56 Sparta Avenue • Newton, New Jersey 07860
(973) 300-3000 Sales • (973) 300-3600 Fax
www.thorlabs.com

THORLABS

LPVISB050 - Feb. 3, 2017

Item # LPVISB050 was discontinued on Feb. 3, 2017. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

NANOPARTICLE LINEAR FILM POLARIZER

- **UV, Visible, NIR, and IR Spectral Ranges**
- **Unmounted and Mounted Versions**
- **Extinction Ratios up to 100 000:1**
- **Laser Damage Thresholds up to 25 W/cm^2**

Unmounted Linear Polarizers

LPVIS100
(Ø25.0 mm)

LPUV050
(Ø12.5 mm)

Mounted Linear Polarizers

LPMIR100-MP2
(SM1 Compatible)

LPUV050-MP2
(SM05 Compatible)

Mounted Linear Polarizer in RSP1X15 Indexed Rotation Mount

OVERVIEW

Features

- High Extinction Ratio and Laser Damage Threshold (See Tables Below)
- Two Polarizer Sizes: Ø12.5 mm and Ø25.0 mm
- Unmounted or Mounted in SM-Threaded Housing
- Unmounted Versions Have Protective Glass Substrate (Except LPNIRA & LPMIR)
- Resistant to UV Radiation and Chemicals

Linear Polarizer Selection Guide	
Item # Prefix	**Wavelength Range**
LPUV	365 - 395 nm
LPVISA	480 - 550 nm
LPVISB	500 - 720 nm
LPVISC	510 - 800 nm
LPVIS	550 nm - 1.5 µm
LPNIR	650 nm - 2.0 µm
LPNIRA	1.0 - 3.0 µm
LPMIR	1.5 - 5.0 µm

These Nanoparticle Linear Film Polarizers consist of spherical ellipsoid nanoparticles that have been embedded in sodium-silicate glass. They offer superior performance compared to conventional polymer-based polarizers. While both conventional and nanoparticle polarizers absorb the light that is polarized perpendicular to the transmission axis, the nanoparticles have a significantly higher damage threshold and a dramatically better extinction ratio. The polarizer's transmission axis is indicated by two black marks on the edge of every unmounted polarizer except the LPMIR050 and LPMIR100. On the mounted polarizers, the polarization axis is indicated by engraved white lines on the housing.

The housings for the Ø12.5 mm and Ø25.0 mm mounted polarizers are externally SM05-threaded (0.535"-40) or SM1-threaded (1.035"-40), respectively, allowing for easy integration into our SM-threaded components. Alternatively, the mounted polarizers can be implemented into a number of systems, including cage systems and lens tubes, using our selection of rotation mounts.

The unmounted polarizers shown below (except for the LPNIRA and LPMIR) consist of a thin layer of sodium-silicate polarizer laminated between two pieces of index-matched Schott glass (B270) for additional strength. The mounted polarizers, as well as LPNIRA and LPMIR unmounted polarizers, are not laminated, allowing for a higher laser damage threshold. They only consist of the thin sodium-silicate polarizer, which is between 0.20 mm and 0.28 mm thick; as a result, they are more delicate to handle. However, they may still be cleaned using standard optics cleaning methods and solvents.

Please note that the mounted polarizers cannot be separated from their housings. Due to their thickness and precise alignment, they are bounded by a retaining ring and epoxy.

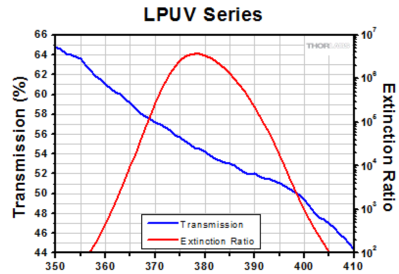
SPECS

Item # Prefix		LPUV	LPVISA	LPVISB[a]	LPVISC[a]	LPVIS	LPNIR	LPNIRA	LPMIR
Wavelength Range		365 - 395 nm	480 - 550 nm	500 - 720 nm	510 - 800 nm	550 - 1500 nm	650 - 2000 nm	1000 - 3000 nm	1500 - 5000 nm
Extinction Ratios[b]									
> 100 000 : 1		372 - 388 nm	-	-	530 - 640 nm	600 - 1200 nm	850 - 1600 nm	-	-
> 10 000 : 1		369 - 390 nm	480 - 550 nm	500 - 720 nm	520 - 740 nm	550 - 1500 nm	750 - 1800 nm	1200 - 3000 nm	2000 - 4500 nm
> 1000 : 1		365 - 395 nm	-	-	510 - 800 nm	-	650 - 2000 nm	1000 - 3000 nm	1500 - 5000 nm
General Specifications									
Polarizer Material		Nanoparticles in Sodium-Silicate Glass							
Substrate Material		Unmounted Version: Schott Glass B270 Mounted Version: None						None	
Optic Diameter		Ø12.5 mm (Ø0.49") ± 0.2 mm (0.008") Ø25.0 mm (Ø0.98") ± 0.2 mm (0.008")							
Optic Thickness	Unmounted	2.0 ± 0.2 mm						250 ± 65 µm	200 ± 50 µm
	Mounted[c]	220 ± 50 µm	280 ± 50 µm	280 ± 50 µm	280 ± 50 µm	260 ± 50 µm	220 ± 50 µm	250 ± 65 µm	200 ± 50 µm
Housing Diameter[d]		Ø17.8 mm (Ø0.70") or Ø30.5 mm (Ø1.20")							
Housing Depth[d]		10.4 mm for Ø12.5 mm Polarizers or 11.4 mm for Ø25.0 mm Polarizers							
Clear Aperture		Unmounted Version: 90% of Surface Area Mounted Version: Ø10.90 mm (Ø0.43") or Ø22.90 mm (Ø0.90")							
Wavefront Distortion	Unmounted	<λ/4 @ 633 nm						<3λ @ 633 nm	
	Mounted[c]	3λ @ 633 nm							
Parallelism	Unmounted	<1 arcmin						<20 arcmin	
	Mounted[c]	<20 arcmin							
Surface Quality		Scratch-Dig: 40-20 (MIL-O-13830A) Surface Imperfections: 5/2 x 0.04 per Ø10 mm acc. (ISO 10110-07)						N/A	
Acceptance Angle[e]		±20°							
Laser Damage Threshold		Unmounted Version: 1 W/cm² Continuous Block, 5 W/cm² Continuous Pass Mounted Version: 10 W/cm² Continuous Block, 25 W/cm² Continuous Pass						10 W/cm² Continuous Block 25 W/cm² Continuous Pass	
Operating Temperature		-20 to +120 °C						-50 to +400 °C (Unmounted) -20 to +120 °C (Mounted)	
Maintenance		Clean with Standard Cleaning Solvents							

- We do not offer mounted or unmounted Ø25.0 mm LPVISB polarizers, mounted Ø12.5 mm LPVISB polarizers, or unmounted Ø12.5 mm LPVISC polarizers.
- The extinction ratio (ER) is the ratio of maximum to minimum transmission of a linearly polarized input. When the transmission axis and input polarization are parallel, the transmission is at its maximum; rotate the polarizer by 90° for minimum transmission. These polarizers maintain an extinction ratio of at least 1000:1 over the full operating bandwidth. Extinction ratios of >10 000:1 or >100 000:1 are maintained over specific wavelength ranges (see the Graphs tab for details).
- Optics in mounted polarizers are permanently epoxied and not removable.
- Applies to mounted polarizers only.
- The acceptance angle is limited by losses due to Fresnel reflections.

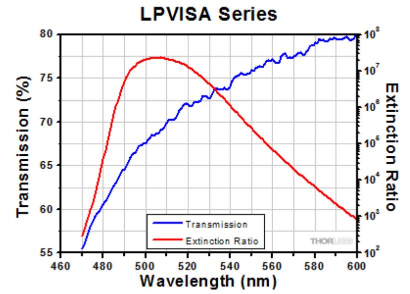
GRAPHS

The plots below show the measured transmission as a function of wavelength (blue lines) and the theoretically calculated extinction ratio (ER) as a function of wavelength (red lines) for each linear polarizer when the light is normally incident. For measured extinction ratio values which are guaranteed, please see the Specs tab. The percent transmission is the percentage of light with a linear state of polarization (SOP) aligned with the transmission axis that is transmitted through the linear polarizer. This number is less than 100% because of surface reflections and internal absorption. The ER is the ratio of the transmitted intensity of a linearly polarized beam of light with the orientation of the SOP parallel to the transmission axis to the transmitted intensity of the same linearly polarized beam of light with the orientation of the SOP perpendicular to the transmission axis. For reference, an ER of 1×10^6 is typical of a top-of-the-line Glan-Laser Calcite Polarizer, although a calcite polarizer has a significantly higher damage threshold.



Click to Enlarge

Click to Download LPUV Series Transmission Data



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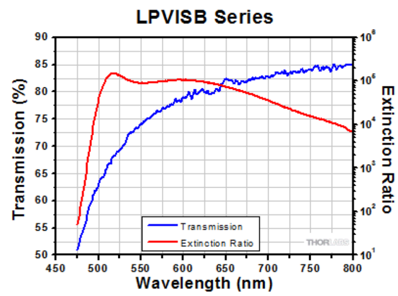
Click to Download LPVISA Series Transmission Data



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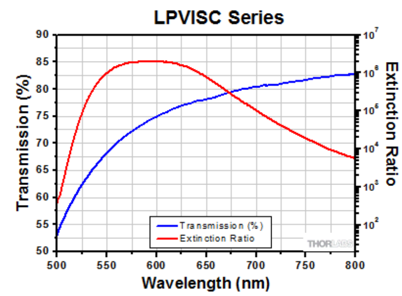
Click to Download LPVISB Series Transmission Data



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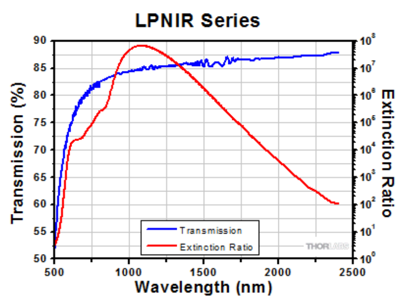
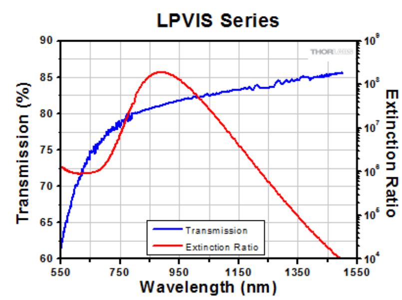


Click to Enlarge

Click to Download LPNIR Transmission Data



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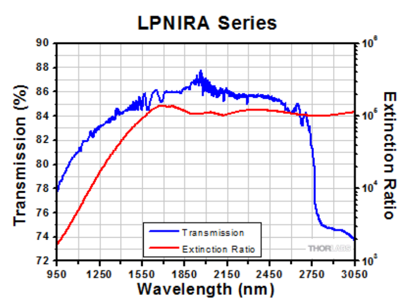
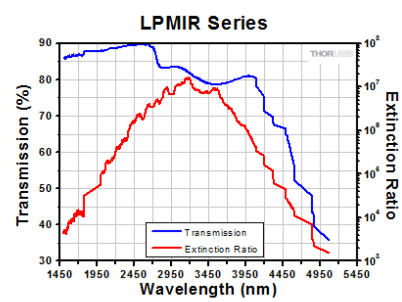
Click to Download LPVIS Series Transmission Data



Click to Enlarge

Click to Download LPNIRA Transmission Data



Click to Enlarge

Click to Download LPMIR Transmission Data

Damage Threshold Data for Thorlabs' Nanoparticle Linear Film Polarizers

The specifications in the table to the right are for Thorlabs' Nanoparticle Linear Film Polarizers. Damage threshold specifications are constant for all nanoparticle linear film polarizers, regardless of the size of the polarizer.

Damage Threshold Specifications	
Item # Prefix	Damage Threshold
LPUV	Unmounted Versions: 1 W/cm^2 Continuous Block; 5 W/cm^2 Continuous Pass Mounted Versions: 10 W/cm^2 Continuous Block; 25 W/cm^2 Continuous Pass
LPVIS	
LPVISA	
LPVISB	
LPVISC	
LPNIR	
LPNIRA	10 W/cm^2 Continuous Block; 25 W/cm^2 Continuous Pass
LPMIR	

Laser Induced Damage Threshold Tutorial

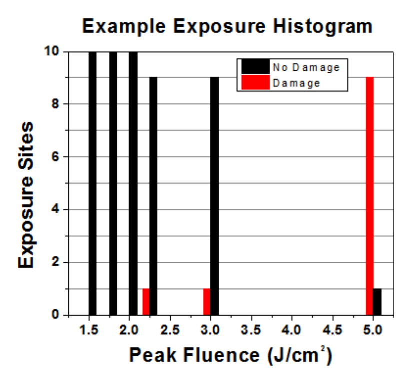
The following is a general overview of how laser induced damage thresholds are measured and how the values may be utilized in determining the appropriateness of an optic for a given application. When choosing optics, it is important to understand the Laser Induced Damage Threshold (LIDT) of the optics 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/DIS11254 specifications. A standard 1-on-1 testing regime is performed to test the damage threshold.

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 a set duration of time (CW) or 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.



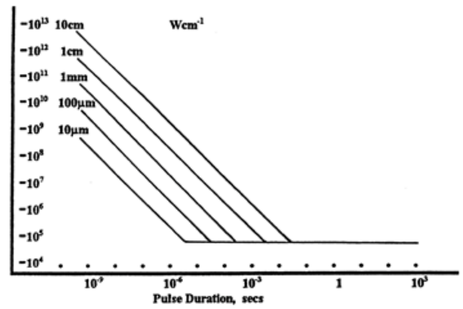
Example Test Data			
Fluence	# of Tested Locations	Locations with Damage	Locations Without Damage
1.50 J/cm^2	10	0	10
1.75 J/cm^2	10	0	10
2.00 J/cm^2	10	0	10
2.25 J/cm^2	10	1	9
3.00 J/cm^2	10	1	9
5.00 J/cm^2	10	9	1

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. Additionally, when pulse lengths are between 1 ns and 1 µs, LIDT can occur either because of absorption or a dielectric breakdown (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 large 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.

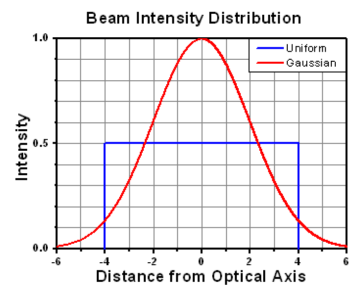


LIDT in linear power density vs. pulse length and spot size. For long pulses to CW, linear power density becomes a constant with spot size. This graph was obtained from [1].

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

The power density of your beam should be calculated in terms of W/cm. The graph to the right shows why expressing the LIDT as a linear power density provides the best metric for long pulse and CW sources. 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. This calculation 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.

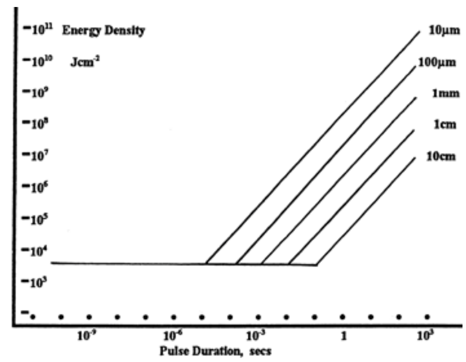
Pulse Duration	$t < 10^{-9}$ s	$10^{-9} < t < 10^{-7}$ s	$10^{-7} < t < 10^{-4}$ s	$t > 10^{-4}$ s
Damage Mechanism	Avalanche Ionization	Dielectric Breakdown	Dielectric Breakdown or Thermal	Thermal
Relevant Damage Specification	N/A	Pulsed	Pulsed and CW	CW

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)

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.



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].

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/cm^2, 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.

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[1] R. M. Wood, Optics and Laser Tech. 29, 517 (1997).
[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).

In order to illustrate the process of determining whether a given laser system will damage an optic, a number of example calculations of laser induced damage threshold are given below. For assistance with performing similar calculations, we provide a spreadsheet calculator that can be downloaded by clicking the button to the right. To use the calculator, enter the specified LIDT value of the optic under consideration and the relevant parameters of your laser system in the green boxes. The spreadsheet will then calculate a linear power density for CW and pulsed systems, as well as an energy density value for pulsed systems. These values are used to calculate adjusted, scaled LIDT values for the optics based on accepted scaling laws. This calculator assumes a Gaussian beam profile, so a correction factor must be introduced for other beam shapes (uniform, etc.). The LIDT scaling laws are determined from empirical relationships; their accuracy is not guaranteed. Remember that absorption by optics or coatings can significantly reduce LIDT in some spectral regions. These LIDT values are not valid for ultrashort pulses less than one nanosecond in duration.

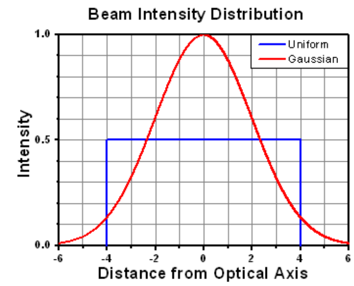
LIDT Calculator

CW Laser Example

Suppose that a CW laser system at 1319 nm produces a 0.5 W Gaussian beam that has a $1/e^2$ diameter of 10 mm. A naive calculation of the average linear power density of this beam would yield a value of 0.5 W/cm, given by the total power divided by the beam diameter:

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

However, the maximum power density of a Gaussian beam is about twice the maximum power density of a uniform beam, as shown in the graph to the right. Therefore, a more accurate determination of the maximum linear power density of the system is 1 W/cm.



A Gaussian beam profile has about twice the maximum intensity of a uniform beam profile.

An AC127-030-C achromatic doublet lens has a specified CW LIDT of 350 W/cm, as tested at 1550 nm. CW damage threshold values typically scale directly with the wavelength of the laser source, so this yields an adjusted LIDT value:

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

The adjusted LIDT value of 350 W/cm x (1319 nm / 1550 nm) = 298 W/cm is significantly higher than the calculated maximum linear power density of the laser system, so it would be safe to use this doublet lens for this application.

Pulsed Nanosecond Laser Example: Scaling for Different Pulse Durations

Suppose that a pulsed Nd:YAG laser system is frequency tripled to produce a 10 Hz output, consisting of 2 ns output pulses at 355 nm, each with 1 J of energy, in a Gaussian beam with a 1.9 cm beam diameter ($1/e^2$). The average energy density of each pulse is found by dividing the pulse energy by the beam area:

$$Energy\ Density = \frac{Pulse\ Energy}{Beam\ Area}$$

As described above, the maximum energy density of a Gaussian beam is about twice the average energy density. So, the maximum energy density of this beam is ~0.7 J/cm^2.

The energy density of the beam can be compared to the LIDT values of 1 J/cm^2 and 3.5 J/cm^2 for a BB1-E01 broadband dielectric mirror and an NB1-K08 Nd:YAG laser line mirror, respectively. Both of these LIDT values, while measured at 355 nm, were determined with a 10 ns pulsed laser at 10 Hz. Therefore, an adjustment must be applied for the shorter pulse duration of the system under consideration. As described on the previous tab, LIDT values in the nanosecond pulse regime scale with the square root of the laser pulse duration:

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

This adjustment factor results in LIDT values of 0.45 J/cm^2 for the BB1-E01 broadband mirror and 1.6 J/cm^2 for the Nd:YAG laser line mirror, which are to be compared with the 0.7 J/cm^2 maximum energy density of the beam. While the broadband mirror would likely be damaged by the laser, the more specialized laser line mirror is appropriate for use with this system.

Pulsed Nanosecond Laser Example: Scaling for Different Wavelengths

Suppose that a pulsed laser system emits 10 ns pulses at 2.5 Hz, each with 100 mJ of energy at 1064 nm in a 16 mm diameter beam ($1/e^2$) that must be attenuated with a neutral density filter. For a Gaussian output, these specifications result in a maximum energy density of 0.1 J/cm^2. The damage threshold of an NDUV10A Ø25 mm, OD 1.0, reflective neutral density filter is 0.05 J/cm^2 for 10 ns pulses at 355 nm, while the damage threshold of the similar NE10A absorptive filter is 10 J/cm^2 for 10 ns pulses at 532 nm. As described on the previous tab, the LIDT value of an optic scales with the square root of the wavelength in the nanosecond pulse regime:

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

This scaling gives adjusted LIDT values of 0.08 J/cm^2 for the reflective filter and 14 J/cm^2 for the absorptive filter. In this case, the absorptive filter is the best choice in order to avoid optical damage.

Pulsed Microsecond Laser Example
Consider a laser system that produces 1 µs pulses, each containing 150 µJ of energy at a repetition rate of 50 kHz, resulting in a relatively high duty cycle of 5%. This system falls somewhere between the regimes of CW and pulsed laser induced damage, and could potentially damage an optic by mechanisms associated with either regime. As a result, both CW and pulsed LIDT values must be compared to the properties of the laser system to ensure safe operation.

If this relatively long-pulse laser emits a Gaussian 12.7 mm diameter beam (1/e^2) at 980 nm, then the resulting output has a linear power density of 5.9 W/cm and an energy density of 1.2 x 10^{-4} J/cm^2 per pulse. This can be compared to the LIDT values for a WPQ10E-980 polymer zero-order quarter-wave plate, which are 5 W/cm for CW radiation at 810 nm and 5 J/cm^2 for a 10 ns pulse at 810 nm. As before, the CW LIDT of the optic scales linearly with the laser wavelength, resulting in an adjusted CW value of 6 W/cm at 980 nm. On the other hand, the pulsed LIDT scales with the square root of the laser wavelength and the square root of the pulse duration, resulting in an adjusted value of 55 J/cm^2 for a 1 µs pulse at 980 nm. The pulsed LIDT of the optic is significantly greater than the energy density of the laser pulse, so individual pulses will not damage the wave plate. However, the large average linear power density of the laser system may cause thermal damage to the optic, much like a high-power CW beam.

POLARIZER GUIDE

Polarizer Selection Guide

Thorlabs offers a diverse range of polarizers, including wire grid, film, calcite, alpha-BBO, rutile, and beamsplitting polarizers. Collectively, our line of wire grid polarizers offers coverage from the visible range to the beginning of the Far-IR range. Our nanoparticle linear film polarizers provide extinction ratios as high as 100 000:1. Alternatively, our other film polarizers offer an affordable solution for polarizing light from the visible to the Near-IR. Next, our beamsplitting polarizers allow for use of the reflected beam, as well as the more completely polarized transmitted beam. Finally, our alpha-BBO (UV), calcite (visible to Near-IR), rutile (Near-IR to Mid-IR), and yttrium orthovanadate (YVO_4) (Near-IR to Mid-IR) polarizers each offer an exceptional extinction ratio of 100 000:1 within their respective wavelength ranges.

To explore the available types, wavelength ranges, extinction ratios, transmission, and available sizes for each polarizer category, click More [+] in the appropriate row below.

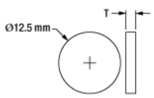
Wire Grid Polarizers	More [+]
Film Polarizers	More [+]
Beamsplitting Polarizers	More [+]
alpha-BBO Polarizers	More [+]
Calcite Polarizers	More [+]
Quartz Polarizers	More [+]
Magnesium Fluoride Polarizers	More [+]
Yttrium Orthovanadate (YVO_4) Polarizers	More [+]
Rutile Polarizers	More [+]

a. Click on the graph icons in this column to view a transmission curve for the corresponding polarizer. Each curve represents one substrate sample or coating run and is not guaranteed.
b. Mounted in a protective box, unthreaded ring, or cylinder that indicates the polarization axis.
c. Available unmounted or in an SM05-threaded (0.535"-40) mount that indicates the polarization axis.
d. Available unmounted or in an SM1-threaded (1.035"-40) mount that indicates the polarization axis.
e. Available in an SM1-threaded (1.035"-40) mount that indicates the polarization axis.
f. Available unmounted or mounted in cubes for cage system compatibility.
g. Calcite's transmittance of light near 350 nm is typically around 75% (see Transmission column).
h. Available unmounted or in an unthreaded Ø1/2" housing.
i. The transmission curves for calcite are valid for linearly polarized light with a polarization axis aligned with the mark on the polarizer's housing.
j. The 1064 nm V coating corresponds to a -C26 suffix in the item number.
k. Available unmounted or mounted in a protective box or unthreaded cylinder that indicates the polarization axis.

Ø12.5 mm Unmounted Linear Polarizers

Item #	Extinction Ratio[a] > 1000:1	Extinction Ratio[a] > 10 000:1	Extinction Ratio[a] > 100 000:1	Transmission and ER Graph	Laser Damage Threshold	Thickness (T)	Clear Aperture
LPUV050	365 - 395 nm	369 - 390 nm	372 - 388 nm		1 W/cm² Continuous Block 5 W/cm² Continuous Pass	2.0 ± 0.2 mm	Ø11.86 mm (Ø0.47")
LPVISA050	-	480 - 550 nm	-				
LPVISB050	-	500 - 720 nm	-				
LPVIS050	-	550 - 1500 nm	600 - 1200 nm				
LPNIR050	650 - 2000 nm	750 - 1800 nm	850 - 1600 nm				
LPNIRA050	1000 - 3000 nm	1200 - 3000 nm	-		10 W/cm² Continuous Block 25 W/cm² Continuous Pass	250 ± 65 µm	
LPMIR050	1500 - 5000 nm	2000 - 4500 nm	-			200 ± 50 µm	

a. The extinction ratio (ER) is the ratio of the maximum transmission of a linear polarized signal when the polarizer's axis is aligned with the signal to the minimum transmission when the polarizer is rotated by 90°. These polarizers maintain an extinction ratio of at least 1000:1 over the full operating bandwidth. Extinction ratios of >10 000:1 or >100 000:1 are maintained over specific wavelength ranges (see the Graphs tab for details).

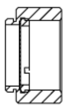


Part Number	Description	Price	Availability
LPUV050	Ø12.5 mm Unmounted Linear Polarizer, 365 - 395 nm	$263.16	Today
LPVISA050	Ø12.5 mm Unmounted Linear Polarizer, 480 - 550 nm	$316.20	Today
LPVISB050	Ø12.5 mm Unmounted Linear Polarizer, 500 - 720 nm	$316.20	Lead Time
LPVIS050	Ø12.5 mm Unmounted Linear Polarizer, 550 - 1500 nm	$334.56	Today
LPNIR050	Ø12.5 mm Unmounted Linear Polarizer, 650 - 2000 nm	$344.76	Today
LPNIRA050	Ø12.5 mm Unmounted Linear Polarizer, 1000 - 3000 nm	$473.00	Today
LPMIR050	Ø12.5 mm Unmounted Linear Polarizer, 1500 - 5000 nm	$558.96	Today

Mounted Ø12.5 mm Linear Polarizers, SM05-Threaded Housing

Item #	Extinction Ratio[a]			Transmission and ER Graph	Laser Damage Threshold	Optic Thickness[b] (T)	Clear Aperture
	> 1000:1	> 10 000:1	> 100 000:1				
LPUV050-MP2	365 - 395 nm	369 - 390 nm	372 - 388 nm		10 W/cm² Continuous Block 25 W/cm² Continuous Pass	220 ± 50 µm	Ø10.9 mm (Ø0.43")
LPVISA050-MP2	-	480 - 550 nm	-			280 ± 50 µm	
LPVISC050-MP2	510 - 800 nm	520 - 740 nm	530 - 640 nm			200 ± 50 µm	
LPVIS050-MP2	-	550 - 1500 nm	600 - 1200 nm			260 ± 50 µm	
LPNIR050-MP2	650 - 2000 nm	750 - 1800 nm	850 - 1600 nm			220 ± 50 µm	
LPNIRA050-MP2	1000 - 3000 nm	1200 - 3000 nm	-			250 ± 65 µm	
LPMIR050-MP2	1500 - 5000 nm	2000 - 4500 nm	-			200 ± 50 µm	

- The extinction ratio (ER) is the ratio of the maximum transmission of a linear polarized signal when the polarizer's axis is aligned with the signal to the minimum transmission when the polarizer is rotated by 90°. These polarizers maintain an extinction ratio of at least 1000:1 over the full operating bandwidth. Extinction ratios of >10 000:1 or >100 000:1 are maintained over specific wavelength ranges (see the *Graphs* tab for details).
- Optics are permanently epoxied into the mount and not removable.



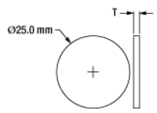
Click for Details

Part Number	Description	Price	Availability
LPUV050-MP2	**Ø12.5 mm SM05-Mounted Linear Polarizer, 365 - 395 nm**	**$357.00**	**Today**
LPVISA050-MP2	**Ø12.5 mm SM05-Mounted Linear Polarizer, 480 - 550 nm**	**$357.00**	**Today**
LPVISC050-MP2	**Ø12.5 mm SM05-Mounted Linear Polarizer, 510 - 800 nm**	**$357.00**	**Today**
LPVIS050-MP2	**Ø12.5 mm SM05-Mounted Linear Polarizer, 550 - 1500 nm**	**$385.00**	**Today**
LPNIR050-MP2	**Ø12.5 mm SM05-Mounted Linear Polarizer, 650 - 2000 nm**	**$404.00**	**Today**
LPNIRA050-MP2	**Ø12.5 mm SM05-Mounted Linear Polarizer, 1000 - 3000 nm**	**$533.00**	**Today**
LPMIR050-MP2	**Ø12.5 mm SM05-Mounted Linear Polarizer, 1500 - 5000 nm**	**$662.00**	**Today**

Ø25.0 mm Unmounted Linear Polarizers

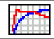
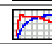
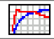
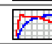
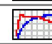
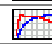
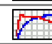
Item #	Extinction Ratio[a]			Transmission and ER Graph	Laser Damage Threshold	Thickness (T)	Clear Aperture
	> 1000:1	> 10 000:1	> 100 000:1				
LPUV100	365 - 395 nm	369 - 390 nm	372 - 388 nm		1 W/cm² Continuous Block 5 W/cm² Continuous Pass	2.0 ± 0.2 mm	Ø24.37 mm (Ø0.96")
LPVISA100	-	480 - 550 nm	-				
LPVISC100	510 - 800 nm	520 - 740 nm	530 - 640 nm				
LPVIS100	-	550 - 1500 nm	600 - 1200 nm				
LPNIR100	650 - 2000 nm	750 - 1800 nm	850 - 1600 nm				
LPNIRA100	1000 - 3000 nm	1200 - 3000 nm	-		10 W/cm² Continuous Block 25 W/cm² Continuous Pass	250 ± 65 µm	
LPMIR100	1500 - 5000 nm	2000 - 4500 nm	-			200 ± 50 µm	

a. The extinction ratio (ER) is the ratio of the maximum transmission of a linear polarized signal when the polarizer's axis is aligned with the signal to the minimum transmission when the polarizer is rotated by 90°. These polarizers maintain an extinction ratio of at least 1000:1 over the full operating bandwidth. Extinction ratios of >10 000:1 or >100 000:1 are maintained over specific wavelength ranges (see the Graphs tab for details).



Part Number	Description	Price	Availability
LPUV100	Ø25.0 mm Unmounted Linear Polarizer, 365 - 395 nm	$734.40	Today
LPVISA100	Ø25.0 mm Unmounted Linear Polarizer, 480 - 550 nm	$832.32	Today
LPVISC100	NEW! Ø25.0 mm Unmounted Linear Polarizer, 510 - 800 nm	$832.32	Today
LPVIS100	Ø25.0 mm Unmounted Linear Polarizer, 550 - 1500 nm	$848.64	Today
LPNIR100	Ø25.0 mm Unmounted Linear Polarizer, 650 - 2000 nm	$848.64	Today
LPNIRA100	Ø25.0 mm Unmounted Linear Polarizer, 1000 - 3000 nm	$1,130.00	Today
LPMIR100	Ø25.0 mm Unmounted Linear Polarizer, 1500 - 5000 nm	$1,428.00	Today

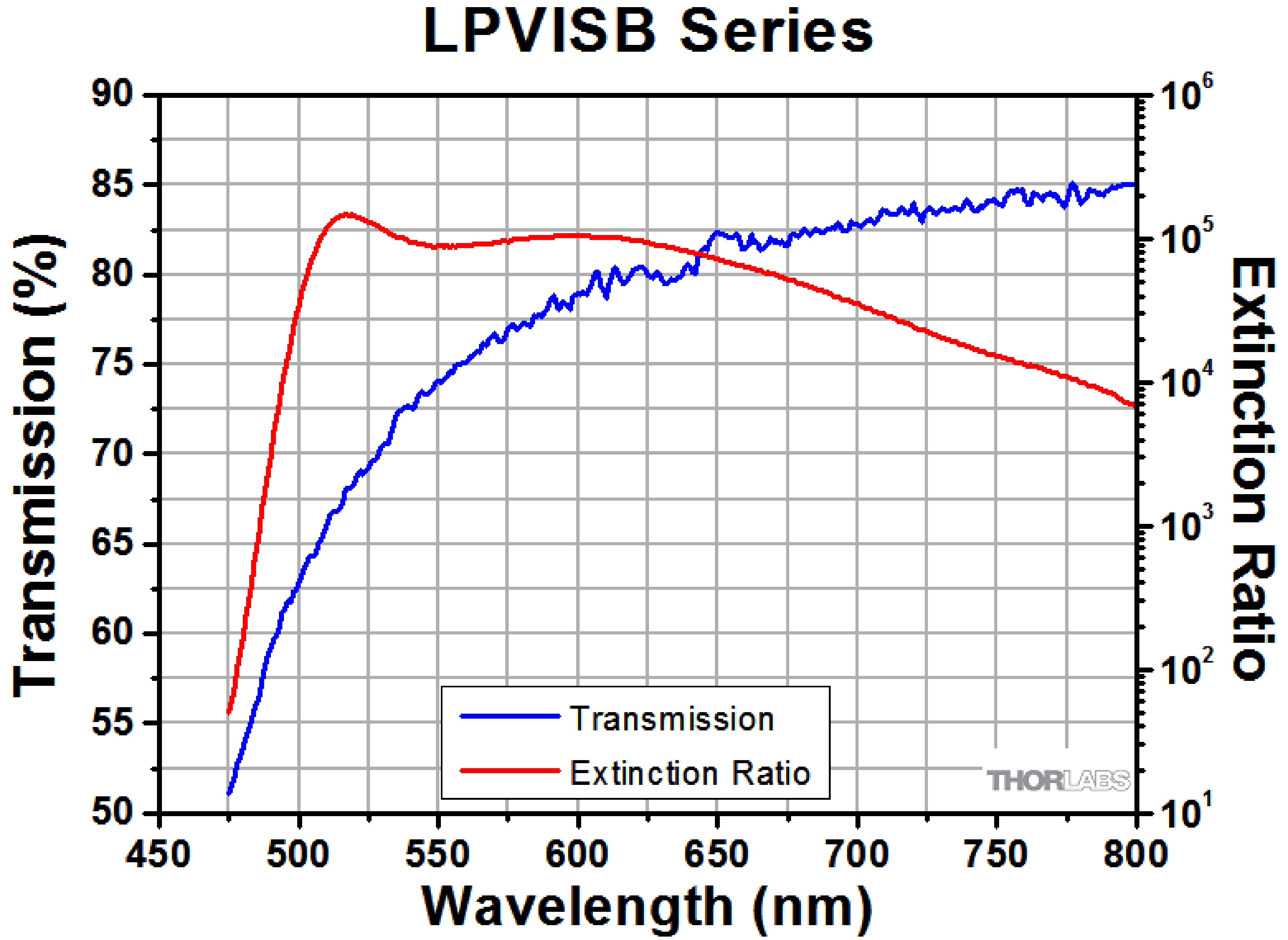
Mounted Ø25.0 mm Linear Polarizers, SM1-Threaded Housing

Item #	Extinction Ratio[a]			Transmission and ER Graph	Laser Damage Threshold	Optic Thickness[b] (T)	Clear Aperture
	> 1000:1	> 10 000:1	> 100 000:1				
LPUV100-MP2	365 - 395 nm	369 - 390 nm	372 - 388 nm		10 W/cm² Continuous Block 25 W/cm² Continuous Pass	220 ± 50 µm	Ø22.9 mm (Ø0.90")
LPVISA100-MP2	-	480 - 550 nm	-			280 ± 50 µm	
LPVISC100-MP2	510 - 800 nm	520 - 740 nm	530 - 640 nm			280 ± 50 µm	
LPVIS100-MP2	-	550 - 1500 nm	600 - 1200 nm			260 ± 50 µm	
LPNIR100-MP2	650 - 2000 nm	750 - 1800 nm	850 - 1600 nm			220 ± 50 µm	
LPNIRA100-MP2	1000 - 3000 nm	1200 - 3000 nm	-			250 ± 65 µm	
LPMIR100-MP2	1500 - 5000 nm	2000 - 4500 nm	-			200 ± 50 µm	

- The extinction ratio (ER) is the ratio of the maximum transmission of a linear polarized signal when the polarizer's axis is aligned with the signal to the minimum transmission when the polarizer is rotated by 90°. These polarizers maintain an extinction ratio of at least 1000:1 over the full operating bandwidth. Extinction ratios of >10 000:1 or >100 000:1 are maintained over specific wavelength ranges (see the *Graphs* tab for details).
- Optics are permanently epoxied into the mount and not removable.

Click for Details

Part Number	Description	Price	Availability
LPUV100-MP2	**Ø25.0 mm SM1-Mounted Linear Polarizer, 365 - 395 nm**	**$769.00**	**Today**
LPVISA100-MP2	**Ø25.0 mm SM1-Mounted Linear Polarizer, 480 - 550 nm**	**$846.00**	**Today**
LPVISC100-MP2	**NEW! Ø25.0 mm SM1-Mounted Linear Polarizer, 510 - 800 nm**	**$846.00**	**Today**
LPVIS100-MP2	**Ø25.0 mm SM1-Mounted Linear Polarizer, 550 - 1500 nm**	**$950.00**	**Today**
LPNIR100-MP2	**Ø25.0 mm SM1-Mounted Linear Polarizer, 650 - 2000 nm**	**$984.00**	**3-5 Days**
LPNIRA100-MP2	**Ø25.0 mm SM1-Mounted Linear Polarizer, 1000 - 3000 nm**	**$1,230.00**	**Today**
LPMIR100-MP2	**Ø25.0 mm SM1-Mounted Linear Polarizer, 1500 - 5000 nm**	**$1,582.00**	**Today**


LPVISB Series
Transmission (%)
Extinction Ratio
Wavelength (nm)
90
85
80
75
70
65
60
55
50
450
500
550
600
650
700
750
800
10^6
10^5
10^4
10^3
10^2
10^1
Transmission
Extinction Ratio
THORLABS