THORLABS
43 Sparta Avenue
Newton, NJ 07860
Sales: (973) 300-3000
www.thorlabs.com

MRA05L-E02 - February 23, 2024

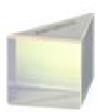
Item # MRA05L-E02 was discontinued on February 23, 2024. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

LEG-COATED RIGHT-ANGLE PRISM MIRRORS

- **Broadband Dielectric Coatings Available for 400 - 750 nm or 750 - 1100 nm**
- **Leg Dimensions from 5.0 mm to 25.0 mm**

MRA25L-E02
(L = 25.0 mm)

MRA20L-E03
(L = 20.0 mm)



MRA10L-E03
(L = 10.0 mm)

MRA05L-E02
(L = 5.0 mm)

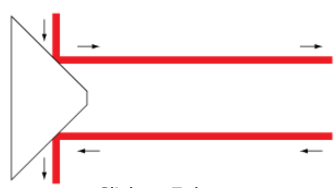
Application Idea
The MRA25L-E02 prism mirror used with a hollow roof prism mirror to create an optical delay line.

Hide Overview

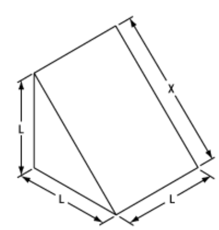
OVERVIEW

Features

- Right-Angle Prism with Dielectric-Coated Legs
- Two Broadband Dielectric Coatings with R_{avg} > 99% for 400 - 750 nm or 750 - 1100 nm
- Leg Lengths Ranging from 5.0 mm to 25.0 mm



Click to Enlarge
A leg-coated prism mirror can be used to create an optical delay line.



The size of these prisms is defined by the leg dimension, L, which is indicated in the product list below. See the *Specs* tab for full product dimensions.

Thorlabs' Leg-Coated Right-Angle Prism Mirrors feature dielectric coatings on the two legs and offer a clear aperture greater than 70% of the face length and width. Note that this clear aperture does not include the beveled edge between the two legs. These prism mirrors are manufactured from N-BK7 and are offered with dielectric coating ranges of 400 - 750 nm or 750 - 1100 nm. Please see the *Specs* and *Graphs* tabs above for details on the reflectance of the two coatings.

These mirrors can be used optical delay lines, which can be used to extend the path length in an optical system. They allow two counterpropagating beams to be made parallel with the output orthogonal to the input, as shown to the left. For applications which seek to split a beam orthogonally or combine two inputs into an orthogonal co-linear output, please view our knife-edge right-angle prisms.

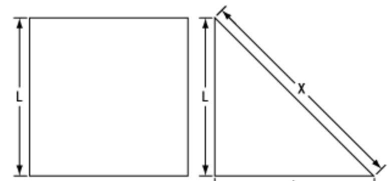
While the hypotenuse is polished, these mirrors are not intended for use as retroreflectors due to the adhesion layers used in the coating process. For retroreflection applications we suggest the PS911K, an uncoated version of our right angle prisms, or our selection of mounted and unmounted retroreflectors. Thorlabs also offers a selection of hypotenuse-coated right-angle prism mirrors.

Right Angle Prism Mirror Selection Guide
Hypotenuse Coated
Metallic Coatings (250 nm - 20 µm)
Dielectric Coatings (400 nm - 1100 nm)
Laser Line (532 nm and 1064 nm)
Leg Coated
Knife-Edge, Metallic and Dielectric Coatings (250 nm - 20 µm)
Dielectric Coatings (400 nm - 1100 nm)

Additional leg sizes and coatings are available upon request. Please contact Tech Support with inquiries.

Hide Specs

SPECS

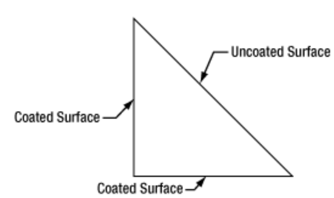


Right-Angle Prism Dimensions

Common Specifications	
Substrate Material	N-BK7[a]
Dimensional Tolerance	±0.1 mm
Surfaces Flatness	λ/10 @ 633 nm (Peak to Valley)
Surfaces Quality	10-5 Scratch-Dig
Clear Aperture	>70% of Face Length and Width
45°-45°-90° Prism Angular Tolerance	±3 arcmin

Item #	L[a]	X[a]	Reflectance (Click for Graph)
Broadband Dielectric Coating: 400 nm - 750 nm			
MRA05L-E02	5.0 mm	7.1 mm	R_{avg} > 99% (400 nm - 750 nm)
MRA10L-E02	10.0 mm	14.1 mm	
MRA12L-E02	12.5 mm	17.7 mm	
MRA20L-E02	20.0 mm	28.3 mm	
MRA25L-E02	25.0 mm	35.4 mm	
Broadband Dielectric Coating: 750 nm - 1100 nm			
MRA05L-E03	5.0 mm	7.1 mm	R_{avg} > 99% (750 nm - 1100 nm)
MRA10L-E03	10.0 mm	14.1 mm	
MRA12L-E03	12.5 mm	17.7 mm	
MRA20L-E03	20.0 mm	28.3 mm	
MRA25L-E03	25.0 mm	35.4 mm	

a. As Specified in the Uppermost Drawing to the Right



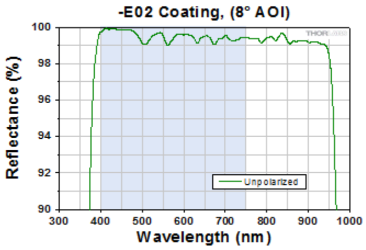
Right-Angle Prism Diagram

Hide Graphs

GRAPHS

These plots show the reflectance of our -E02 (400 - 750 nm) and -E03 (750 - 1100 nm) dielectric coatings for a typical coating run. The shaded region in each graph denotes the spectral range over which the coating is highly reflective. Due to variations in each run, this recommended spectral range is narrower than the actual range over which the optic will be highly reflective. If you have any concerns about the interpretation of this data, please contact Tech Support. For applications that require a mirror that bridges the spectral range between the dielectric coatings, please consider a metallic mirror.

-E02 Coating (400 - 750 nm)



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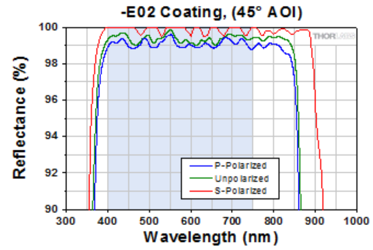

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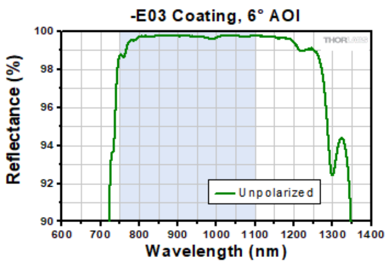
Excel Spreadsheet with Raw Data for -E02 Coating, 8° and 45° AOI

-E03 Coating (750 - 1100 nm)



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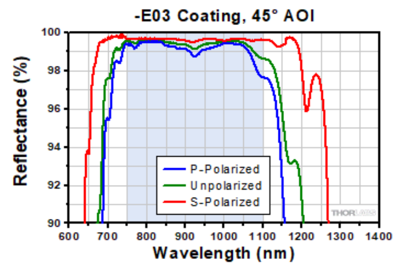

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Excel Spreadsheet with Raw Data for -E03 Coating, 6° and 45° AOI

Hide Damage Thresholds

DAMAGE THRESHOLDS

Damage Threshold Data for Thorlabs' Broadband Dielectric Mirrors

The specifications to the right are measured data for Thorlabs' broadband dielectric mirrors. Damage threshold specifications are constant for a given coating type, regardless of the size and shape of the mirror.

Damage Threshold Specifications		
Coating Designation (Item # Suffix)	Type	Damage Threshold
-E02	Pulsed	0.25 J/cm² (532 nm, 10 ns, 10 Hz, Ø0.803 mm)
	CW[a,b]	550 W/cm (532 nm, Ø1.000 mm)
-E03	Pulsed	0.205 J/cm² (800 nm, 99 fs, 1 kHz, Ø0.166 mm) 1 J/cm² (810 nm, 10 ns, 10 Hz, Ø0.133 mm) 0.5 J/cm² (1064 nm, 10 ns, 10 Hz, Ø0.433 mm)
	CW[a,b]	10 kW/cm (1070 nm, Ø0.971 mm)

a. The power density of your beam should be calculated in terms of W/cm. For an explanation of why the linear power density provides the best metric for long pulse and CW sources, please see below.
b. The stated damage threshold is a certification measurement, as opposed to a true damage threshold (i.e., the optic was able to withstand the maximum output of the laser with no damage).

Laser Induced Damage Threshold Tutorial

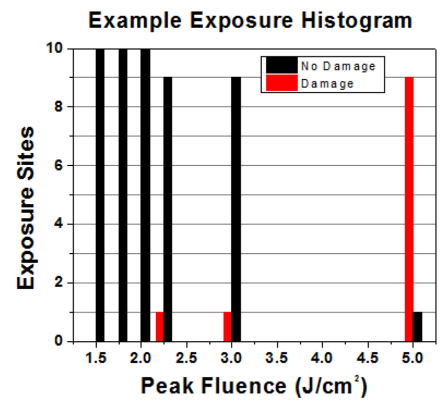
The following is a general overview of how laser induced damage thresholds are measured and how the values may be utilized in determining the appropriateness of an optic for a given application. When choosing optics, it is important to understand the Laser Induced Damage Threshold (LIDT) of the optics being used. The LIDT for an optic greatly depends on the type of laser you are using. Continuous wave (CW) lasers typically cause damage from thermal effects (absorption either in the coating or in the substrate). Pulsed lasers, on the other hand, often strip electrons from the lattice structure of an optic before causing thermal damage. Note that the guideline presented here assumes room temperature operation and optics in new condition (i.e., within scratch-dig spec, surface free of contamination, etc.). Because dust or other particles on the surface of an optic can cause damage at lower thresholds, we recommend keeping surfaces clean and free of debris. For more information on cleaning optics, please see our *Optics Cleaning* tutorial.

Testing Method

Thorlabs' LIDT testing is done in compliance with ISO/DIS 11254 and ISO 21254 specifications.

First, a low-power/energy beam is directed to the optic under test. The optic is exposed in 10 locations to this laser beam for 30 seconds (CW) or for a number of pulses (pulse repetition frequency specified). After exposure, the optic is examined by a microscope (~100X magnification) for any visible damage. The number of locations that are damaged at a particular power/energy level is recorded. Next, the power/energy is either increased or decreased and the optic is exposed at 10 new locations. This process is repeated until damage is observed. The damage threshold is then assigned to be the highest power/energy that the optic can withstand without causing damage. A histogram such as that below represents the testing of one BB1-E02 mirror.

The photograph above is a protected aluminum-coated mirror after LIDT testing. In this particular test, it handled 0.43 J/cm^2 (1064 nm, 10 ns pulse, 10 Hz, Ø1.000 mm) before damage.



Example Test Data			
Fluence	# of Tested Locations	Locations with Damage	Locations Without Damage
1.50 J/cm^2	10	0	10
1.75 J/cm^2	10	0	10
2.00 J/cm^2	10	0	10
2.25 J/cm^2	10	1	9
3.00 J/cm^2	10	1	9
5.00 J/cm^2	10	9	1

According to the test, the damage threshold of the mirror was 2.00 J/cm^2 (532 nm, 10 ns pulse, 10 Hz, Ø0.803 mm). Please keep in mind that these tests are performed on clean optics, as dirt and contamination can significantly lower the damage threshold of a component. While the test results are only representative of one coating run, Thorlabs specifies damage threshold values that account for coating variances.

Continuous Wave and Long-Pulse Lasers

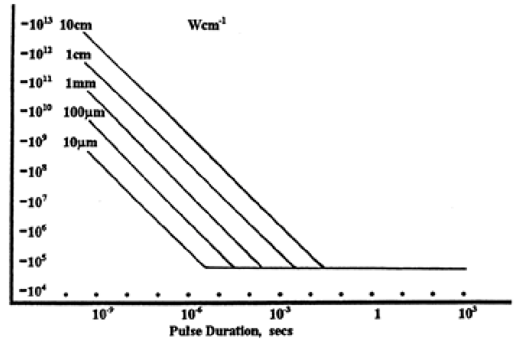
When an optic is damaged by a continuous wave (CW) laser, it is usually due to the melting of the surface as a result of absorbing the laser's energy or damage to the optical coating (antireflection) [1]. Pulsed lasers with pulse lengths longer than 1 µs can be treated as CW lasers for LIDT discussions.

When pulse lengths are between 1 ns and 1 µs, laser-induced damage can occur either because of absorption or a dielectric breakdown (therefore, a user must check both CW and pulsed LIDT). Absorption is either due to an intrinsic property of the optic or due to surface irregularities; thus LIDT values are only valid for optics meeting or exceeding the surface quality specifications given by a manufacturer. While many optics can handle high power CW lasers, cemented (e.g., achromatic doublets) or highly absorptive (e.g., ND filters) optics tend to have lower CW damage thresholds. These lower thresholds are due to absorption or scattering in the cement or metal coating.

Pulsed lasers with high pulse repetition frequencies (PRF) may behave similarly to CW beams. Unfortunately, this is highly dependent on factors such as absorption and thermal diffusivity, so there is no reliable method for determining when a high PRF laser will damage an optic due to thermal effects. For beams with a high PRF both the average and peak powers must be compared to the equivalent CW power. Additionally, for highly transparent materials, there is little to no drop in the LIDT with increasing PRF.

In order to use the specified CW damage threshold of an optic, it is necessary to know the following:

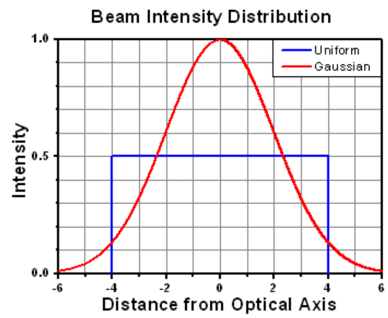
1. Wavelength of your laser
2. Beam diameter of your beam ($1/e^2$)
3. Approximate intensity profile of your beam (e.g., Gaussian)
4. Linear power density of your beam (total power divided by $1/e^2$ beam diameter)



LIDT in linear power density vs. pulse length and spot size. For long pulses to CW, linear power density becomes a constant with spot size. This graph was obtained from [1].

Thorlabs expresses LIDT for CW lasers as a linear power density measured in W/cm. In this regime, the LIDT given as a linear power density can be applied to any beam diameter; one does not need to compute an adjusted LIDT to adjust for changes in spot size, as demonstrated by the graph to the right. Average linear power density can be calculated using the equation below.

$$Linear\ Power\ Density = \frac{Power}{Beam\ Diameter}$$



The calculation above assumes a uniform beam intensity profile. You must now consider hotspots in the beam or other non-uniform intensity profiles and roughly calculate a maximum power density. For reference, a Gaussian beam typically has a maximum power density that is twice that of the uniform beam (see lower right).

Now compare the maximum power density to that which is specified as the LIDT for the optic. If the optic was tested at a wavelength other than your operating wavelength, the damage threshold must be scaled appropriately. A good rule of thumb is that the damage threshold has a linear relationship with wavelength such that as you move to shorter wavelengths, the damage threshold decreases (i.e., a LIDT of 10 W/cm at 1310 nm scales to 5 W/cm at 655 nm):

$$Adjusted\ LIDT = LIDT\ Power\left(\frac{Your\ Wavelength}{LIDT\ Wavelength}\right)$$

While this rule of thumb provides a general trend, it is not a quantitative analysis of LIDT vs wavelength. In CW applications, for instance, damage scales more strongly with absorption in the coating and substrate, which does not necessarily scale well with wavelength. While the above procedure provides a good rule of thumb for LIDT values, please contact Tech Support if your wavelength is different from the specified LIDT wavelength. If your power density is less than the adjusted LIDT of the optic, then the optic should work for your application.

Please note that we have a buffer built in between the specified damage thresholds online and the tests which we have done, which accommodates variation between batches. Upon request, we can provide individual test information and a testing certificate. The damage analysis will be carried out on a similar optic (customer's optic will not be damaged). Testing may result in additional costs or lead times. Contact Tech Support for more information.

Pulsed Lasers

As previously stated, pulsed lasers typically induce a different type of damage to the optic than CW lasers. Pulsed lasers often do not heat the optic enough to damage it; instead, pulsed lasers produce strong electric fields capable of inducing dielectric breakdown in the material. Unfortunately, it can be very difficult to compare the LIDT specification of an optic to your laser. There are multiple regimes in which a pulsed laser can damage an optic and this is based on the laser's pulse length. The highlighted columns in the table below outline the relevant pulse lengths for our specified LIDT values.

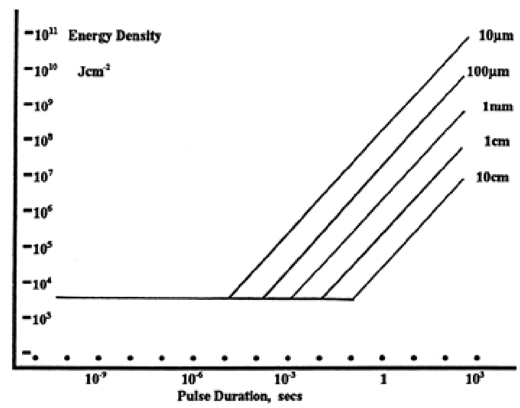
Pulses shorter than 10^{-9} s cannot be compared to our specified LIDT values with much reliability. In this ultra-short-pulse regime various mechanics, such as multiphoton-avalanche ionization, take over as the predominate damage mechanism [2]. In contrast, pulses between 10^{-7} s and 10^{-4} s may cause damage to an optic either because of dielectric breakdown or thermal effects. This means that both CW and pulsed damage thresholds must be compared to the laser beam to determine whether the optic is suitable for your application.

Pulse Duration	$t < 10^{-9}$ s	$10^{-9} < t < 10^{-7}$ s	$10^{-7} < t < 10^{-4}$ s	$t > 10^{-4}$ s

Damage Mechanism	Avalanche Ionization	Dielectric Breakdown	Dielectric Breakdown or Thermal	Thermal
Relevant Damage Specification	No Comparison (See Above)	Pulsed	Pulsed and CW	CW

When comparing an LIDT specified for a pulsed laser to your laser, it is essential to know the following:

1. Wavelength of your laser
2. Energy density of your beam (total energy divided by 1/e^2 area)
3. Pulse length of your laser
4. Pulse repetition frequency (prf) of your laser
5. Beam diameter of your laser (1/e^2)
6. Approximate intensity profile of your beam (e.g., Gaussian)



LIDT in energy density vs. pulse length and spot size. For short pulses, energy density becomes a constant with spot size. This graph was obtained from [1].

The energy density of your beam should be calculated in terms of J/cm^2. The graph to the right shows why expressing the LIDT as an energy density provides the best metric for short pulse sources. In this regime, the LIDT given as an energy density can be applied to any beam diameter; one does not need to compute an adjusted LIDT to adjust for changes in spot size. This calculation assumes a uniform beam intensity profile. You must now adjust this energy density to account for hotspots or other nonuniform intensity profiles and roughly calculate a maximum energy density. For reference a Gaussian beam typically has a maximum energy density that is twice that of the 1/e^2 beam.

Now compare the maximum energy density to that which is specified as the LIDT for the optic. If the optic was tested at a wavelength other than your operating wavelength, the damage threshold must be scaled appropriately [3]. A good rule of thumb is that the damage threshold has an inverse square root relationship with wavelength such that as you move to shorter wavelengths, the damage threshold decreases (i.e., a LIDT of 1 J/cm^2 at 1064 nm scales to 0.7 J/cm^2 at 532 nm):

$$Adjusted\ LIDT = LIDT\ Energy\sqrt{\frac{Your\ Wavelength}{LIDT\ Wavelength}}$$

You now have a wavelength-adjusted energy density, which you will use in the following step.

Beam diameter is also important to know when comparing damage thresholds. While the LIDT, when expressed in units of J/cm², scales independently of spot size; large beam sizes are more likely to illuminate a larger number of defects which can lead to greater variances in the LIDT [4]. For data presented here, a <1 mm beam size was used to measure the LIDT. For beams sizes greater than 5 mm, the LIDT (J/cm2) will not scale independently of beam diameter due to the larger size beam exposing more defects.

The pulse length must now be compensated for. The longer the pulse duration, the more energy the optic can handle. For pulse widths between 1 - 100 ns, an approximation is as follows:

$$Adjusted\ LIDT = LIDT\ Energy\sqrt{\frac{Your\ Pulse\ Length}{LIDT\ Pulse\ Length}}$$

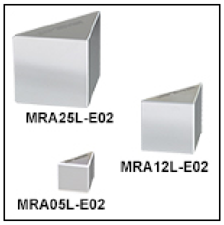
Use this formula to calculate the Adjusted LIDT for an optic based on your pulse length. If your maximum energy density is less than this adjusted LIDT maximum energy density, then the optic should be suitable for your application. Keep in mind that this calculation is only used for pulses between 10^{-9} s and 10^{-7} s. For pulses between 10^{-7} s and 10^{-4} s, the CW LIDT must also be checked before deeming the optic appropriate for your application.

Please note that we have a buffer built in between the specified damage thresholds online and the tests which we have done, which accommodates variation between batches. Upon request, we can provide individual test information and a testing certificate. Contact Tech Support for more information.

[1] R. M. Wood, Optics and Laser Tech. **29**, 517 (1998).
[2] Roger M. Wood, *Laser-Induced Damage of Optical Materials* (Institute of Physics Publishing, Philadelphia, PA, 2003).
[3] C. W. Carr *et al.*, Phys. Rev. Lett. **91**, 127402 (2003).
[4] N. Bloembergen, Appl. Opt. **12**, 661 (1973).

Hide Leg-Coated Right-Angle Prism Mirrors, Dielectric Coating (400 nm - 750 nm)

Leg-Coated Right-Angle Prism Mirrors, Dielectric Coating (400 nm - 750 nm)



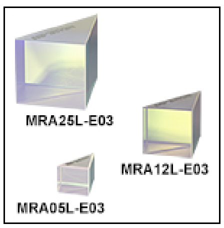
- Five Sizes Available with Leg Dimensions from 5.0 mm to 25.0 mm
- Average Reflectance: >99% (400 - 750 nm)

These broadband dielectric-coated right angle prisms are ideal for near-normal and 45° reflections. They perform well with both S- and P-polarized light over their specified wavelength range of 400 - 750 nm. For more information on the typical performance of these mirrors, please see the *Graphs* tab. For detailed specifications on each prism mirror, please see the *Specs* tab.

Part Number	Description	Price	Availability
MRA05L-E02	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 400 - 750 nm, L = 5.0 mm	$112.02	Lead Time
MRA10L-E02	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 400 - 750 nm, L = 10.0 mm	$136.51	Lead Time
MRA12L-E02	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 400 - 750 nm, L = 12.5 mm	$148.87	Today
MRA20L-E02	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 400 - 750 nm, L = 20.0 mm	$168.18	Today
MRA25L-E02	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 400 - 750 nm, L = 25.0 mm	$203.43	Today

Hide Leg-Coated Right-Angle Prism Mirrors, Dielectric Coating (750 nm - 1100 nm)

Leg-Coated Right-Angle Prism Mirrors, Dielectric Coating (750 nm - 1100 nm)



- Five Sizes Available with Leg Dimensions from 5.0 mm to 25.0 mm
- Average Reflectance: >99% (750 nm - 1100 nm)

These broadband dielectric-coated right angle prisms are ideal for near-normal and 45° reflections. They perform well with both S- and P-polarized light over their specified wavelength range of 750 - 1100 nm. For more information on the typical performance of these mirrors, please see the *Graphs* tab. For detailed specifications on each prism mirror, please see the *Specs* tab.

Part Number	Description	Price	Availability
MRA05L-E03	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 750 - 1100 nm, L = 5.0 mm	$119.57	Today
MRA10L-E03	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 750 - 1100 nm, L = 10.0 mm	$144.53	Today
MRA12L-E03	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 750 - 1100 nm, L = 12.5 mm	$155.77	Today
MRA20L-E03	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 750 - 1100 nm, L = 20.0 mm	$177.83	Today
MRA25L-E03	Customer Inspired! Leg-Coated Right-Angle Prism Dielectric Mirror, 750 - 1100 nm, L = 25.0 mm	$211.46	7-10 Days