number
157nm (F ₂)	157-P1045	157-P3045	157-P5045	157-P7045	157-P9045
172nm (Xe ₂)	172-P1045	172-P3045	172-P5045	172-P7045	172-P9045
193nm (ArF)	193-P1045	193-P3045	193-P5045	193-P7045	193-P9045
212nm (Nd:YAG)	212-P1045	212-P3045	212-P5045	212-P7045	212-P9045
222nm (KrCl)	222-P1045	222-P3045	222-P5045	222-P7045	222-P9045
248nm (KrF)	248-P1045	248-P3045	248-P5045	248-P7045	248-P9045
266nm (Nd:YAG)	266-P1045	266-P3045	266-P5045	266-P7045	266-P9045
282nm (XeBr)	282-P1045	282-P3045	282-P5045	282-P7045	282-P9045
308nm (XeCl)	308-P1045	308-P3045	308-P5045	308-P7045	308-P9045
325nm (HeCd)	325-P1045	325-P3045	325-P5045	325-P7045	325-P9045
337nm (N ₂)	337-P1045	337-P3045	337-P5045	337-P7045	337-P9045
353nm (XeF)	353-P1045	353-P3045	353-P5045	353-P7045	353-P9045
355nm (Nd:YAG)	355-P1045	355-P3045	355-P5045	355-P7045	355-P9045

*Transmittance • Other transmittance values from 10-90% are available on request.

Ordering Information

For Complete Beamsplitter:

Coating Part # + Substrate Part # =

Complete Beamsplitter

Ex. To order a 308nm, 45° beamsplitter with 30% transmittance on a 1.0" flat UV grade fused silica substrate:

Part #: 308-P3045-1D-FL

Coatings for rear surface use must be specified by adding '-S2' to coating part numbers.

Part numbers listed above are for 45° angle of incidence coating only. If normal incidence coatings are required, delete the '45' from the coating part number. Ex: Part #193-P1045 would be Part #193-P10.

When choosing a substrate, refer to pages 14-15 for transmittance properties of materials and page 17 for substrate specifications and part numbers. Generally, laser grade UV fused silica substrates are recommended for beamsplitters above 170nm. Beamsplitter coatings can be applied to customer supplied material.

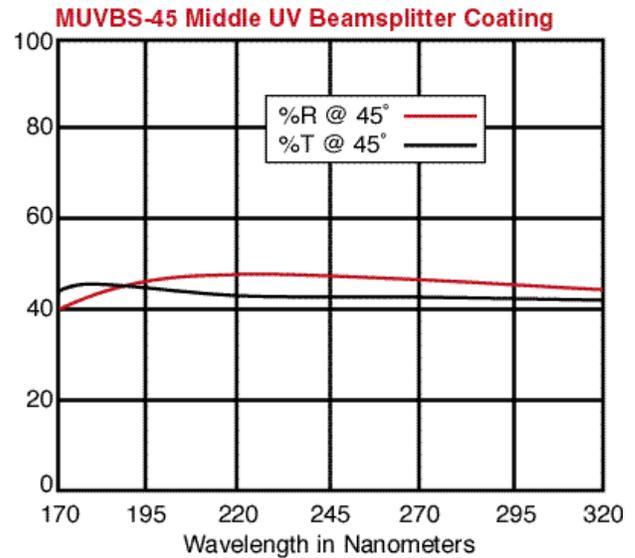
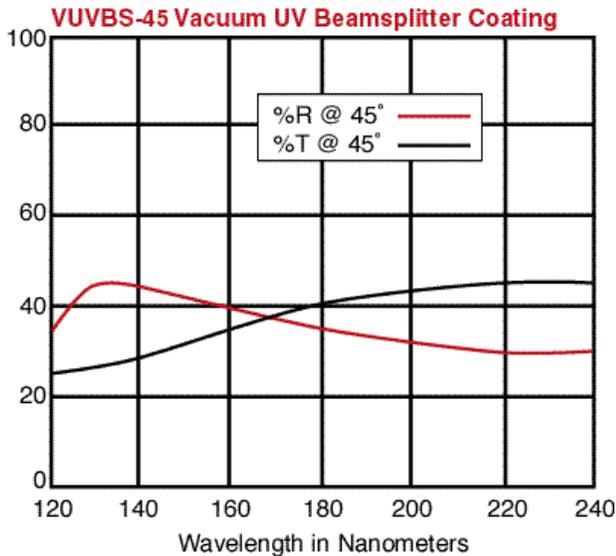


VUV/UV Beamsplitter Coatings

Broadband Metallic Designs

Broadband Metallic Beamsplitters

Acton Research offers two types of broadband metallic beamsplitter coatings. These beamsplitters are designed for low power applications in the wavelength ranges 120-300nm.



Vacuum UV Beamsplitters

- Transmittance & Reflectance averages 32-42% each over the wavelength range 120-240nm @ 45° AOI.
- Coating Part # **VUVBS-45**

Middle UV Beamsplitters

- Transmittance & Reflectance averages 40-50% each over the wavelength range 170-300nm @ 45° AOI.
- Coating Part # **MUVBS-45**

Ordering Information

For Complete Beamsplitter:

Coating Part # + Substrate Part # =
Complete Beamsplitter

Ex: An MUVBS beamsplitter coating (45° AOI)
on a 1.0" flat UV grade fused silica window:

Complete Part # = MUVBS-45-FS-1D

Part numbers listed above are for 45° angle of incidence coatings. Contact Acton Research for other AOIs.

When choosing a substrate, refer to pages 14-15 for transmittance properties of materials and page 17 for specifications and part numbers. Generally, UV grade fused silica for MUVBS and MgF₂ for VUVBS are recommended.

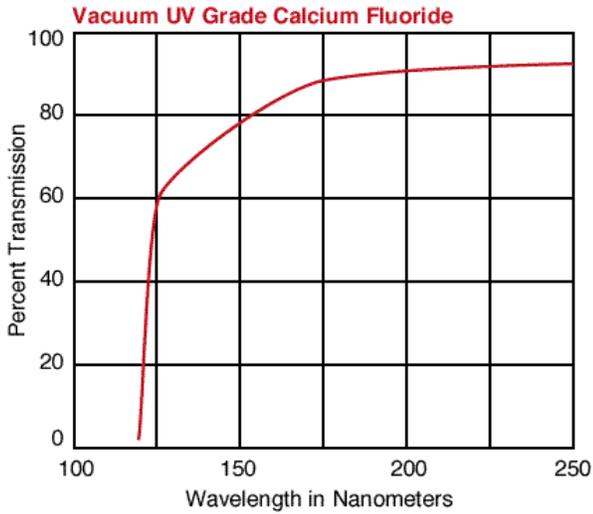
Beamsplitter coatings can also be applied to customer supplied material.



Standard Window & Substrate Materials

These curves illustrate the transmittance properties of Acton Research's standard windows and substrate materials (windows 2-3mm thick).

Please note that transmittance can vary slightly, therefore these curves should be used for reference only.

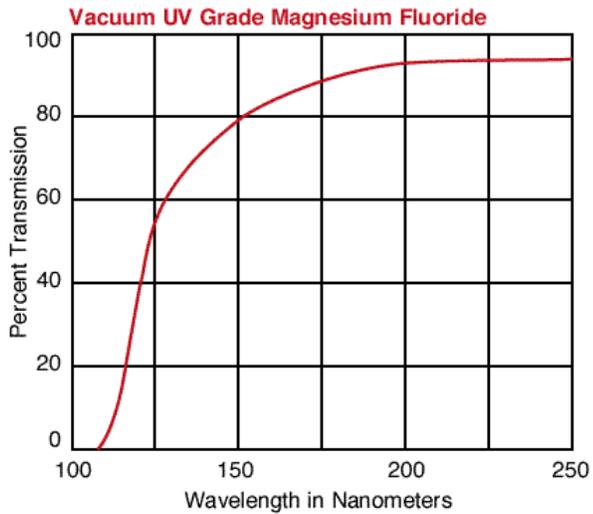


VUV Grade Calcium Fluoride (CaF₂)

Calcium Fluoride is cubic single crystal optical material with good vacuum UV to infrared transmittance properties. Advantages of calcium fluoride are its low birefringent properties and its availability in a variety of different grades.

Chemically pure grades of CaF₂ are used as excimer laser windows, lenses, prisms and filter substrates. Care should be taken when handling CaF₂ as it is sensitive to thermal shock.

Wavelength	157nm	193nm	248nm	308nm	353nm
*Refractive Index	1.500	1.492	1.469	1.460	1.445



VUV Grade Magnesium Fluoride (MgF₂)

Magnesium Fluoride is an optical crystal with high transmittance from the vacuum ultraviolet to the infrared. It is provided with surfaces cut perpendicular to the C-axis to minimize birefringent properties.

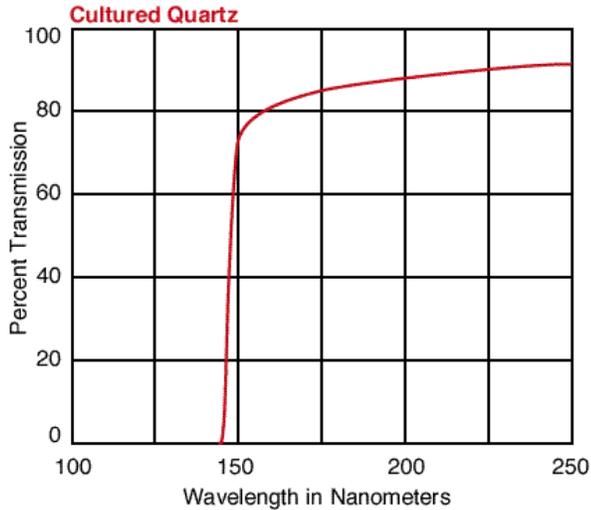
Due to its chemical composition, it is a proven material for use in fluorine environments as an excimer laser window.

Wavelength	157nm	193nm	248nm	308nm	353nm
*Refractive Index	1.464	1.428	1.415	1.405	1.387

*Approximate values



Standard Window & Substrate Materials

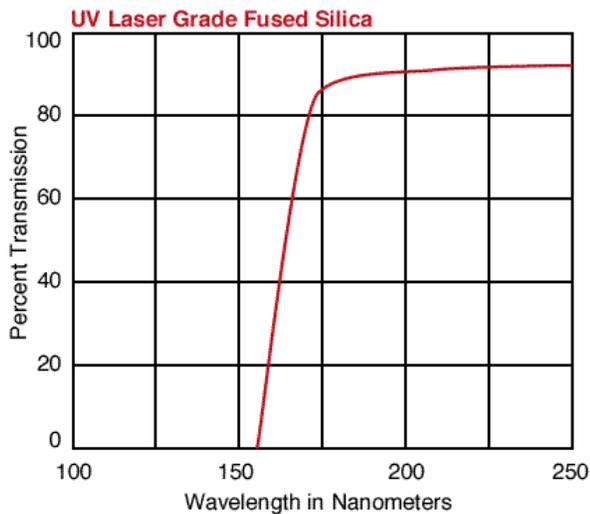


Cultured Quartz

Cultured quartz is a grown crystalline form of silicon dioxide. It is very hard, with a low expansion coefficient and transmits light through the range of 147nm (vacuum ultraviolet) to 4.5 microns (infrared).

It is primarily used for deep UV windows, VUV filter substrates and cut-off filters due to the sharpness of the cut-off at 147nm.

Wavelength	157nm	193nm	248nm	308nm	353nm
*Refractive Index	1.660	1.562	1.508	1.486	1.476



UV Laser Grade Fused Silica

UV Laser Grade Fused Silica is a widely used synthetic glass for UV laser windows and lenses. It has excellent transmission from 170nm to approximately 2.5µm and minimal fluorescence.

There are a number of special grades of fused silica with high chemical purity and excellent homogeneity in one direction.

Wavelength	170nm	193nm	248nm	308nm	353nm
*Refractive Index	1.611	1.561	1.508	1.485	1.476

*Approximate values

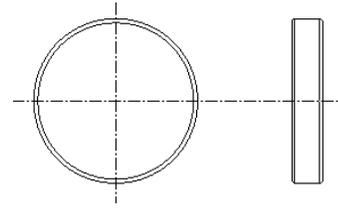


Windows

Acton Research windows are made from select grades of the finest available materials. VUV-UV windows are suitable for general VUV-UV applications. Flat laser windows are suitable for high power laser applications and as substrates for mirrors and beamsplitters.

Windows are available with transmittance traces for an additional charge. See pages 14-15 for typical transmittance properties and descriptions of materials. These windows are available with high efficiency anti-reflection coatings described on pages 8-9 of this catalog.

Plano / Plano Design



Flat Laser Windows

Material	Diameter	Thickness	Part #
UV Laser Grade Fused Silica	1.000" (25.4mm)	0.250"	1D-FL
VUV MgF ₂	1.000"	0.250"	1D-FLM
VUV CaF ₂	1.000"	0.250"	1D-FLC
UV Laser Grade Fused Silica	1.500" (38.1mm)	5mm	1.5D-FL
VUV MgF ₂	1.500"	5mm	1.5D-FLM
VUV CaF ₂	1.500"	5mm	1.5D-FLC
UV Laser Grade Fused Silica	2.000" (50.8mm)	0.375"	2D-FL
VUV MgF ₂	2.000"	0.375"	2D-FLM
VUV CaF ₂	2.000"	0.375"	2D-FLC
UV Laser Grade Fused Silica	2.000" (50.8mm)	5mm	2D5-FL
VUV MgF ₂	2.000"	5mm	2D5-FLM
VUV CaF ₂	2.000"	5mm	2D5-FLC

Flat Laser Window Specifications

Surface Figure: 1/10 wave both surfaces @ 632.8nm

Surface Finish: 20-10 scratch-dig

Parallelism: 3 arc minutes

Chamfer: 0.5mm x 45° nominal

Clear Aperture: Central 80%

Diameter Tolerance: + 0.00" / - 0.005"

Thickness Tolerance: ± 0.25mm

Other sizes are available on request.

VUV-UV Grade Windows

Material	Diameter	Thickness	Part #
VUV MgF ₂	0.5" (12.7mm)	2mm	MF-.5D
VUV CaF ₂	0.5"	2mm	CF-.5D
Cultured Quartz	0.5"	2mm	CQ-.5D
UV Grade Fused Silica	0.5"	2mm	FS-.5D
VUV MgF ₂	1.0" (25.4mm)	2.5mm	MF-1D
VUV CaF ₂	1.0"	2.5mm	CF-1D
Cultured Quartz	1.0"	2.5mm	CQ-1D
UV Grade Fused Silica	1.0"	2.5mm	FS-1D
VUV MgF ₂	1.5" (38.1mm)	5mm	MF-1.5D
VUV CaF ₂	1.5"	5mm	CF-1.5D
Cultured Quartz	1.5"	5mm	CQ-1.5D
UV Grade Fused Silica	1.5"	5mm	FS-1.5D
VUV MgF ₂	2.0" (50.8mm)	5mm	MF-2D
VUV CaF ₂	2.0"	5mm	CF-2D
UV Grade Fused Silica	2.0"	4mm	FS-2D
VUV MgF ₂	2.0" sq. (50.8mm)	5mm	MF-2S
VUV CaF ₂	2.0" sq.	5mm	CF-2S
UV Grade Fused Silica	2.0" sq.	4mm	FS-2S

VUV-UV Grade Window Specifications

Surface Figure: 2 waves at 632.8nm, both surfaces.

Surface Finish: 20-10 scratch-dig both surfaces.

Parallelism: 3 arc minutes or better

Chamfer: 0.5mm x 45° nominal

Clear Aperture: Central 80%

Diameter Tolerance: +.000" / -.005"

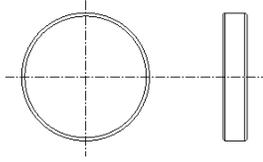
Thickness Tolerance: ± 0.25mm

Other sizes are available on request.

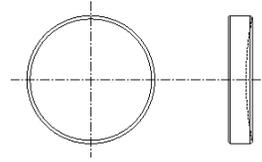


Mirror Blanks

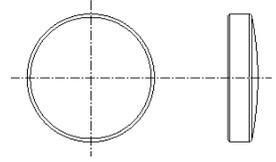
Plano / Plano Design



Plano/Concave Design



Plano/Convex Design



Mirror Blanks

(plano/plano)

Diameter	Material	Thickness	Part #
0.500" (12.7mm)	UV Laser Grade Fused Silica	0.250"	.5D-MB
1.000" (25.4mm)	UV Laser Grade Fused Silica	0.250"	1D-MB
1.500" (38.1mm)	UV Laser Grade Fused Silica	5mm	1.5D-MB
2.000" (50.8mm)	UV Laser Grade Fused Silica	0.375"	2D-MB
2.000" (50.8mm)	UV Laser Grade Fused Silica	5mm	2D5-MB

Specifications

Surface Figure: 1/10 wave - 1st surface @ 632.8nm
1/4 wave - 2nd surface

Polished Surface Finish: 20-10 scratch-dig

Parallelism: 3 arc minutes

Chamfer: 0.5mm x 45° nominal

Clear Aperture: Central 80%

Thickness Tolerance: ± 0.25mm

Diameter Tolerance: + 0.00" / - 0.005"

Other sizes are available on request.

Curved Mirror Blanks

Diameter	Radius of Curvature	Plano/Concave Part #	Plano/Convex Part #
0.5" (12.7mm)	0.1 meter	.5D-.1M	.5D-.1MX
0.5"	0.25 meter	.5D-.25M	.5D-.25MX
0.5"	0.5 meter	.5D-.5M	.5D-.5MX
0.5"	1 meter	.5D-1M	.5D-1MX
0.5"	2 meter	.5D-2M	.5D-2MX
0.5"	3 meter	.5D-3M	.5D-3MX
0.5"	4 meter	.5D-4M	.5D-4MX
0.5"	5 meter	.5D-5M	.5D-5MX
0.5"	10 meter	.5D-10M	.5D-10MX
1.0" (25.4mm)	0.1 meter	1D-.1M	1D-.1MX
1.0"	0.25 meter	1D-.25M	1D-.25MX
1.0"	0.5 meter	1D-.5M	1D-.5MX
1.0"	1 meter	1D-1M	1D-1MX
1.0"	2 meter	1D-2M	1D-2MX
1.0"	3 meter	1D-3M	1D-3MX
1.0"	4 meter	1D-4M	1D-4MX
1.0"	5 meter	1D-5M	1D-5MX
1.0"	10 meter	1D-10M	1D-10MX
1.5" (38.1mm)	0.1 meter		1.5D-.1MX
1.5"	0.25 meter	1.5D-.25M	
1.5"	0.5 meter	1.5D-.5M	1.5D-.5MX
1.5"	1 meter	1.5D-1M	1.5D-1MX
1.5"	2 meter	1.5D-2M	1.5D-2MX
1.5"	3 meter	1.5D-3M	
1.5"	4 meter	1.5D-4M	1.5D-4MX
1.5"	5 meter	1.5D-5M	1.5D-5MX
1.5"	10 meter	1.5D-10M	
2.0" (50.8mm)	0.25 meter	2D-.25M	
2.0"	0.5 meter	2D-.5M	2D-.5MX
2.0"	1 meter	2D-1M	2D-1MX
2.0"	2 meter	2D-2M	2D-2MX
2.0"	3 meter	2D-3M	2D-3MX
2.0"	4 meter	2D-4M	2D-4MX
2.0"	5 meter	2D-5M	2D-5MX
2.0"	10 meter	2D-10M	2D-10MX

Specifications

Material: UV Laser Grade Fused Silica

Surface Figure: 1/10 wave both surfaces at 632.8nm

Surface Finish: 20-10 scratch-dig, both surfaces

Chamfer: 0.35mm x 45° nominal • **Clear Aperture:** Central 80%

Edge Thickness: 0.375" • **Dia. Tolerance:** ± 0.005"

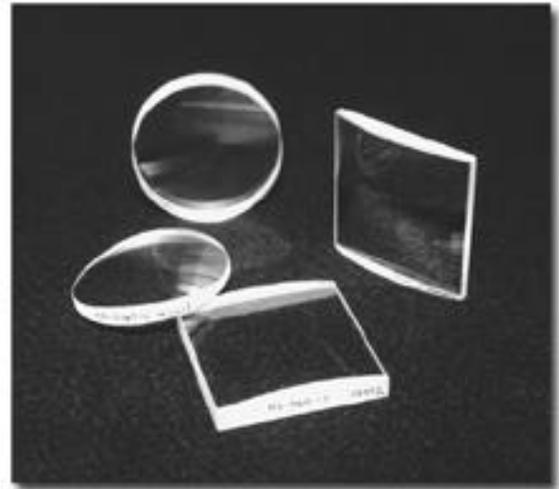


UV Laser Grade Cylindrical Lenses

Acton Research precision UV laser grade fused silica cylindrical lenses are designed for use with excimer and UV lasers. They are useful for reshaping excimer laser beams to desired sizes and shapes.

Combined with our high efficiency anti-reflection coatings (see pages 8-9), these lenses are unsurpassed for performance over the wavelength region from 190nm to 355nm.

Other sizes and materials are available on request.



Specifications

Material: UV Laser Grade Fused Silica

Surface Figure: 1/4 wave at 632.8nm both surfaces

Surface Finish: 40-20 scratch-dig, both surfaces

Centration: Within 3 arc minutes

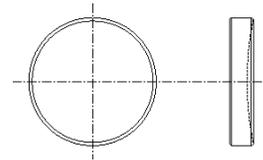
Clear Aperture: Central 80%

Chamfer: 0.5mm x 45° nominal

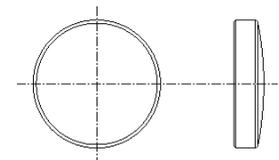
Size Tolerance: ± 0.005"

Edge Thickness: Varies with radius of curvature

Plano/Concave Design



Plano/Convex Design



UV Laser Grade Cylindrical Lenses

Radius of Curvature	Design	Part # 2" Dia. (50.8mm)	Part # 2" Sq. (50.8mm)	Nominal Focal Lengths vs. Wavelength			
				193nm	248nm	308nm	353nm
30.48mm	PL/CX	02-010-1	03-010-1	54mm	60mm	63mm	64mm
76.76mm	PL/CX	02-020-1	03-020-1	137mm	150mm	158mm	161mm
78.48mm	PL/CX	02-030-1	03-030-1	140mm	155mm	161mm	165mm
100.2mm	PL/CX	02-040-1	03-040-1	179mm	197mm	206mm	210mm
101.6mm	PL/CX	02-050-1	03-050-1	181mm	200mm	209mm	213mm
117.88mm	PL/CX	02-060-1	03-060-1	210mm	230mm	243mm	247mm
125.35mm	PL/CX	02-070-1	03-070-1	223mm	250mm	258mm	263mm
152.27mm	PL/CX	02-080-1	03-080-1	271mm	300mm	313mm	320mm
253.82mm	PL/CX	02-090-1	03-090-1	452mm	500mm	522mm	532mm
381mm	PL/CX	02-095-1	03-095-1	680mm	750mm	786mm	800mm
507.6mm	PL/CX	02-100-1	03-100-1	904mm	1000mm	1044mm	1065mm
1000mm	PL/CX	02-110-1	03-110-1	1783mm	1967mm	2058mm	2098mm
5000mm	PL/CX	02-200-1	03-200-1	8913mm	9834mm	10288mm	10488mm
51.26mm	PL/CC	02-010-2	03-010-2	-91mm	-100mm	-106mm	-108mm
61.01mm	PL/CC	02-020-2	03-020-2	-109mm	-120mm	-126mm	-128mm
80.01mm	PL/CC	02-040-2	03-040-2	-143mm	-160mm	-165mm	-168mm
151.38mm	PL/CC	02-050-2	03-050-2	-270mm	-300mm	-312mm	-318mm
193.04mm	PL/CC	02-060-2	03-060-2	-344mm	-380mm	-397mm	-405mm
199.99mm	PL/CC	02-070-2	03-070-2	-357mm	-395mm	-412mm	-420mm
357.27mm	PL/CC	02-080-2	03-080-2	-637mm	-703mm	-736mm	-749mm
469.90mm	PL/CC	02-090-2	03-090-2	-838mm	-924mm	-968mm	-986mm



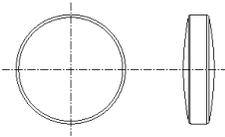
Spherical Lenses

Acton Research spherical lenses are manufactured from the finest VUV / UV transmitting materials available. UV laser grade fused silica lenses are suitable for use at 193nm (ArF), 248nm (KrF), 308nm (XeCl), 353nm (XeF). Lenses made from VUV MgF₂ provide excellent transmission down to 122nm.

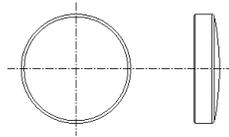
See pages 8-9 for high efficiency anti-reflection coatings which are available for optimum efficiency at individual wavelengths. Refer to pages 14-15 for transmittance properties and information materials. Other sizes and materials available on request.



Biconvex Design (CX/CX)



Plano/Convex Design (PL/CX)



UV Laser Grade Spherical Lenses

Radius of Curvature	1.0" dia. (25.4mm)	2.0" dia. (50.8mm)	Design	Nominal Focal Lengths vs. Wavelength			
				193nm	248nm	308nm	353nm
50mm	100-01-50	100-02-50	CX/CX	45mm	50mm	51mm	53mm
75mm	100-01-75	100-02-75	CX/CX	67mm	75mm	77mm	79mm
100mm	100-01-100	100-02-100	CX/CX	90mm	100mm	103mm	105mm
150mm	100-01-150	100-02-150	CX/CX	135mm	150mm	155mm	160mm
100mm	100-01-200	100-02-200	PL/CX	180mm	200mm	205mm	210mm
127mm	100-01-250	100-02-250	PL/CX	227mm	250mm	262mm	267mm
150mm	100-01-300	100-02-300	PL/CX	270mm	300mm	310mm	315mm
250mm	100-01-500	100-02-500	PL/CX	445mm	500mm	515mm	525mm
394mm	100-01-775	100-02-775	PL/CX	703mm	775mm	812mm	828mm
500mm	100-01-1000	100-02-1000	PL/CX	890mm	1000mm	1030mm	1050mm

Material: UV Laser Grade Fused Silica • **Surface Figure:** 1/10 wave or better both surfaces at 632.8nm • **Surface Finish:** 20-10 scratch-dig
Chamfer: 0.5mm x 45° nominal • **Centration:** Within 3 arc minutes • **Clear Aperture:** Central 80% • **Dia. Tolerance:** ± 0.005" • **Edge Thickness:** 0.125", ±0.010"

VUV MgF₂ Spherical Lenses

Radius of Curvature	1.0" dia. (25.4mm)	2.0" dia. (50.8mm)	Design	Nominal Focal Lengths vs. Wavelength			
				120nm	157nm	193nm	248nm
40mm	200-01-50	200-02-50	CX/CX	32mm	43mm	47mm	50mm
82mm	200-01-100	200-02-100	CX/CX	65mm	90mm	95mm	100mm
105mm	200-01-150		CX/CX	85mm	115mm	120mm	125mm
125mm		200-02-150	CX/CX	100mm	135mm	145mm	150mm
80mm	200-01-200	200-02-200	PL/CX	130mm	175mm	185mm	195mm
100mm	200-01-300	200-02-300	PL/CX	160mm	215mm	235mm	240mm
200mm	200-01-500	200-02-500	PL/CX	320mm	435mm	470mm	485mm
400mm	200-01-1000	200-02-1000	PL/CX	640mm	860mm	935mm	965mm

Material: Single crystal VUV grade MgF₂ • **Surface Figure:** 1/2 wave at 632.8nm, both surfaces • **Surface Finish:** 20-10 scratch-dig, both surfaces • **Clear Aperture:** Central 80%
Chamfer: 0.005" - 0.060" face width • **Dia. Tolerance:** +0.00", -0.005" • **Edge Thickness:** 1.0" dia = 0.08", 2.0" dia = 0.10", ±0.010" • **Edge Thickness Variation:** 0.001"



Standard Filter Information

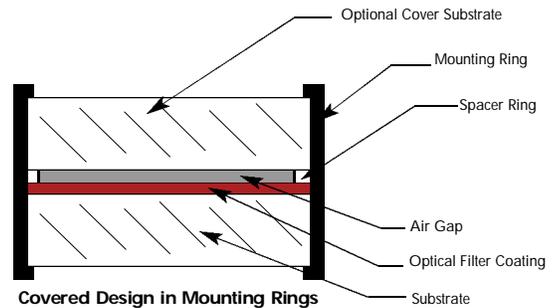
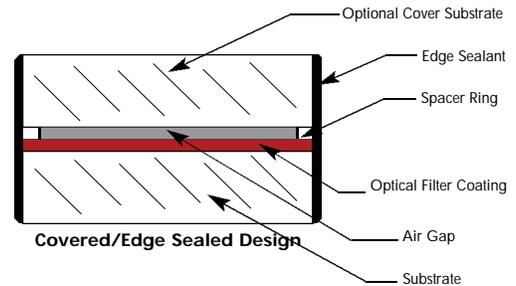
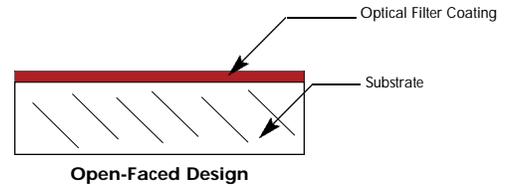
Available Designs for Standard Bandpass Filters

Open-Faced - The open-faced design includes a substrate with an optical filter coating on one surface. Open-faced filters must be handled with care as the soft filter coating is exposed. Potential damage from moisture, atmospheric contaminants or handling can be reduced by sealing the filter with a protective fused silica cover, as shown below (available above 170nm only).

Covered / Edge Sealed - Filters above 170nm may be supplied with a fused silica cover for protective purposes. As shown in the diagram, a spacer ring is placed between the substrates to form a small air gap, then the edges are sealed. This design enables the filter to be handled without risk of touching the delicate filter coating. Please note that covering a filter decreases its transmission by 2-3%.

Edge sealing adds approximately 0.010" (0.254mm) to the diameter of the filter. Total thickness for a covered and edge sealed filter is approximately twice that of an open-faced design. Exact dimensions are available from the Optics Sales Department.

Mounted - Open-faced or covered filters (without edge sealant) can be supplied in metal mounting rings, if desired. The rings are constructed from aluminum, and are black anodized. Mounting a filter reduces clear aperture and increases the outside diameter as outlined below.



Diameter Information for "-N", "-B", "-W" and "VBB" Filters

Unmounted Filter Diameter	Diameter Tolerance	Mounted Filter Diameter ($\pm 0.005"$)	Unmounted Filter Thickness	Mounted Thickness	Clear Aperture
0.5" (12.7mm)	+0.00"/-0.005" (0.127mm)	0.625" (15.88mm)	2mm	0.300" (7.62mm)	0.450" (11.43mm)
1.0" (25.4mm)	+0.00"/-0.005" (0.127mm)	1.200" (30.48mm)	2.5mm	0.375" (9.53mm)	0.800" (20.32mm)
2.0" (50.8mm)	+0.00"/-0.005" (0.127mm)	2.225" (56.52mm)	4mm*	0.500" (12.7mm)	1.900" (48.26mm)

NOTE: These filters are supplied open-faced unless otherwise requested.

* 2.0" dia. 120nm, 122nm and 157nm filters are 5mm thick.

Filter Material Information

Wavelengths	120nm - 122nm	157nm	170nm - 320nm
Substrate Materials	VUV MgF ₂	VUV CaF ₂	UV Grade Fused Silica

NOTE: Substrate material is dependent on the filter design and wavelength. See page 16 "VUV-UV Grade Windows" table for more substrate information.

Other Standard Filter Information

Maximum survival temperature range is -20°C to 100°C. • Peak Wavelength Shift - approx. 0.1Å/1°C.

Typical Out of Band Blocking- N-type: 1×10^{-4} , B-type: 1×10^{-2} - 1×10^{-3} , W-type: average $\sim 1 \times 10^{-2}$ - 5×10^{-2} in the visible



Standard Bandpass Filters

Acton Research standard bandpass filters are made from the highest quality materials for use in research and industrial applications. Filters are visually and optically checked before they are shipped, and include individual transmittance curves to show the filter's performance characteristics. Detailed "rejection" curves may be purchased at the time of manufacture. Image quality filters are available on request.

Below is a list of Acton Research's most popular standard bandpass filters and specifications. Other wavelengths and sizes are available. Please feel free to contact us with details of your OEM filter requirements.

See the following page for examples of transmission traces from selected Acton Research bandpass filters.

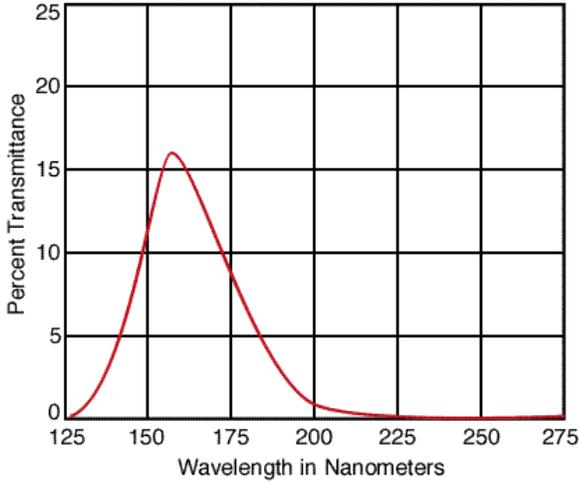
Peak Wavelength (nm)	Type	FWHM (nm)	Min. Peak % Transmittance	Part Numbers		
				0.5" dia. (12.7mm)	1.0" dia. (25.4mm)	2.0" dia. (50.8mm)
122 ± 2.5	Lyman Alpha	10 max.	5	122-XN-.5D	122-XN-1D	122-XN-2D
122 ± 2.5	Lyman Alpha	15 max.	10	122-VN-.5D	122-VN-1D	122-VN-2D
122 ± 2.5	Lyman Alpha	20 max.	15	122-N-.5D	122-N-1D	122-N-2D
157 ± 2.5	F ₂ Laser	30±6	12	157-N-CF.5D	157-N-CF1D	157-N-CF2D
172 ± 2.5	Xe ₂ Laser	20±7.5	15	172-N-.5D	172-N-1D	172-N-2D
180 ± 5	S, Ph	40±10	30	180-B-.5D	180-B-1D	180-B-2D
184.9 ± 2.5	Hg	20±7.5	15	185-N-.5D	185-N-1D	185-N-2D
184.9 ± 2.5	Hg*	20±7.5	10	185-HR-.5D	185-HR-1D	185-HR-2D
190 ± 5	As	35±10	30	190-B-.5D	190-B-1D	190-B-2D
193 ± 2.5	ArF Laser	20±5	15	193-N-.5D	193-N-1D	193-N-2D
200 ± 2.5		20±5	15	200-N-.5D	200-N-1D	200-N-2D
200 ± 5	Se	35±10	30	200-B-.5D	200-B-1D	200-B-2D
220 ± 5	Pb	35±10	30	220-B-.5D	220-B-1D	220-B-2D
220 ± 10		70±20	45	220-W-.5D	220-W-1D	220-W-2D
230 ± 5	Cd, Ni	35±10	30	230-B-.5D	230-B-1D	230-B-2D
248 ± 2.5	KrF Laser	20±5	15	248-N-.5D	248-N-1D	248-N-2D
250 ± 10		80±20	45	250-W-.5D	250-W-1D	250-W-2D
253.7 ± 2.5	Hg	20±5	15	254-N-.5D	254-N-1D	254-N-2D
253.7 ± 5	Hg	40±10	30	254-B-.5D	254-B-1D	254-B-2D
260 ± 5	Fe	40±10	30	260-B-.5D	260-B-1D	260-B-2D
296.7 ± 2.5	Hg	20±5	15	296-N-.5D	296-N-1D	296-N-2D
300 ± 10		100±25	45	300-W-.5D	300-W-1D	300-W-2D

**HR": high rejection of 253.7nm line supplied in mounting rings.

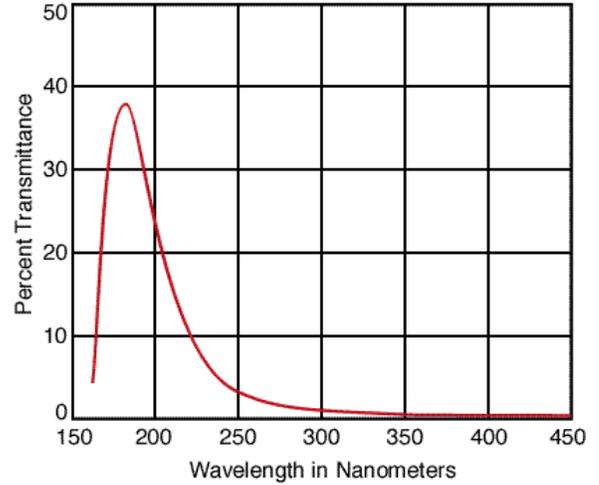


Examples of Standard Bandpass Filters

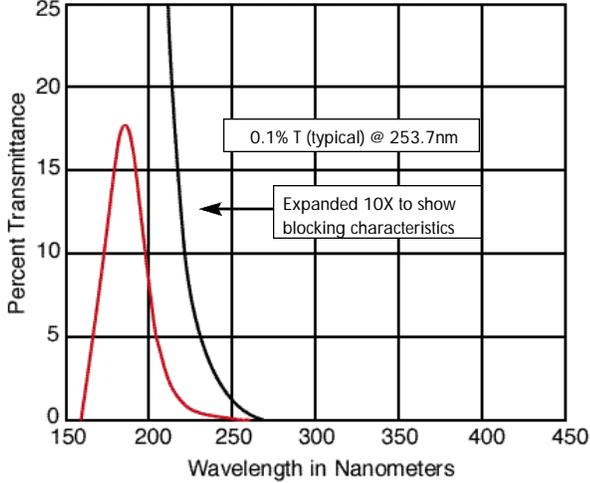
157-N: 157nm Narrowband Filter



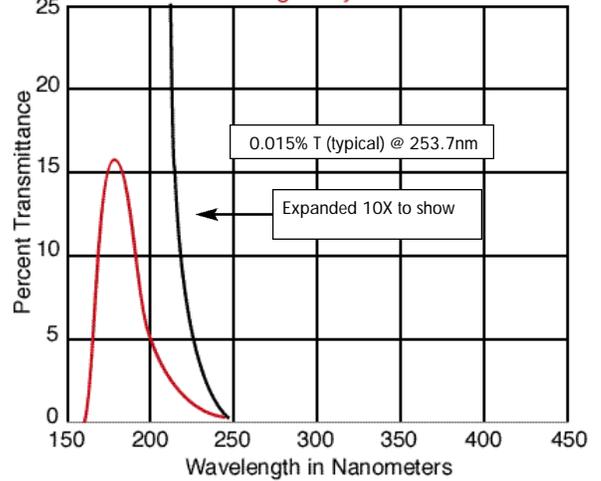
180-B: 180nm Broadband Filter



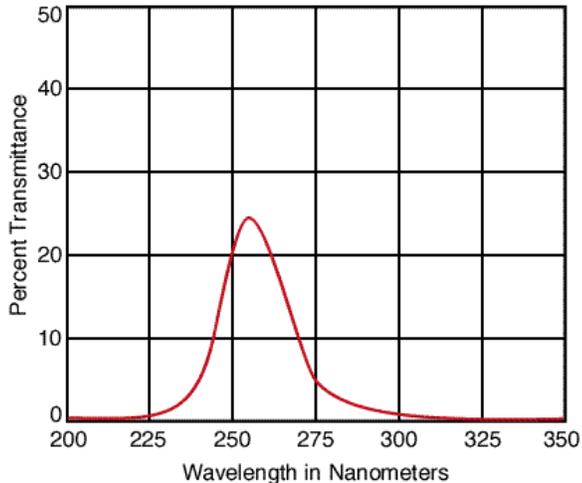
185-N: 185nm Narrowband Filter



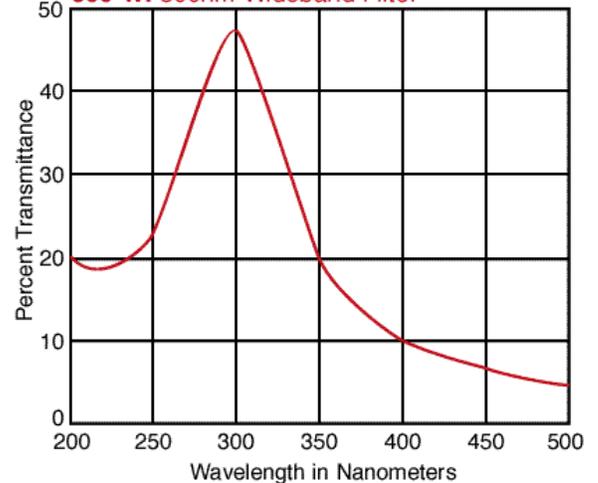
185-HR: 185nm High-Rejection Filter



254-N: 254nm Narrowband Filter



300-W: 300nm Wideband Filter



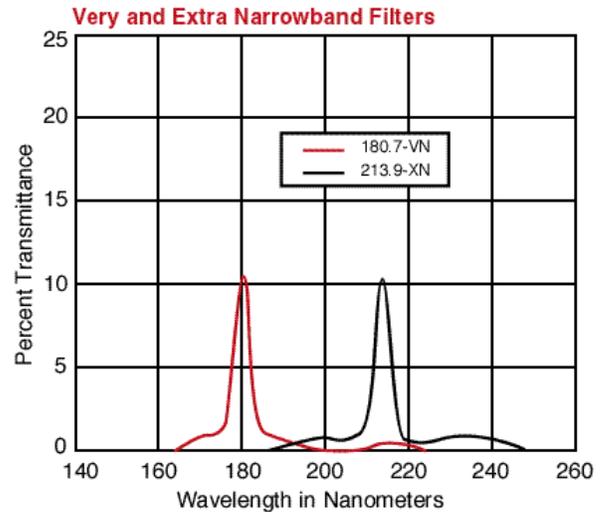


Extra and Very Narrowband Filters

High resolution optical filters are available for the 160nm to 239nm region with FWHM bandwidths of 4.5nm to 10nm. The VN (very narrow) series filters have bandwidths of 2% - 3% of peak wavelengths; the XN (extra narrow) series filters have bandwidths of 1-1.5% of the peak.

Please note that some shorter wavelength VN and XN filters have slight sidebands close to the peak wavelength, with transmittance normally less than 1%.

NOTE: Due to the narrow bandwidths (FWHM) of these filters, they are manufactured to customer specifications. Peak wavelength tolerances are $\pm 25\%$ of the bandwidths. All VN and XN filters listed on this page are supplied in metal mounting rings. See page 20 for detailed information on mounting rings.



UV analytical & resonance wavelengths for which filters may be produced include:

178.3nm = Phosphorus (P)

190.9nm = Nitric Oxide (NO)

193.7nm = Arsenic (As)

196nm = Selenium (Se)

213.6nm = Phosphorus (P)

213.9nm = Zinc (Zn)

217nm = Lead (Pb)

226.2nm = Nitric Oxide (NO)

231.6nm = Nickel (Ni)

Extra and Very Narrowband Filters

VN (Very Narrow) Series Specifications:

Wavelength Range	Minimum Transmission	Maximum FWHM	Out of Band %Transmittance
160-209nm	5%	7.0nm	0.01% at 400nm
210-239nm	8%	8.0nm	0.001% at 700nm & 10^{-6} to FIR

XN (Extra Narrow) Series Specifications:

Wavelength Range	Minimum Transmission	Maximum FWHM	Out of Band %Transmittance
160-209nm	4%	4.5nm	0.01% at 400nm
210-239nm	5%	4.5nm	0.001% at 700nm & 10^{-6} to FIR

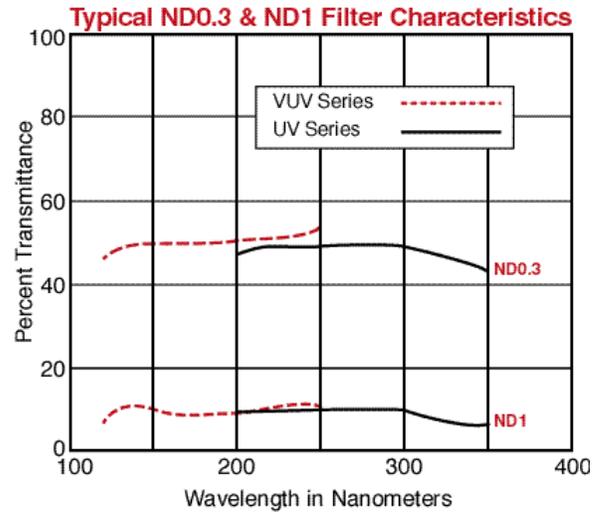


VUV/UV Neutral Density Filters

These neutral density filters are made of metallic films, some of which are over-coated with a dielectric protective layer. Density is determined by the combined transmittance, reflectance and absorption of these films.

Each filter is individually calibrated for transmittance at a series of wavelengths, and supplied with a transmittance curve. VUV and UV ND5 and ND6 filters are offered as special order items, and are calibrated at strong VUV-UV spectral lines only, such as 160.8nm and 253.7nm.

VUV and UV neutral density filters are supplied in anodized metal rings as described on page 20.



Neutral Density Filters

Vacuum Ultraviolet Mounted Neutral Density Filters (122nm - 200nm) - VUV MgF₂ Substrate

Optical Density	Nominal Transmittance	Transmittance Range	Part Numbers	
			0.625" dia.* (15.88mm)	1.200" dia.* (30.48mm)
0.3	50%	42-58%	ND0.3-.5D-V	ND0.3-1D-V
0.5	30%	25-35%	ND0.5-.5D-V	ND0.5-1D-V
1.0	10%	8-12%	ND1-.5D-V	ND1-1D-V
1.5	3.0%	2.5%-3.5%	ND1.5-.5D-V	ND-1.5-1D-V
2.0	1.0%	0.7-1.4%	ND2-.5D-V	ND2-1D-V
3.0	0.1%	0.06-0.17%	ND3-.5D-V	ND3-1D-V
4.0	0.01%	0.005-0.02%	ND4-.5D-V	ND4-1D-V
5.0	0.001%	0.0007-0.0015%**	ND5-.5D-V	ND5-1D-V
6.0	0.0001%	0.00007-0.00014%**	ND6-.5D-V	ND6-1D-V

Ultraviolet Mounted Neutral Density Filters (200nm - 320nm) - UV Grade Fused Silica Substrate

Optical Density	Nominal Transmittance	Transmittance Range	Part Numbers	
			0.625" dia.* (15.88mm)	1.200" dia.* (30.48mm)
0.3	50%	42-58%	ND0.3-.5D-M	ND0.3-1D-M
0.5	30%	25-35%	ND0.5-.5D-M	ND0.5-1D-M
1.0	10%	8-12%	ND1-.5D-M	ND1-1D-M
1.5	3.0%	2.5%-3.5%	ND1.5-.5D-M	ND-1.5-1D-M
2.0	1.0%	0.7-1.4%	ND2-.5D-M	ND2-1D-M
3.0	0.1%	0.06-0.17%	ND3-.5D-M	ND3-1D-M
4.0	0.01%	0.005-0.02%	ND4-.5D-M	ND4-1D-M
5.0	0.001%	0.0007-0.0015%**	ND5-.5D-M	ND5-1D-M
6.0	0.0001%	0.00007-0.00014%**	ND6-.5D-M	ND6-1D-M

*Diameters include mounting rings. See page 20 for more information.

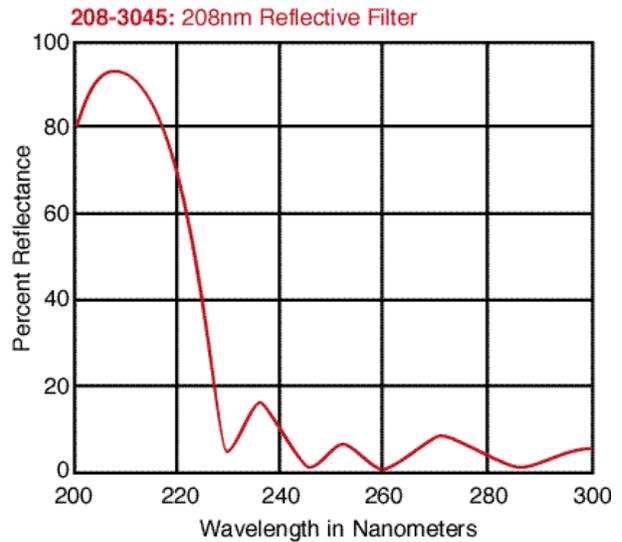
**provided on a best efforts basis



VUV/UV Reflective Filters

Multi-layer reflective filters are all dielectric reflectors that offer high reflectance at specific VUV through UV wavelengths while transmitting longer wavelength UV to IR light. These filters are produced on UV grade fused silica substrates. Refer to page 16 "VUV-UV Grade Windows" table for specifications.

Custom UV filters for peak wavelengths 280nm are available with deep UV - vacuum UV transmittance below ~210nm. Reflectance for custom UV reflective filters may be less than 90% due to material limitations. Contact the Optics Sales Department for ordering information.



VUV-UV Reflective Filters: All Dielectric Design @ 45° Angle of Incidence

Wavelength	Peak Reflectance	Part Numbers			
		0.5" dia. (12.7mm)	1.0" dia. (25.4mm)	1.5" dia. (38.1mm)	2.0" dia. (50.8mm)
147nm	40-70%	147-3045-.5D	147-3045-1D	147-3045-1.5D	147-3045-2D
157nm	82-92%	157-3045-.5D	157-3045-1D	157-3045-1.5D	157-3045-2D
165nm	82-92%	165-3045-.5D	165-3045-1D	165-3045-1.5D	165-3045-2D
172nm	82-92%	172-3045-.5D	172-3045-1D	172-3045-1.5D	172-3045-2D
185nm	82-92%	185-3045-.5D	185-3045-1D	185-3045-1.5D	185-3045-2D
190nm	82-92%	190-3045-.5D	190-3045-1D	190-3045-1.5D	190-3045-2D
193nm	82-92%	193-3045-.5D	193-3045-1D	193-3045-1.5D	193-3045-2D
200nm	90-95%	200-3045-.5D	200-3045-1D	200-3045-1.5D	200-3045-2D
208nm	90-95%	208-3045-.5D	208-3045-1D	208-3045-1.5D	208-3045-2D
212nm	90-95%	212-3045-.5D	212-3045-1D	212-3045-1.5D	212-3045-2D
220nm	90-95%	220-3045-.5D	220-3045-1D	220-3045-1.5D	220-3045-2D
240nm	90-95%	240-3045-.5D	240-3045-1D	240-3045-1.5D	240-3045-2D
248nm	90-95%	248-3045-.5D	248-3045-1D	248-3045-1.5D	248-3045-2D
254nm	90-95%	254-3045-.5D	254-3045-1D	254-3045-1.5D	254-3045-2D
260nm	90-95%	260-3045-.5D	260-3045-1D	260-3045-1.5D	260-3045-2D
266nm	90-95%	266-3045-.5D	266-3045-1D	266-3045-1.5D	266-3045-2D
280nm	90-95%	280-3045-.5D	280-3045-1D	280-3045-1.5D	280-3045-2D
300nm	90-95%	300-3045-.5D	300-3045-1D	300-3045-1.5D	300-3045-2D
320nm	90-95%	320-3045-.5D	320-3045-1D	320-3045-1.5D	320-3045-2D
340nm	90-95%	340-3045-.5D	340-3045-1D	340-3045-1.5D	340-3045-2D
352nm	90-95%	352-3045-.5D	352-3045-1D	352-3045-1.5D	352-3045-2D
360nm	90-95%	360-3045-.5D	360-3045-1D	360-3045-1.5D	360-3045-2D

NOTE: Customers must specify angle of incidence if other than 45°.

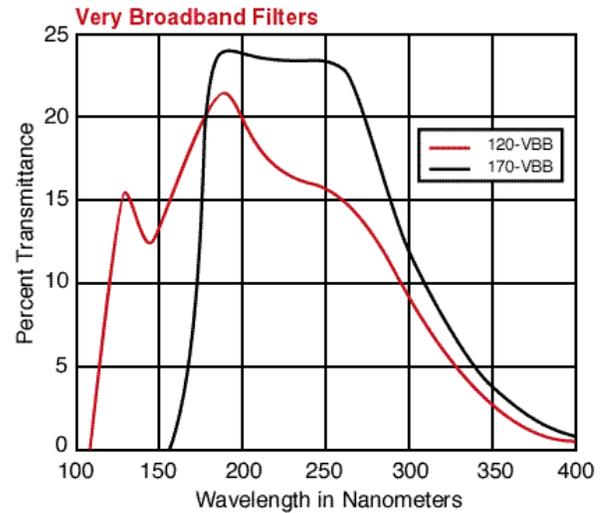


"Solar Blind" Very Broadband Filters

Originally designed for the space program, these unique "very broadband" UV and VUV filters are useful for isolating broad bands of UV or UV-VUV radiation. Our very broadband filters offer broadband transmittance properties, averaging 10-20% over the bands specified. Rejection is approximately 5×10^{-3} at 500nm.

Model 120-VBB: Care must be taken to avoid contact with the coated surface of this open-faced design, as absorption of the substrate at wavelengths near 120nm typically prohibits covering and edge sealing.

Model 170-VBB: is manufactured open-faced, however it can be supplied covered and edge sealed to protect the coated surface See page 20 for more information.



Very Broadband Filters				
Wavelength Range	Average Transmission	Part Numbers		
		0.5" dia (12.7mm)	1.0" dia (25.4mm)	2.0" dia. (50.8mm)
120-250nm	10-20%	120-VBB-.5D	120-VBB-1D	120-VBB-2D
170-300nm	10-20%	170-VBB-.5D	170-VBB-1D	170-VBB-2D

Sub-Assembly Capabilities

Acton Research offers precision opto-mechanical assembly services for our OEM customers. Our skilled optical technicians will build optical sub-assemblies from your mechanical drawings for integration with our optical components.

We can produce the entire sub-assembly including mirror, mount and pre-alignment procedure. You get a "ready to install" assembly, saving time and avoiding any extra, potentially damaging handling of the optical components.



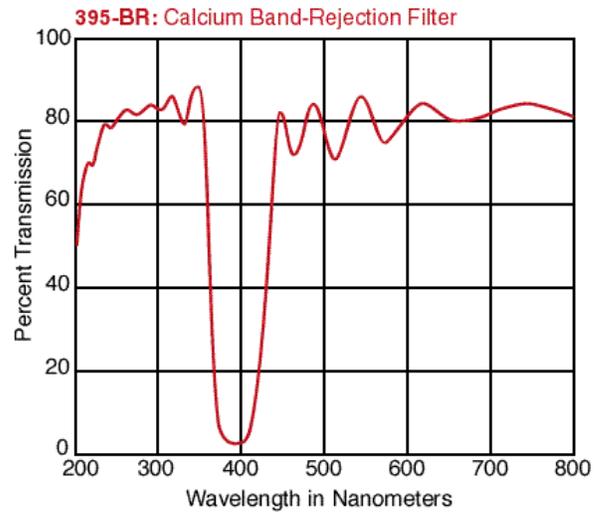
Contact the Optics Sales Department with your optical assembly questions and requirements.



Band Rejection "Notch" Filters

Standard band rejection (notch) filters for the bright 393.4nm and 396.9nm wavelengths of Calcium are manufactured to allow plasma emission spectroscopy in the 170-370nm region, with reduced Ca spectral interferences. Analysis of As 193.7nm, Zn 213.9nm, Cd 226.5nm, etc. in direct-reading emission spectrometers is allowed by the filter's average transmittance level of 60-70% in the 200-350nm region. 80% ±10% transmittance is maintained from 450nm to the near infrared; useful transmittance down to 170nm is obtained by use of UV grade fused silica substrates, 395nm transmittance is 4.0% or less. Magnesium band rejection filters are available for the Magnesium 279.6, 280.3, and 285.2nm lines offering performance similar to the transmittance curve shown at right.

Filters designed to reject wavelengths of 190nm through 400nm are available on a custom basis. Performance of custom notch filters can vary depending on the design wavelength.



Standard Band Rejection Filters

Filter Type	Part Numbers	
	0.625" dia.* (15.88mm)	1.200" dia.* (30.48mm)
Magnesium Band Rejection	280-BR-.5D	280-BR-1D
Calcium Band Rejection	395-BR-.5D	395-BR-1D

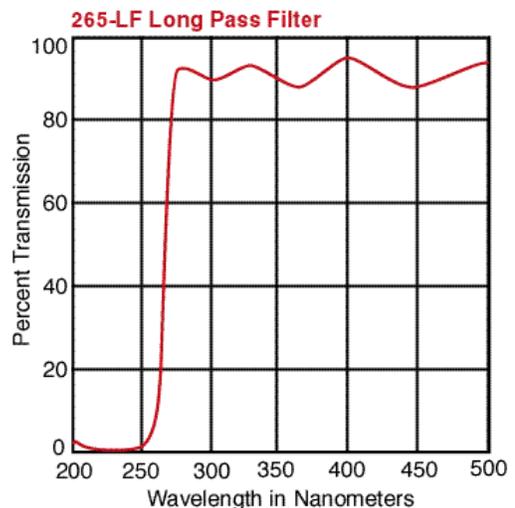
*provided in metal mounting rings Diameter shown includes mounting rings.

UV Long Pass Filters

Long Pass Optical Filters for the UV are designed to block specific "short" wavelength ranges by reflection. For example, a filter with 200nm - 250nm blocking (shown at right), would have transmission of approximately 50% at the cut-on wavelength (265nm) and 85% average transmission from the visible to the near IR.

These "cold mirrors" are ideal for gas detection systems as well as other environmental or analytical monitoring system that require differentiation of the shorter ultraviolet wavelengths from longer visible to near infrared wavelengths.

Acton Research can design long pass filters for other ultraviolet cut-on wavelengths from approximately 200nm - 400nm. Please contact the Optics Sales Department with your requirement.





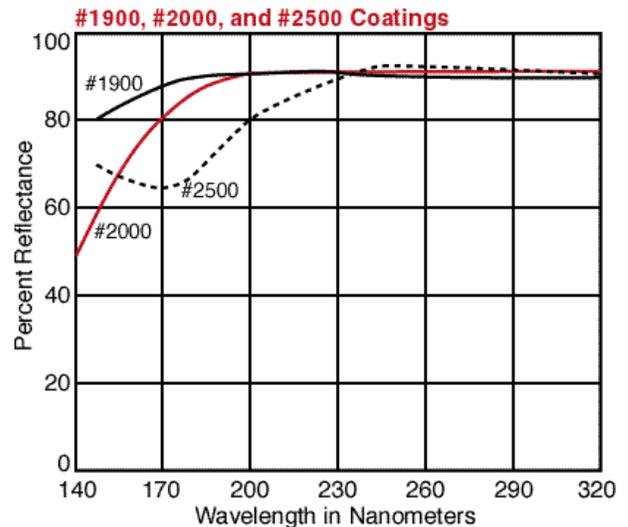
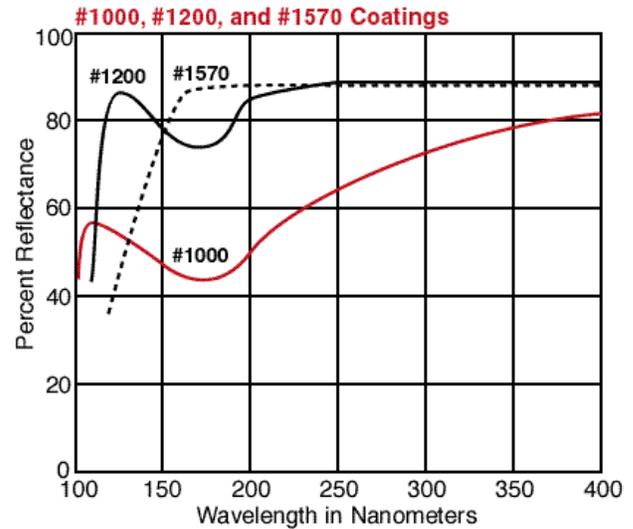
VUV/UV Broadband Coatings

Broadband VUV-UV Al+MgF₂ Coatings

For nearly three decades, Acton Research high efficiency Al+MgF₂ coatings have set the standard for broadband UV and VUV reflectance. These coatings are designed to offer superior reflectance at specific wavelengths listed below, with excellent broadband reflectance throughout the visible and near infrared. Each coating lot is measured for reflectance properties to insure excellent performance of every mirror supplied.

Our VUV-UV broadband coatings offer state-of-the-art reflectance as specified below, and approximately 88-90% reflectance throughout the UV and visible. The #1900 DUV Broadband Coating is optimized for 190-195nm as specified below, and 85% reflectance for 200-600nm at normal incidence.

Acton Research routinely coats Customer Supplied Material (CSM). Please call for details.



Broadband VUV-UV Al+MgF ₂ Coatings		
Coating	Reflectance @ N.I.*	Mirror Part # 1.0" dia. x 2.5mm thick**
#1000	50-60% at 104.0nm	1000-FS-1D
#1200	78-83% at 121.6nm	1200-FS-1D
#1570	84-86% at 157nm	1570-FS-1D
#1600	84-86% at 160.8nm	1600-FS-1D
#1900	88% for 190-195nm	1900-FS-1D
#2000	88-90% at 200nm	2000-FS-1D
#2500	92-94% at 250nm	2500-FS-1D

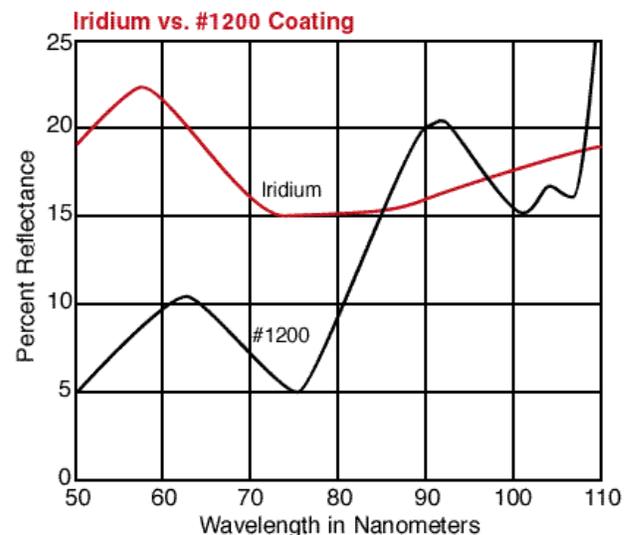
*45° reflectance is normally within 2-4% of normal incidence specifications.
**See page 16 for mirror substrate information.

Extreme UV Reflective Coatings

Acton Research has developed a stable, high reflectance Iridium coating with superior reflectance at wavelengths between 50nm and 110nm. Iridium coatings are recommended when optimum reflectance below 110nm is required.

Graph at Right: Normal incidence reflectance properties of a typical Acton Research Iridium coating compared to ARC #1200 Al+MgF₂ broadband UV-VUV coating.

NOTE: Gold, aluminum, rhodium and platinum coatings are also available. Call for more information.



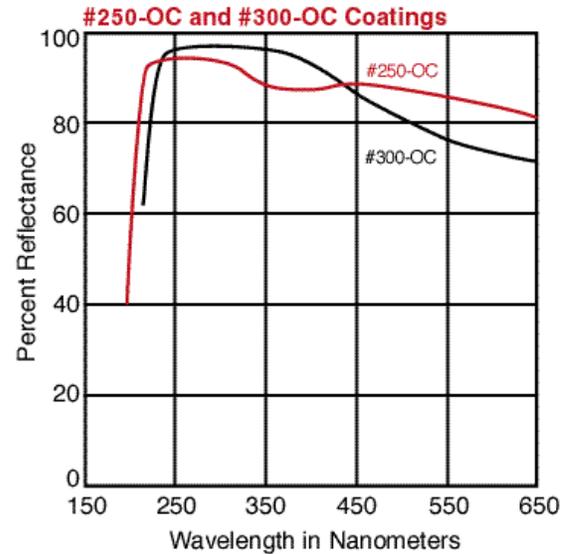


VUV/UV Broadband Coatings

Dielectric Enhanced UV Coatings

The #300-OC coating is a metallic based design with a special dielectric overcoat which offers excellent broadband reflectance from 250nm to 350nm. The #300-OC reflects 95% over this wavelength range, with approximately 70% visible reflectance. If required, the UV reflecting band can be shifted slightly to longer or shorter wavelengths. Angles of incidence other than normal (0°) are available.

Our #250-OC coating was developed to provide enhanced UV reflectance from approximately 235nm to 300nm, with 80-90% visible reflectance.

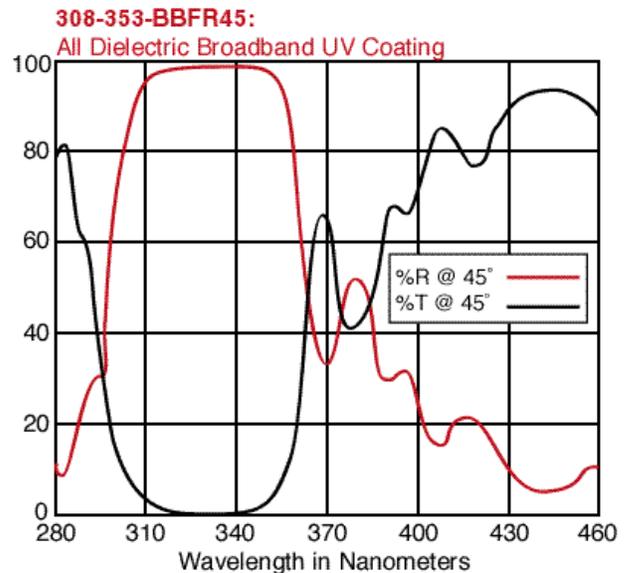


Dielectric Enhanced UV Coatings		
Coating	Reflectance @ N.I.*	Mirror Part # 1.0" dia. x 2.5mm thick
#250-OC	92-95% from 235-300nm	250-OC-FS-1D
#300-OC	95% from 250-350nm	300-OC-FS-1D

*45° reflectance is normally within 2-4% of normal incidence specifications.

All Dielectric Broadband UV Coatings

Our 308-353-BBFR coating is an all dielectric broadband coating designed to offer maximum reflectance from 308nm to 353nm. Designed primarily as a dual wavelength excimer laser mirror coating, it offers excellent near UV reflectance with an average of 80-90% visible to near IR transmittance.



All Dielectric Broadband UV Coatings	
Coating Part #	Reflectance
308-353-BBFR	97 - 99.5%
308-353-BBFR45	95 - 97.5%

Note: Coating shown on graph at right is at 45° AOI.

Note: Please contact the Optics Sales Department for information on additional available substrates and their properties. Acton Research routinely coats Customer Supplied Material (CSM). Please call for details.



Unsurpassed DUV-VIS-NIR Optical Measurement Capability

Acton Research offers precise reflectance and transmittance measurement services for catalog components and qualified customer supplied samples. Measurements are performed using our in-house vacuum and atmospheric spectrophotometers including Acton Research custom manufactured and designed "CAMS" automated measurement systems.

Since air absorbs light at wavelengths below 190nm, a vacuum or purged measurement system is necessary to accurately measure coatings in this region. Our CAMS-507 DUV provides precise reflectance, absorption, and transmittance measurements in the 120 to 300nm wavelength range, with unsurpassed repeatability. The fully computerized system has an automated 8-position sample holder which can be positioned under operating conditions to change the measurement angle from 15° to 70°. A vacuum system is used to remove the air from the light path in order to allow transmission of deep UV wavelengths.

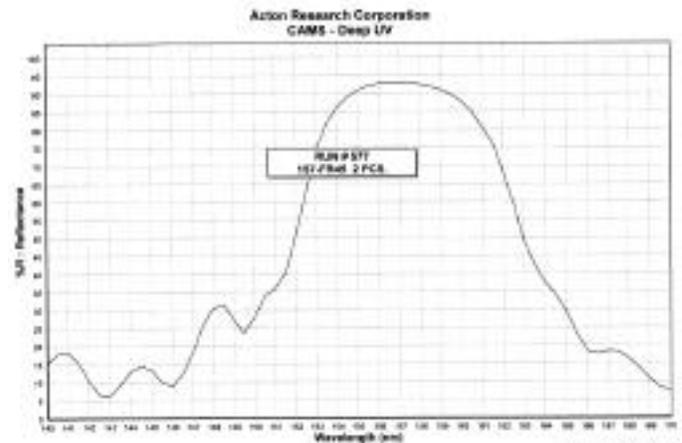
The CAMS system is configured with a high resolution 0.75 meter focal length Acton Research vacuum monochromator, focused deuterium light source (with output from 115-300nm), a large sample chamber with hinged vacuum tight access door, detectors and vacuum pumping system. Additionally, our SpectraSense® software enables full presentation and analysis of your data with optional ASCII format for exporting into data processing software.

Please see the "Measurement Specifications" below for more specific information, and contact the Optics Sales Staff with your questions and pricing information.

The CAMS-507 is also available for sales as an integrated, automated measurement system for operation either under vacuum or nitrogen purged conditions. Contact the Instrument Sales Staff to learn more about purchasing a CAMS system for your specific requirement.



Critical coating performance is guaranteed by our ability to measure reflectance and transmittance using in-house state-of-the-art CAMS™ spectrophotometer systems.



Example of reflectance curve of a 157-FR45 coating measured in the CAMS-507 DUV system.

Measurement Specifications

Capabilities

- Atmospheric Transmittance and Reflectance from 200nm up to 1100nm
- Vacuum Transmittance or Reflectance from 120nm up to 600nm

Angles (dependent on sample size)

- Near normal incidence (15°) up to 70° for vacuum reflectance
- Normal incidence (0°) up to 60° for atmospheric and vacuum transmittance

Typical Samples

- Crystals: LiF, MgF2, CaF2, BaF2, Sapphire
- Fused Silica / Quartz
- Mirrors • Optical Filters

Sizes

- From 0.5" to 3.0" diameter or 2.0" square (accommodations for other sizes are available for additional charge)
- Samples should be flat or have radii of ≥ 2.0 meters to insure accurate measurement



Ordering & Warranty Information

Placing Orders

When placing orders, please use Acton Research part numbers whenever possible.

Telephone Orders

Place from 7:30AM to 5:00PM EST at 978-263-3584. Written, clearly marked "Confirmations" are required on all verbal orders to avoid duplications. Please be specific with all details to avoid unnecessary delay.

Fax Orders

Place at 978-263-5086 with written confirmations by mail. Please include complete name and address with these orders to avoid confusion.

Submit all written orders to our mailing address below. Orders are accepted subject to current prices.

Mail orders to:

Acton Research Corporation
530 Main Street • Acton, MA 01720 USA

Customer Supplied Materials (CSM)

Customer Supplied Material (CSM) to be coated or measured must have an authorization number (RA#) listed on the outside of the box and referenced on all documentation accompanying the shipment. Please contact Acton Research to acquire an authorization number.

Ship Customer Supplied Materials to:

Acton Research Corporation
525 Main Street • Acton, MA 01720-6215 USA
Attention: RA# _____

NOTE: All Material Safety Data Sheets (MSDS) must accompany shipments where applicable.

Terms

Shipping Point: Acton, Massachusetts USA
FOB: Acton, Massachusetts USA

Shipping Charges

Prepaid and added separately to invoices unless otherwise specified by the customer.

Minimum Order

Minimum order is \$150.00.

Payment Terms

Established Accounts: Net 30 days
MasterCard & VISA also accepted for purchases



Non-Established Accounts: Normally net 30 days upon approval of credit references. Otherwise COD, prepaid or Letter of Credit / CAD.

Foreign Orders

Acton Research Corporation is represented around the world by various organizations. Contact Acton Research directly for referral to the representative in your country.

Shipping

UPS (Ground, Blue or Red services), Federal Express, and air freight are available. UPS ground service will be used unless the buyer notes otherwise. Acton Research prepays freight charges and adds them to the customer's invoices. Special handling charges may be added if appropriate.

It is the buyers responsibility to report any shipping errors or damage in shipment within fifteen (15) days after delivery (must have original packing material).

Returns

A restocking fee of 20% will be charged on all standard catalog optics accepted by Acton Research for return to stock. All returns must be labeled on the outside of the package with a Return Authorization Number (RA#) issued by Acton Research Corporation. Specially designed optics or coatings, or products damaged by the customer may not be returned.

Limited Warranty

Acton Research Corporation optical components are warranted to perform within published specifications and against defects in workmanship or materials. This warranty does not cover products which were, as determined solely by Acton Research Corporation, improperly handled, cleaned or stored. Customers must notify Acton Research Corporation of any non-conformity within thirty (30) days of receipt of materials. All returns must be labeled on the outside of the package with a Return Authorization Number (RA#) issued by Acton Research Corporation.

There are no warranties, expressed or implied, including any warranty of merchantability or fitness for a particular purpose, except as provided herein. Liability of Acton Research Corporation shall be limited to the price paid and in no event shall Acton Research Corporation be liable for lost profit or any other special or consequential damage.

Every effort has been made to provide the most accurate specifications in this catalog. However, Acton Research reserves the right to alter specifications at any time, if necessary.

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