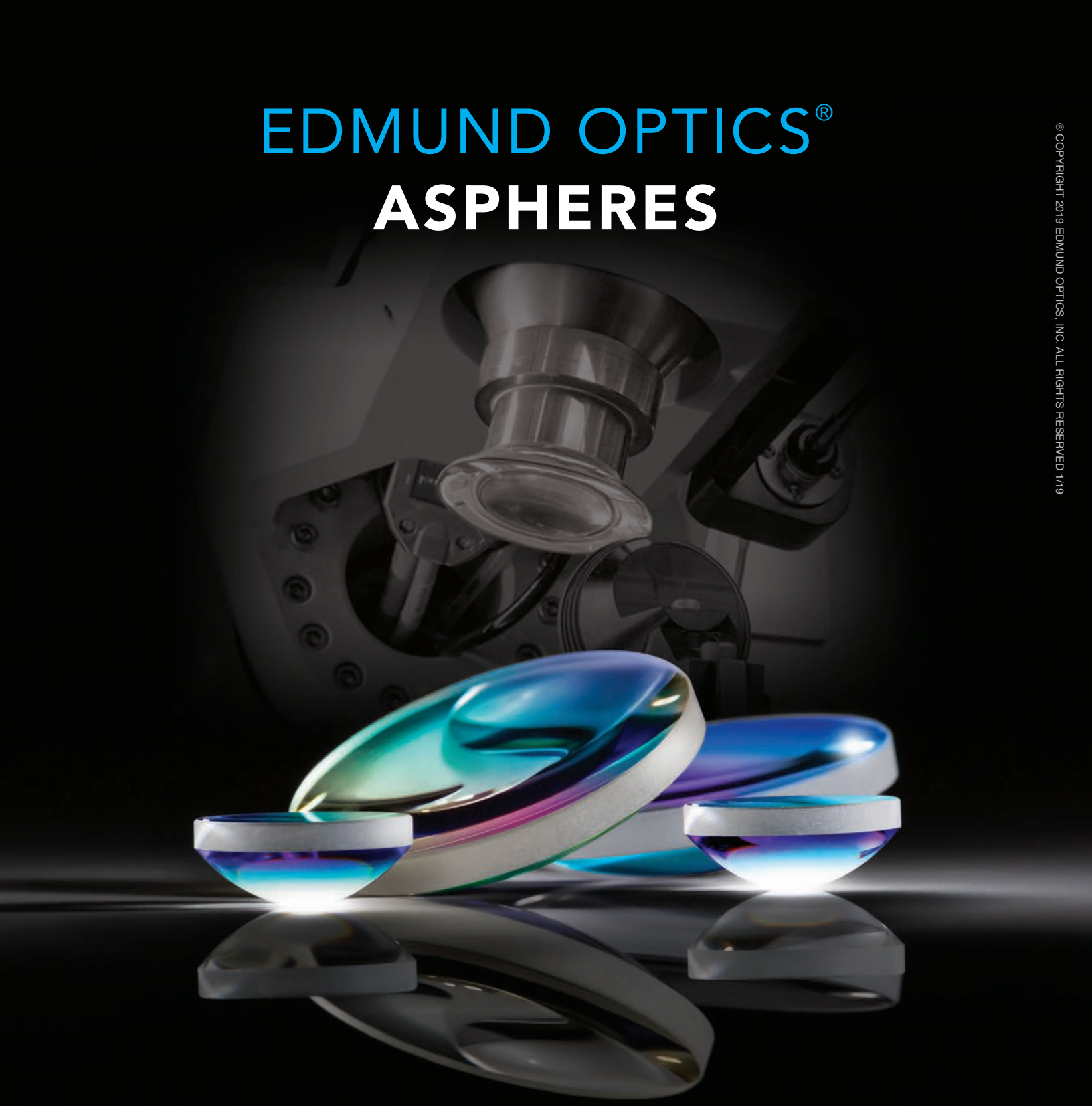
EDMUND OPTICS®
ASPHERES



CAPABILITIES | NEW ASPHERIC LENSES | TECH NOTES

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www.edmundoptics.com/aspheres

CNC POLISHING CAPABILITIES

Edmund Optics® is a recognized leader in aspheric lens manufacturing, with extensive experience producing aspheric lenses for ophthalmic instruments, surgical devices, analytical instruments, and defense applications. Edmund Optics®' high volume aspheric lens manufacturing cell operates 24 hours a day to produce thousands of precision aspheric lenses per month. Our manufacturing cells feature state-of-the-art production and metrology equipment, which complements our expert knowledge in aspheric lens design and manufacturing. Whether your application calls for a stock component from our vast inventory, a build-to-print lens, or a fully customized design effort, our expert optical design and manufacturing engineers can develop solutions to meet your needs. Contact us today to speak with an expert or receive an expedited quote.

Aspheric Manufacturing Capabilities

	Commercial	Precision	High Precision
Diameter:	10 - 150mm	10 - 150mm	10 - 150mm
Diameter Tolerance:	+0/-0.100mm	+0/-0.025mm	+0/-0.010mm
Asphere Figure Error (P - V):	3µm	1µm	<0.06µm
Vertex Radius (Asphere):	±0.5%	±0.1%	±0.05%
Sag:	25mm max	25mm max	25mm max
Typical Slope Tolerance:	1µm/mm	0.35µm/mm	0.15µm/mm
Centering (Beam Deviation):	3 arcmin	1 arcmin	0.5 arcmin
Center Thickness Tolerance:	±0.100mm	±0.050mm	±0.010mm
Surface Quality (Scratch Dig):	80-50	40-20	10-5
Aspheric Surface Metrology:	Profilometry (2D)	Profilometry (2D & 3D)	Interferometry

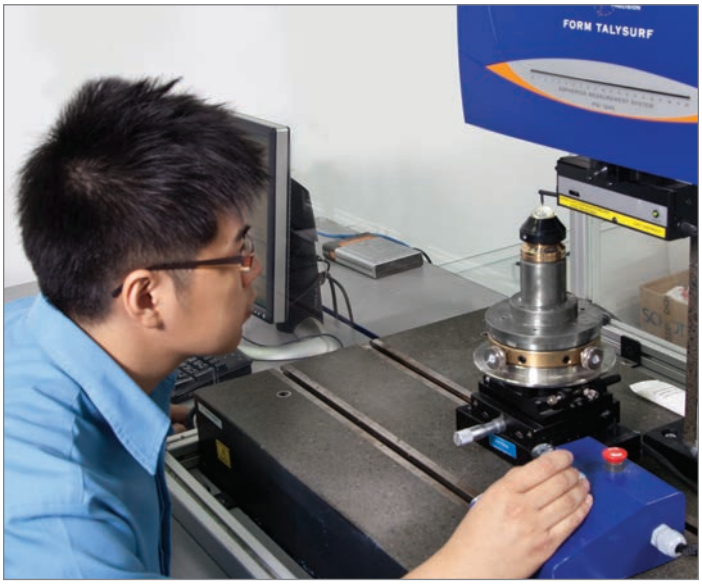
METROLOGY AND PRODUCTION EQUIPMENT

Manufacturing Equipment
- 5-Axis CNC Grinding Machines
- 5-Axis CNC Polishing Machines
- QED MRF Finishing Machines for Fine Finishing
- Centering Machines

Metrology
- Talysurf PGI 1240 Profilometers
- QED ASI™ Aspheric Stitching Interferometers
- Zygo® NewView White Light Interferometers
- OptiPro UltraSurf 4X 100 Non-Contact Profilometers
- TRIOPTICS Opticentric® Centration Measurement Machines
- Zeiss Contura G2 CMMs
- Olympus MX51 Microscopes
- Design-Specific Computer Generated Holograms (CGH)

Watch the **MAKING OF AN ASPHERIC LENS VIDEO,** visit **www.edmundoptics.com/making-aspherics**

ASPHERIC METROLOGY CAPABILITIES



To learn more about our **Manufacturing Capabilities,** visit **www.edmundoptics.com/manufacturing**

At Edmund Optics®, we truly believe that you can't make it if you can't measure it. For that reason, we've invested in the latest aspheric metrology equipment, including 2D Profilometry and 3D Stitching Interferometry.

The Taylor Hobson® Talysurf utilizes a stylus to trace the aspheric profile, and measure deviations from the ideal-fit aspheric equation. Typically, measurements are made in 2 axes (0° and 90°) to measure any asymmetric errors in the aspheric polishing. Accuracy is highly dependent upon the geometry of the lens and length of the stylus, but Edmund Optics® routinely measures aspheric lenses with 1µm surface figure requirements and up to 25mm of Sag.

The Optipro Ultrasurf is a non-contact profilometer providing comprehensive 2D and 3D analysis of surface figure, radius of curvature, center thickness, and wedge in a single measurement. By incorporating multi non-contact optical sensors, the Ultrasurf is capable of measuring virtually any asphere.

The QED Technologies® Aspheric Stitching Interferometer (ASI™) provides a full aperture map of the asphere being tested, and is capable of measuring complex aspheres with more than 600µm of aspheric departure. Edmund Optics® routinely measures complex asymmetric aspheric profiles and lenses with <0.5µm surface figure requirements with the ASI™.

METROLOGY SERVICES AND CAPABILITIES

- First Article Inspection (FAI) Reports
- Part Serialization with Complete Tested Data Reports including:
  - Dimensional Measurements
  - Centering / Total Image Runout
  - Surface Profiles
  - Surface Roughness
  - Coating Durability, Adhesion, and Abrasion per MIL-PRF-13830B
  - Damage Threshold per ISO-21254-1:2011
  - Unique or Functional Requirements, Including those Requiring Custom Metrology Solutions
- Configuration Control, Change Control, and Copy Exact! (CE) Requirements
- FAR, DFAR, Quality Assurance Provisions (QAP), and Testing Requirements Flow-downs

Aspheric Lens Irregularity and Strehl Ratio

All optical systems have a theoretical performance limit known as the diffraction limit. Strehl ratio is a specification used to compare the real performance of an optical system with its diffraction-limited performance. For aspheric lenses and other focusing optics, Strehl ratio is defined as the ratio of peak focal spot irradiance of the manufactured optic to the diffraction-limited peak irradiance *(Figure 1)*.[1] The industry standard threshold to classify a lens as "diffraction-limited" is a Strehl ratio greater than 0.8.

Strehl ratio can also be related to RMS transmitted wavefront error using the following approximation, where σ is RMS wavefront error in waves.[2] This approximation is valid for transmitted wavefront error values <0.1 waves.

$$S = \exp[-(2\pi\sigma)^2] \qquad 1$$

Impact of Surface Irregularity on Strehl Ratio

The Strehl ratio of an optic is highly dependent on its surface irregularity, or the deviation of the optical surface from its nominal form; surface irregularity is a result of the manufacturing method used. Spherical optics are typically polished using an oversized tool, which imparts low spatial frequency errors on the optical surface. Aspherical lens manufacturing, however, typically utilizes subaperture grinding and polishing, creating a more complex irregularity structure. Understanding the relationship between a specified surface irregularity and its underlying structure can provide insight into the lens' performance and resulting Strehl ratio.

For example, consider the impact of spatial frequency. When surface irregularity is modeled as a rotationally-symmetric cosine function, we can explore the resulting Strehl Ratio as a function of RMS surface irregularity for a variety of cosine periods *(Figure 2 and Figure 3)*.

The key factor here is not the period of the cosine in mm, but the number of periods over the aperture of the lens. For a given subaperture tool used in asphere manufacturing, smaller diameter aspheres will have less Strehl Ratio degradation compared to larger diameter aspheres.

The impact of surface irregularity on Strehl Ratio is also dependent on the f/# of the lens. As a general rule, faster aspheres, or aspheres with smaller f/#'s, have greater sensitivity to surface irregularity's impact on Strehl Ratio. For example, *Figure 4* compares an f/2 lens to an f/0.75 lens (both with 25mm diameter).

Power Spectral Density and Irregularity Slope

Based on the examples above, the spatial frequency content of the irregularity maps clearly has an impact on the Strehl Ratio of the lens. In addition to PV or RMS irregularity, additional specifications can be requested to target these spatial frequencies.

One specification used to directly evaluate spatial frequencies is called Power Spectral Density, or PSD.[4] PSD evaluates surface irregularity as a function of spatial frequency and can be used in a targeted way to limit the contribution from a range of spatial frequencies. PSD may also be used to constrain all spatial frequencies simultaneously.

A more simple, yet effective, method to reduce higher spatial frequencies in the irregularity is to constrain the slope of the cosine functions making up the surface irregularity map, in addition to the PV value. For a given PV irregularity limit, higher slopes are associated with higher spatial frequencies on the surface *(Figure 5)*. Slope is often given in terms of a maximum RMS slope value, which is a more comprehensive evaluation of the lens surface than a simple maximum slope requirement.[5]

The spatial frequency of surface irregularity has a significant impact on Strehl Ratio and asphere performance. The smaller the period, the more Strehl Ratio degradation at a given surface irregularity. The shape of the lens' surface irregularity map is required to understand the true impact of its surface irregularity on its performance, not just an irregularity specification by itself.[3] Smaller f/#'s also lead to more degradation.

References

1. Strehl, Karl W. A. "Theory of the telescope due to the diffraction of light," Leipzig, 1894.

2.Mahajan, Virendra N. "Strehl ratio for primary aberrations in terms of their aberration variance." JOSA 73.6 (1983): 860-861.

3.Kasunic, Keith J., Laser Systems Engineering, SPIE Press, 2016. (ISBN 9781510604278)

4.Lawson, Janice K., et al. "Specification of optical components using the power spectral density function." Optical Manufacturing and Testing. Vol. 2536. International Society for Optics and Photonics, 1995.

5.Messelink, Wilhelmus A., et al., "Mid-spatial frequency errors of mass-produced aspheres," Proc. SPIE 10829, Fifth European Seminar on Precision Optics Manufacturing, 7 Aug. 2018, doi:10.1117/12.2318663.

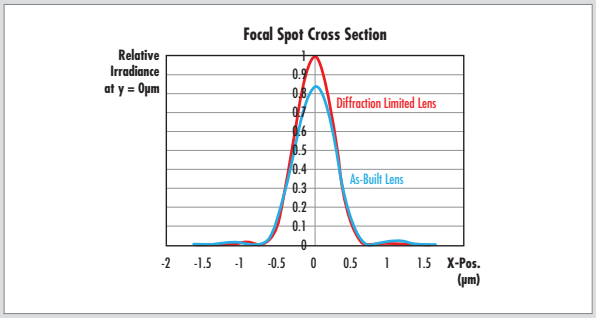


Figure 1: Irradiance cross section plot of the focal spot from a 25mm diameter f/2 aspheric lens at 588nm. The Strehl Ratio of the as-built lens is 0.826, meeting the diffraction-limited criterion

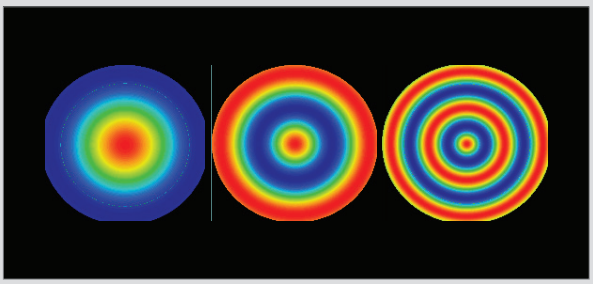


Figure 2: Radial cosine irregularity maps on a 25mm diameter f/2 asphere surface. The cosine periods from left to right are 20mm, 10mm, and 5mm

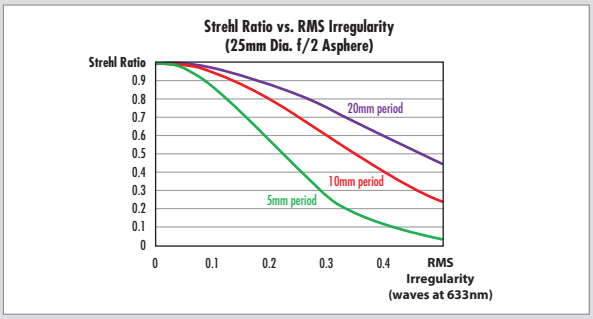


Figure 3: For a particular RMS surface irregularity, the more cosine periods over the aperture of the asphere, the lower the Strehl Ratio

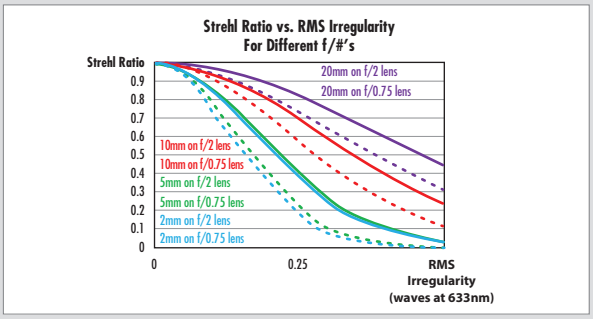


Figure 4: Comparing dotted lines to solid lines shows that a faster asphere (smaller f/#) has greater degradation compared to a slower asphere (larger f/#) over a given cosine period

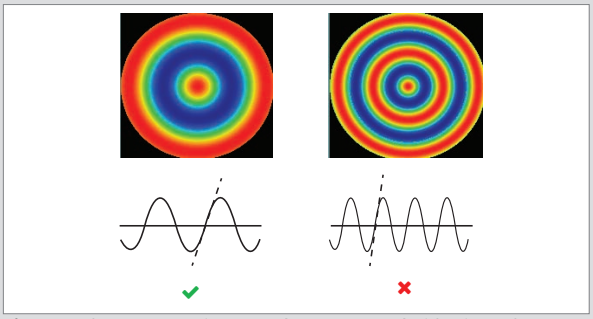
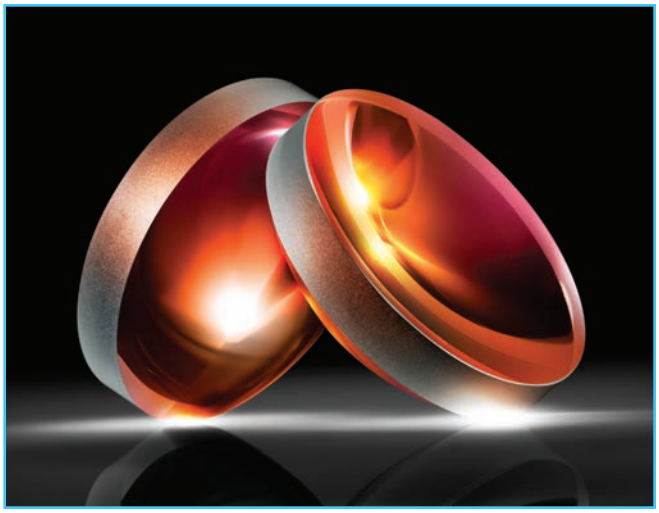


Figure 5: If a maximum slope specification is specified for the surface irregularity map, this creates a threshold to reduce the impact of higher spatial frequency content on the surface

TECHSPEC® λ/40 Aspheric Lenses

- λ/40 RMS Asphere Figure Error
- High Numerical Aperture Designs
- 3D Surface Profile Included with Each Lens

TECHSPEC® λ/40 Aspheric Lenses guarantee better than λ/40 wave aspheric figure error. Achieved via precision magneto-rheological finishing (MRF), these aspheres offer high numerical apertures with diameters ranging from 15 to 50mm and are ideal for a variety of imaging and low light level applications. Each TECHSPEC λ/40 Aspheric Lens is individually measured and a 3D surface profile is included. For diffraction-limited aspheres designed at specific Nd:YAG laser wavelengths, see page 8.

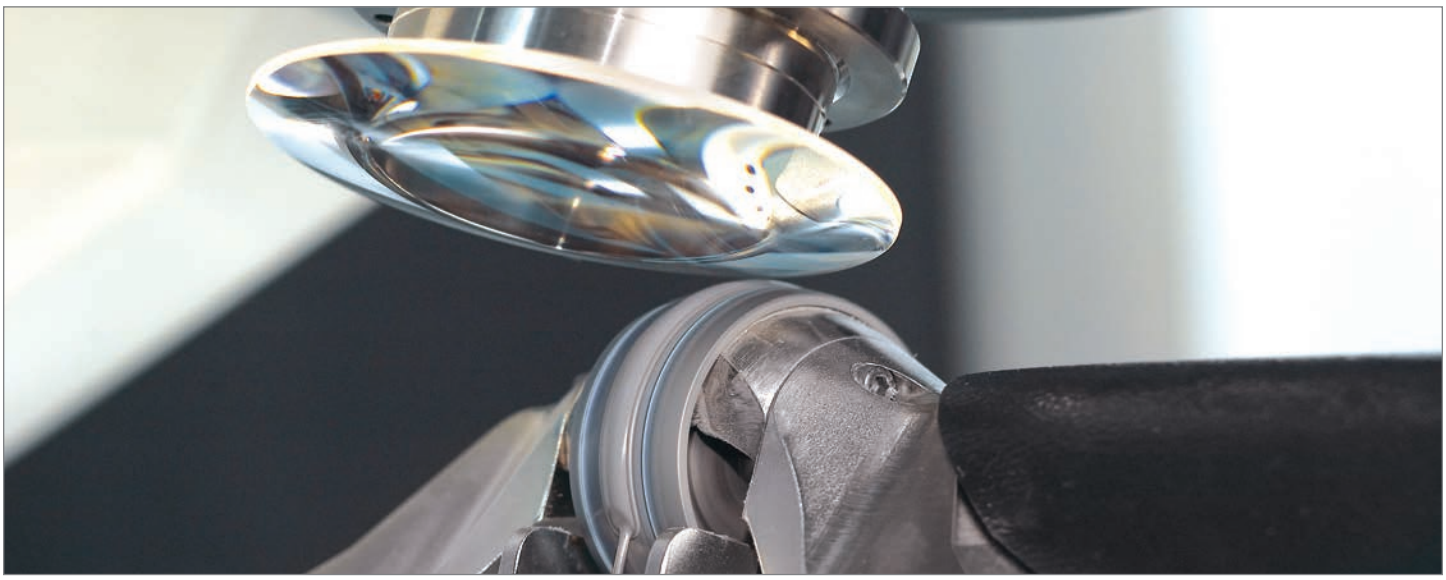


NEW

Aspheric Surface Tolerance (RMS):	λ/40	**Coating:**	Uncoated	**Diameter Tolerance (mm):**	+0.00/-0.025
Clear Aperture (%):	90	**Surface Quality:**	40-20	**Edges:**	Protective Bevel as Needed
Centering (arcmin):	<1	**Center Thickness Tolerance (mm):**	+/- 0.1		

TECHSPEC® λ/40 Aspheric Lenses

Dia. (mm)	EFL (mm)	Numerical Aperture	BFL (mm)	CT (mm)	ET (mm)	Glass Type	Stock No.	Price
15	15	0.50	10.22	8.62	6.21	N-SF6	#12-428	$495.00
15	18.75	0.40	14.32	8	6.1	N-SF6	#12-429	$495.00
15	22.5	0.33	16.71	8.79	6.25	N-BK7	#12-430	$495.00
25	37.5	0.33	31.09	9.72	5.49	N-BK7	#12-438	$595.00
25	50	0.25	45.23	7.24	4.14	N-BK7	#12-439	$595.00
40	40	0.50	31.21	14.7	6.83	N-SF5	#12-445	$750.00
50	50	0.50	42.77	13.06	4.82	N-SF6	#12-448	$850.00



Optical Coatings and Laser Induced Damage Threshold

All of our TECHSPEC® Laser Grade Aspherical Lenses are coated with a high efficiency anti-reflection coating to guarantee maximum transmission of the incident laser illumination. The coatings have been designed not only to exhibit extremely low loss (<0.25% reflection), but also to withstand the high laser fluence commonly found in modern laser systems. See below for an introduction to Laser Induced Damage Threshold (LIDT).

Laser induced damage in optical components causes degradation in system performance that can even result in catastrophic failure. An incorrect understanding of LIDT may lead to significantly higher costs or to component failures. Especially when dealing with high power lasers, LIDT is an important specification for all types of laser optics including reflective, transmissive, and absorptive components. The lack of an industry consensus on how LIDT should be tested, how damage should be detected, and how the test data should be interpreted makes LIDT a complicated specification. An LIDT value on its own does not convey the diameter of the beam used for testing, how many shots per testing site were administered, or the way the test data was analyzed.

Testing Laser Damage Threshold

Laser damage testing is inherently destructive. The optic undergoing testing is exposed to a level of laser fluence and is then examined, typically with Nomarski-type differential interference contrast (DIC) microscopy. The fluence is then increased, and the exposure and examination steps are repeated. This process continues until damage is observed on the optic. While this is conceptually a simple process, there are several levels of complexity.

According to ISO 21254, any detectable change in an optic under test is considered "damage". Different LIDT values may be produced depending on how the damage was evaluated, as not all tests use the same damage detection schemes and different operators might choose different signal-to-noise thresholds. It is important to realize that what ISO defines as "damage" does not necessarily imply performance degradation because it is application-dependent.

LIDT testing is specified by either a single or multi-shot test. A single-shot test, also known as a 1-on-1 test, involves one shot of laser radiation on at least 10 different sample sites across an optical component with varying laser fluence. The number of damaged sites over the total number of tested sites at that fluence determines the damage probability at a particular fluence. The damage probability is plotted as a function of fluence and the data is linearly extrapolated to find where the damage probability is 0%, which gives the LIDT value *(Figure 1)*.

Damage Mechanism	Description
Multiphoton Absorption	Absorption process where two or more photons with energies lower than the material's bandgap energy are absorbed simultaneously, making absorption no longer linearly proportional to intensity.
Multiphoton Ionization	Absorption of two or more photons whose combined energy leads to the photoionization of atoms in the material.
Tunnel Ionization	The strong electric field generated by ultra-short laser pulses allows electrons to "tunnel" through the potential barrier keeping the electrons bound to atoms, allowing them to escape .
Avalanche Ionization	The strong electric field generated by ultra-short laser pulses causes electrons to accelerate and collide with other atoms. This ionizes them and releases more electrons that continue to ionize other atoms.
Carrier-Carrier Scattering	Electrons accelerated by the electric field collide with other electrons, scattering them and causing them to collide with more electrons.
Carrier-Phonon Scattering	Electrons accelerated by the electric field excite phonons, or vibrations in the lattice of the material.
Dielectric Breakdown	A current flowing through an electrical insulator due to the applied voltage exceeding the material's breakdown voltage.
Thermal Effects	Heat diffusion resulting from distortions and vibrations in the material caused by the energy of the laser pulses.

Table 1: Descriptions of different damage mechanisms

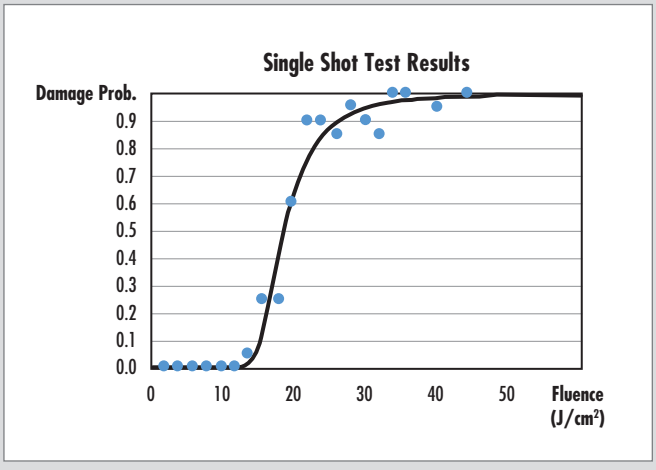


Figure 1: Sample data from a single shot test

To read our **COMPLETE APPLICATION NOTE ON LIDT** visit **www.edmundoptics.com/asphere-lidt**

A multi-shot, or S-on-1, test differs from a single-shot test in that it uses a series of laser shots, or pulses, per testing site as opposed to a single shot. The common number of shots per site, or S, is between 10 and 1000. Multi-shot tests provide a better prediction of the real-world performance of the optic, and allow LIDT testers to avoid a phenomenon called the infant mortality realm. When using between 1 and 10 shots per site, test results are non-deterministic and have high levels of statistical variation; this causes the range of shots per site to be known as the infant mortality realm. When S is greater than 10, the test results are more deterministic and predictable. Therefore, when around 100 shots per site are used, enough information can be gathered to predict the long-term performance of the optic. However, using more shots per site requires longer and more expensive LIDT testing.

Interpreting LIDT Test Results

The specified LIDT of an optic is determined by linearly extrapolating the test data to determine the laser fluence at which the probability of damage is zero. However, this is a linear fit to data that is not truly linear. This single value does not provide all necessary information and damage could still occur at or below the LIDT. Weibull and Burr distributions are continuous probability distributions that provide a much more accurate fit to LIDT data *(Figure 2)*.

At a fluence around 5 J/cm², there is a non-zero probability of damage, even though this is below the specified LIDT value. The vertical error bars in damage probability are caused by the number of test sites and the horizontal error bars in fluence are caused by shot-to-shot variation of the test laser. Because no laser is perfect, there will always be some level of hotspots, or intensity fluctuations. This necessitates adding a factor of safety by choosing an optic with a LIDT higher than the laser's use conditions. The safety factor required is heavily dependent on the application and type of laser, therefore no general safety factor works for all situations. Common industry practice is to use a safety factor of two or three. However, if the laser induced damage is defect driven, there are statistical models that can be used to evaluate the damage probability at different safety factors.

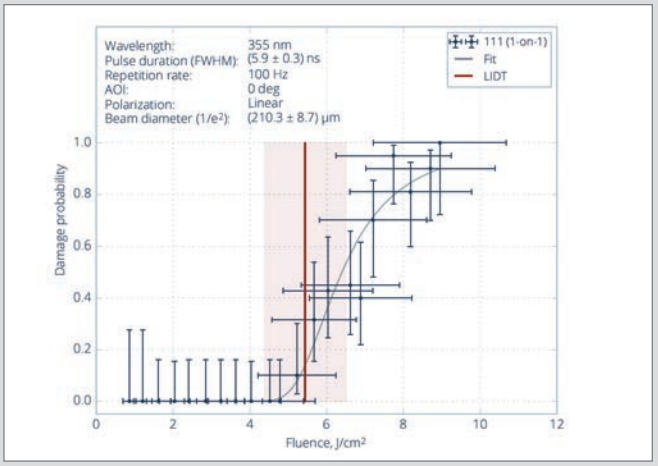


Figure 2: Real LIDT test data with the LIDT value shown by a red vertical line and a best fit 2-parameter Weibull distribution, showing that there is still some probability of damage below the LIDT value

Standard AR Laser Coatings		*See website for full coating list
DWL	**Reflectivity Specifications**	**LIDT, Pulsed (J/cm²)**
266nm	R_{abs} <0.25% @ DWL	3, 20ns @ 20Hz
343nm	R_{abs} <0.25% @ DWL	7.5, 20ns @ 20Hz
355nm	R_{abs} <0.25% @ DWL	7.5, 20ns @ 20Hz
515nm	R_{abs} <0.25% @ DWL	10, 20ns @ 20Hz
532nm	R_{abs} <0.25% @ DWL	10, 20ns @ 20Hz
980nm	R_{abs} <0.25% @ DWL	15, 20ns @ 20Hz
1030nm	R_{abs} <0.25% @ DWL	15, 20ns @ 20Hz
1064nm	R_{abs} <0.25% @ DWL	15, 20ns @ 20Hz

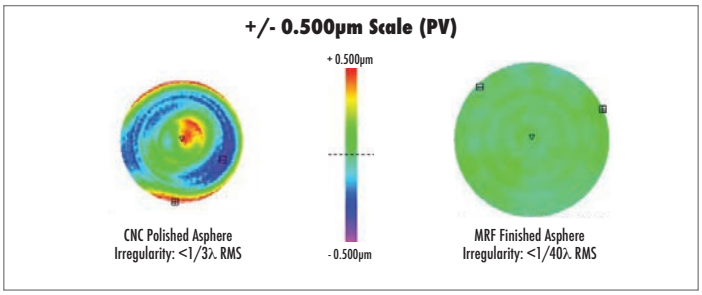
Table 2: Reflectivity specifications and guaranteed laser induced damage thresholds for EO's standard AR laser coatings. For other laser wavelengths, custom coating designs are available upon request

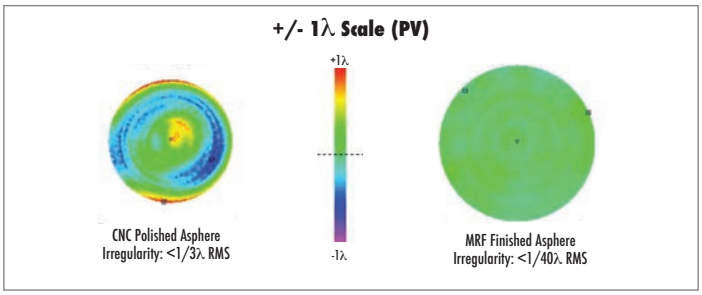
NEW

TECHSPEC® λ/40 Laser Grade Aspheric Lenses

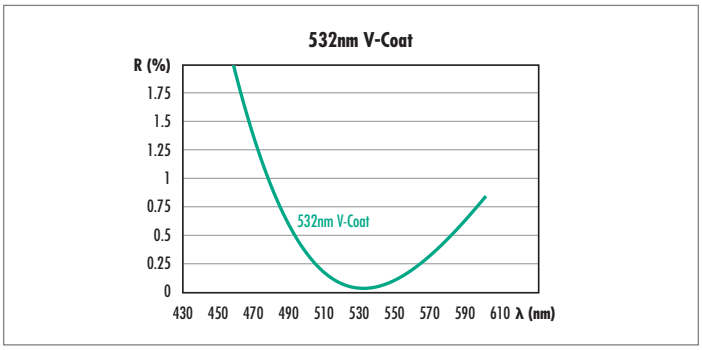
- 1/40 Wave Aspheric Surface Figure Error (RMS)
- Guaranteed Strehl Ratio >0.8
- Laser Line V-Coats with <0.25% Reflection

TECHSPEC® λ/40 Aspheric Lenses are polished through precision magnetorheological finishing (MRF), providing them with an ultra-smooth aspheric surface with an aspheric surface figure error of λ/40 RMS. The resultant aspheric lenses feature a Strehl Ratio above 0.8, guaranteeing diffraction-limited performance at the specified design wavelength. TECHSPEC® λ/40 Aspheric Lenses are coated with a high-performance Laser Line V-Coat to minimize reflection when used at their Nd:YAG design wavelengths. Standard imperial sizes with f/2 designs made from fused silica are ideal for integration into OEM applications.





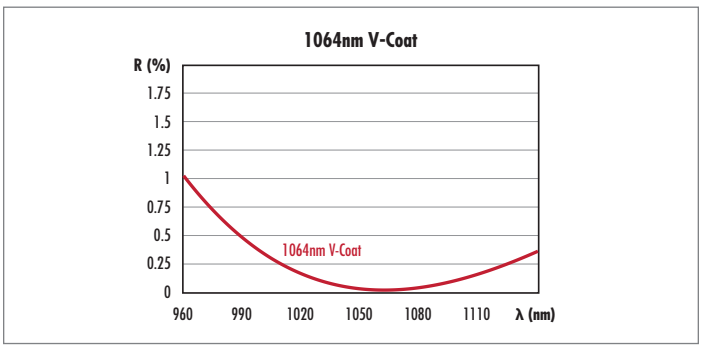
Material:	Corning 7980 Grade 0F Fused Silica	**Surface Quality:**	10-5	**Centering (arcmin):**	<1
Aspheric Surface Tolerance (RMS):	λ/40	**Center Thickness Tolerance (mm):**	+/-0.1	**Coating:**	R_{avg} <0.25% @ DWL
Clear Aperture:	Diameter - 2.0mm	**Diameter Tolerance (mm):**	+0.00/-0.05	**Damage Threshold (J/cm²):**	532nm: 10 @ 20ns, 20Hz 1064nm: 15 @ 20ns, 20Hz
Strehl Ratio:	>0.8				



TECHSPEC® λ/40 532nm Aspheric Lenses

Dia. (mm)	EFL (mm)	BFL (mm)	Design Wavelength (nm)	CT (mm)	ET (mm)	Stock No.	Price
25.4	50.8	45.4	532	7.9	4.4	#39-558	$750.00
50.8	101.6	93.9	532	11.2	4.1	#39-565	$995.00

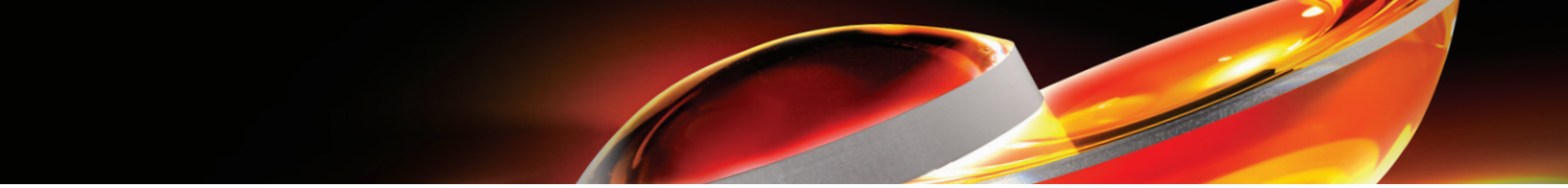
See Website For Pricing



TECHSPEC® λ/40 1064nm Aspheric Lenses

Dia. (mm)	EFL (mm)	BFL (mm)	Design Wavelength (nm)	CT (mm)	ET (mm)	Stock No.	Price
25.4	50.8	45.0	1064	8.4	4.7	#39-560	$750.00
50.8	101.6	94.7	1064	10.0	2.7	#39-567	$995.00

See Website For Pricing



TECHSPEC® Laser Line Coated Precision Aspheric Lenses

- Designed for Nd:YAG Laser Wavelengths
- High Damage Thresholds
- UV Fused Silica Substrate

TECHSPEC® Laser Line Coated Precision Aspheric Lenses are designed to maximize performance in high power Nd:YAG laser applications. The high precision aspheric designs minimize spherical aberration to decrease laser spot size and maintain high power per area. Additionally, TECHSPEC® Laser Line Coated Precision Aspheric Lenses feature high performance coatings that have been optimized for the most popular Nd:YAG laser wavelengths and a high damage threshold, UV fused silica substrate that is highly resistant to thermal expansion.

Substrate:	Fused Silica	**Diameter Tolerance (mm):**	+0.0/-0.1	**Surface Quality:**	60-40
Design Wavelength (nm):	587.6	**Center Thickness Tolerance (mm):**	±0.1	**Centering (arcmin):**	3 - 5
Clear Aperture (%):	90	**Surface Accuracy:**	0.75µm RMS	**Coating:**	R_{abs} <0.25% @ DWL

TECHSPEC® Laser Line Coated Precision Aspheric Lenses

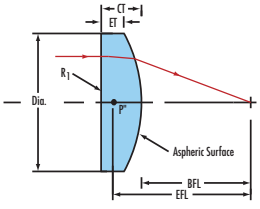
Dia. (mm)	EFL (mm)	Numerical Aperture	BFL (mm)	CT (mm)	ET (mm)	355nm	532nm	1064nm	Price – Coated		
						Stock No.	Stock No.	Stock No.	1-5	6-25	26+
15.0	12.5	0.60	6.33	9.00	2.47	#33-009	#33-013	#33-017	$435.00	$348.00	Call
15.0	15.0	0.50	10.03	7.25	2.43	#33-010	#33-014	#33-018	$435.00	$348.00	
25.0	25.0	0.50	18.32	9.75	1.75	#33-011	#33-015	#33-019	$485.00	$388.00	
25.0	30.0	0.42	24.17	8.50	2.21	#33-012	#33-016	#33-020	$485.00	$388.00	

TECHSPEC® Best Form Aspheric Lenses

- Modified TECHSPEC® PCX Lenses
- Optimized Performance at Designated Wavelengths
- Diffraction-Limited Spot Size

TECHSPEC® Best Form Aspheric Lenses are TECHSPEC® PCX Lenses that have been modified to provide superior performance at specified wavelengths. Unlike the preexisting TECHSPEC® PCX lens, TECHSPEC® Best Form Aspheric Lenses produce diffraction-limited spot sizes at the design wavelength, which is ideal for focusing or collimating applications. Any diameter and focal length TECHSPEC® PCX Lens can be modified to become a TECHSPEC® Best Form Aspheric Lens in order to provide the best solution for any application. **Note:** Unlike traditional focusing lenses, these lenses should be used with the plano side facing the light source.

Surface Quality:	40-20	**Focal Length Tolerance (%):**	±1
Diameter Tolerance (mm):	+0.0/-0.1	**Clear Aperture (mm):**	23
Center Thickness Tolerance (mm):	±0.1	**AR Coating:**	<0.25% @ DWL
Centering (arcmin):	3 - 5	**Bevel:**	Protective as needed



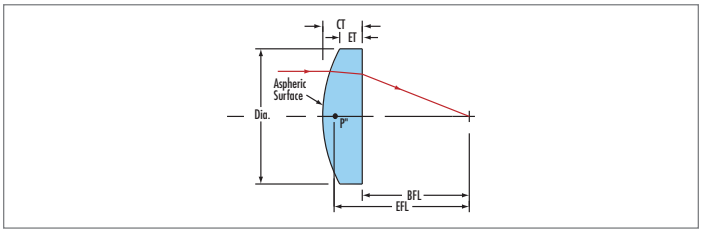
TECHSPEC® Best Form Aspheric Lenses

Diameter (mm)	Effective FL (mm)	Max. Center Thickness (mm)	Max. Edge Thickness (mm)	Glass Type	532nm	633nm	1064nm	Price – Coated		
					Stock No.	Stock No.	Stock No.	1-5	6-25	26+
25.0	25.0	6.61	1.77	N-BK7	#89-431	#89-435	#89-439	$180.00	$162.00	Call
25.0	50.0	4.30	1.49	N-BK7	#89-432	#89-436	#89-440	$180.00	$162.00	
25.0	75.0	4.25	2.31	N-BK7	#89-433	#89-437	#89-441	$180.00	$162.00	
25.0	100.0	4.05	2.57	N-BK7	#89-434	#89-438	#89-442	$180.00	$162.00	

TECHSPEC® Precision Aspheric Lenses

- Designed and Manufactured by Edmund Optics®
- Reduces Spherical Aberration
- Broadband AR Coatings Available

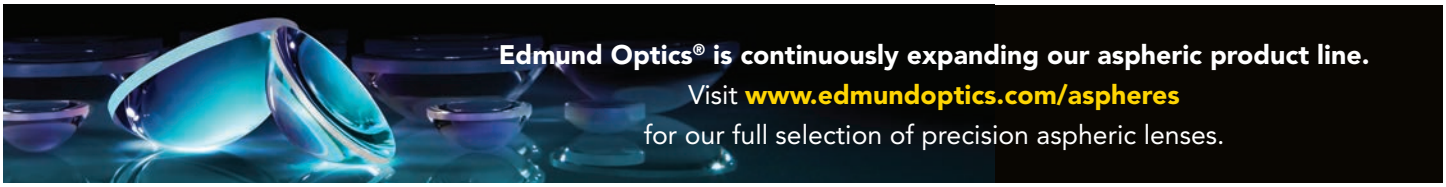
TECHSPEC® Precision Aspheric Lenses are designed to focus light while eliminating spherical aberration from divergent light sources in applications including focusing the output of a laser diode. Aspheric lenses can increase the numerical aperture of a lens while minimizing system aberrations. Aspheric lenses may also reduce the number of elements needed in a multi-element system. Aspheric lenses can reduce overall system weight while providing advantages such as increasing throughput or simplifying assembly.



Design Wavelength (nm):	587.6	**Asphere Figure Error:**	0.75µm RMS
Diameter Tolerance (mm):	+0.0/-0.1	**Surface Quality:**	60-40
Center Thickness Tolerance (mm):	±0.1	**Centering (arcmin):**	3 - 5
Clear Aperture (%):	90		

TECHSPEC® Precision Aspheric Lenses

Dia. (mm)	EFL (mm)	Numerical Aperture	BFL (mm)	CT (mm)	ET (mm)	Glass Type	Stock No. Uncoated	Price – Uncoated 1-5	Price – Uncoated 6-25	Price – Uncoated 26+	Stock No. VIS Coated	Stock No. NIR Coated	Price – Coated 1-5	Price – Coated 6-25	Price – Coated 26+
10.00	7.50	0.67	4.51	5.00	2.21	N-SF5	#69-852	$155.00	$124.00	Call For OEM Quantity Pricing	#69-856	#69-860	$175.00	$140.00	Call For OEM Quantity Pricing
10.00	10.00	0.50	7.48	4.00	1.69	L-BAL35	#69-853	$155.00	$124.00		#69-857	#69-861	$175.00	$140.00	
12.50	9.50	0.66	6.51	5.00	1.60	N-SF5	#69-854	$175.00	$140.00		#69-858	#69-862	$195.00	$156.00	
12.50	12.50	0.50	9.35	5.00	2.11	L-BAL35	#69-855	$175.00	$140.00		#69-859	#69-863	$195.00	$156.00	
15.00	9.00	0.83	4.81	7.00	1.35	N-SF5	#67-243	$295.00	$236.00		#67-250	#67-257	$315.00	$252.00	
15.00	11.25	0.66	6.85	7.00	1.94	L-BAL35	#47-725	$195.00	$156.00		#49-097	#49-109	$215.00	$172.00	
15.00	15.00	0.50	11.54	5.50	2.04	L-BAL35	#47-726	$195.00	$156.00		#49-098	#49-110	$215.00	$172.00	
15.00	18.75	0.40	15.92	4.50	1.82	L-BAL35	#47-727	$195.00	$156.00		#49-099	#49-111	$215.00	$172.00	
15.00	22.50	0.33	19.98	4.00	1.80	L-BAL35	#47-728	$195.00	$156.00		#49-100	#49-112	$215.00	$172.00	
20.00	12.50	0.80	7.12	9.00	1.91	N-SF5	#67-244	$315.00	$252.00		#67-251	#67-258	$335.00	$268.00	
20.00	15.00	0.66	9.16	9.60	3.05	L-BAL35	#66-309	$215.00	$172.00		#66-319	#66-329	$235.00	$188.00	
20.00	20.00	0.50	15.19	8.00	3.44	L-BAL35	#66-310	$215.00	$172.00		#66-320	#66-330	$235.00	$188.00	
25.00	15.00	0.83	8.42	11.00	1.64	N-SF5	#67-245	$350.00	$280.00	Call For OEM Quantity Pricing	#67-252	#67-259	$370.00	$296.00	Call For OEM Quantity Pricing
25.00	18.75	0.66	12.46	10.00	1.63	L-BAL35	#47-729	$230.00	$184.00		#49-101	#49-113	$250.00	$200.00	
25.00	25.00	0.50	20.28	7.50	1.74	L-BAL35	#47-730	$230.00	$184.00		#49-102	#49-114	$250.00	$200.00	
25.00	31.25	0.40	27.16	6.50	2.04	L-BAL35	#47-731	$230.00	$184.00		#49-103	#49-115	$250.00	$200.00	
25.00	37.50	0.33	33.72	6.00	2.30	L-BAL35	#47-732	$230.00	$184.00		#49-104	#49-116	$250.00	$200.00	
25.00	50.00	0.25	46.54	5.50	2.80	L-BAL35	#33-944	$230.00	$184.00		#33-945	#33-946	$250.00	$200.00	
30.00	17.50	0.86	9.43	13.50	1.78	N-SF5	#67-246	$395.00	$316.00		#67-253	#67-260	$445.00	$356.00	
30.00	22.50	0.66	13.73	14.40	4.57	L-BAL35	#66-311	$275.00	$220.00		#66-321	#66-331	$315.00	$252.00	
30.00	30.00	0.50	22.99	11.70	4.81	L-BAL35	#66-312	$275.00	$220.00		#66-322	#66-332	$315.00	$252.00	
40.00	25.00	0.80	15.73	15.50	1.49	N-SF5	#67-247	$495.00	$396.00		#67-254	#67-261	$545.00	$436.00	
40.00	30.00	0.66	20.60	15.50	2.56	L-BAL35	#66-313	$375.00	$300.00		#66-323	#66-333	$415.00	$332.00	
40.00	40.00	0.50	30.68	15.50	6.39	L-BAL35	#66-314	$375.00	$300.00		#66-324	#66-334	$415.00	$332.00	
50.00	30.00	0.83	18.04	20.00	1.44	N-SF5	#67-248	$650.00	$520.00		#67-255	#67-262	$690.00	$552.00	
50.00	37.50	0.66	25.74	19.40	3.23	L-BAL35	#66-315	$450.00	$360.00		#66-325	#66-335	$490.00	$392.00	
50.00	50.00	0.50	38.33	19.40	8.01	L-BAL35	#66-316	$450.00	$360.00		#66-326	#66-336	$490.00	$392.00	



TECHSPEC® Precision UV Fused Silica Aspheric Lenses

- Low f/#s for Optimum Light Gathering
- Low Coefficient of Thermal Expansion
- Prescription Information Available

TECHSPEC® Precision UV Fused Silica Aspheric Lenses offer the benefits of an aspheric element combined with the manufacturing precision of state-of-the-art grinding and polishing equipment. With the available prescription data, these fused silica optics can be easily designed and integrated into complex optical systems. Featuring low f/#'s for optimum light gathering and focusing performance, these fused silica lenses are computer optimized to eliminate spherical and minimize higher order aberrations. UV fused silica optics substrate offers a low coefficient of thermal expansion.

Design Wavelength (nm):	587.6	**Center Thickness Tolerance (mm):**	±0.1	**Prescription Data:**	See our website
Clear Aperture (%):	90	**Surface Accuracy:**	0.75µm RMS	**Coating:** **UV:**	R_{avg} <1.5% @ 250 - 450nm
10mm Dia.:	80	**Surface Quality:**	60-40	**UV-VIS:**	R_{avg} <2.5% @ 250 - 700nm
12.5mm Dia.:	88	**Centering (arcmin):**	3 - 5	**VIS:**	R_{avg} <1.5% @ 425 - 675nm
Diameter Tolerance (mm):	+0.0/-0.1			**NIR:**	R_{avg} <1.5% @ 600 - 1050nm

TECHSPEC® Precision UV Fused Silica Aspheric Lenses *DCX Lens Shape

Dia. (mm)	EFL (mm)	Numerical Aperture	BFL (mm)	CT (mm)	ET (mm)	Stock No. Uncoated	Price – Uncoated			Stock No. UV Coated	Stock No. UV-VIS Coated	Stock No. VIS Coated	Stock No. NIR Coated	Price – Coated		
							1-5	6-25	26+					1-5	6-25	26+
10.00	8.00	0.63	2.52	8.00	3.05	#87-973	$305.00	$244.00	Call For OEM Quantity Pricing	#87-977	#87-981	#87-985	#87-989	$325.00	$260.00	Call For OEM Quantity Pricing
10.00	10.00	0.50	5.89	6.00	2.77	#87-974	$295.00	$236.00		#87-978	#87-982	#87-986	#87-990	$315.00	$252.00	
12.50	10.00	0.63	4.52	8.00	2.03	#87-975	$335.00	$268.00		#87-979	#87-983	#87-987	#87-991	$355.00	$284.00	
12.50	12.50	0.50	8.39	6.00	1.98	#87-976	$325.00	$260.00		#87-980	#87-984	#87-988	#87-992	$345.00	$276.00	
15.00	10.00	0.75	2.69*	11.40	3.70	#33-947	$425.00	$340.00		#33-951	#33-955	#33-959	#33-963	$445.00	$356.00	
15.00	12.50	0.60	6.33	9.00	2.47	#67-264	$415.00	$332.00		#67-269	#84-334	#67-274	#67-279	$435.00	$348.00	
15.00	15.00	0.50	10.03	7.25	2.43	#48-534	$415.00	$332.00		#49-693	#84-335	#49-587	#49-591	$435.00	$348.00	
15.00	20.00	0.38	15.89	6.00	2.68	#48-535	$415.00	$332.00		#49-694	#84-336	#49-588	#49-592	$435.00	$348.00	
15.00	25.00	0.30	22.01	4.36	1.79	#33-948	$415.00	$332.00		#33-952	#33-956	#33-960	#33-964	$435.00	$348.00	
25.00	17.50	0.69	8.37*	14.80	2.85	#33-949	$495.00	$396.00	Call For OEM Quantity Pricing	#33-953	#33-957	#33-961	#33-965	$515.00	$412.00	Call For OEM Quantity Pricing
25.00	20.00	0.63	10.40	14.00	2.27	#67-265	$475.00	$380.00		#67-270	#84-337	#67-275	#67-280	$495.00	$396.00	
25.00	25.00	0.50	18.32	9.75	1.75	#48-536	$465.00	$372.00		#49-695	#84-338	#49-589	#49-593	$485.00	$388.00	
25.00	30.00	0.42	24.17	8.50	2.21	#48-537	$465.00	$372.00		#49-696	#84-339	#49-590	#49-594	$485.00	$388.00	
25.00	50.00	0.25	46.50	5.13	1.61	#33-950	$465.00	$372.00		#33-954	#33-958	#33-962	#33-966	$485.00	$388.00	
50.00	40.00	0.63	21.15	27.50	4.07	#67-266	$715.00	$572.00		#67-271	#84-340	#67-276	#67-281	$755.00	$604.00	
50.00	50.00	0.50	36.63	19.50	3.49	#67-267	$695.00	$556.00		#67-272	#84-341	#67-277	#67-282	$735.00	$588.00	
50.00	60.00	0.42	48.34	17.00	4.42	#67-268	$695.00	$556.00		#67-273	#84-342	#67-278	#67-283	$735.00	$588.00	

To our customers: we understand that our products may be sold to businesses in California that may be subject to California's Proposition 65, Cal. Health & Safety Code 25249.7 et seq. Proposition 65 requires businesses to provide warnings to consumers if they are exposed to certain chemicals above the legal threshold. While trace levels of Proposition 65 chemicals may be detectable in components of our products, these chemicals are generally inaccessible to consumers and would not be expected to present any consumer exposure under customary use conditions. If you have any questions, please contact us at compliance@edmundoptics.com.

NEW

TECHSPEC® Zinc Selenide (ZnSe) Aspheric Lenses

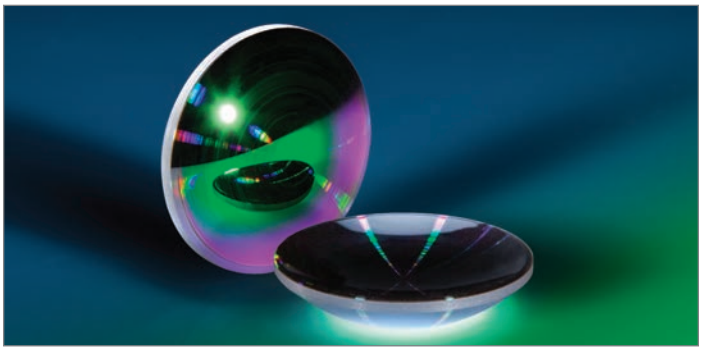
- Edmund Optics® Designed, II-VI Manufactured
- Premier Grade ZnSe Material
- Uncoated or Broadband 8 - 12µm AR Coating Available

TECHSPEC® Zinc Selenide (ZnSe) Aspheric Lenses are designed to provide diffraction-limited focusing performance for 10.6µm CO_2 lasers. Manufactured from II-VI Infrared ZnSe material featuring <0.0005 cm^{-1} bulk absorption at 10.6µm, these lenses are available uncoated or with a broadband anti-reflection coating providing superior transmission from 8 - 12µm. The precision designs are ideal for integration into laser systems, thermal imaging assemblies, and FTIR devices. TECHSPEC® Zinc Selenide Aspheric Lenses feature an irregularity of <λ/20 at 10.6µm, 40-20 surface quality, and <50Å surface roughness.

Substrate:	II-VI Infrared ZnSe	**Surface Roughness, RMS (Å):**	<50		
Clear Aperture (%):	90	**Power (P-V):**	λ/10	**Design Wavelength (µm):**	10.6
Diameter Tolerance (mm):	+0.00/-0.10	**Asphere Figure Error (P-V):**	λ/20	**Coating (as noted):**	R_{avg} <0.5%
Center Thickness Tolerance (mm):	±0.10	**Surface Quality:**	40-20		

TECHSPEC® Zinc Selenide (ZnSe) Aspheric Lenses

Diameter (mm)	Effective Focal Length (mm)	Numerical Aperture (NA)	Back Focal Length (mm)	Center Thickness (mm)	Edge Thickness (mm)	Stock No. Uncoated	Price – Uncoated			Stock No. 8-12µm	Price – 8 - 12µm		
							1-10	11-25	26+		1-10	11-25	26+
12.7	6.35	1.00	4.69	4.00	1.89	#39-469	$650.00	$585.00	Call For OEM Qty. Pricing	#39-504	$750.00	$675.00	Call For OEM Qty. Pricing
12.7	12.7	0.50	11.25	3.50	2.39	#39-470	$595.00	$535.50		#39-509	$695.00	$625.50	
25.4	12.7	1.00	10.21	6.00	1.83	#39-471	$895.00	$805.50		#39-510	$995.00	$895.50	
25.4	15.0	0.85	12.71	5.50	1.89	#39-472	$875.00	$787.50		#39-514	$975.00	$877.50	
25.4	20.0	0.64	17.92	5.00	2.23	#39-476	$850.00	$765.00		#39-515	$950.00	$855.00	
25.4	25.4	0.50	23.53	4.50	2.29	#39-477	$795.00	$715.50		#39-516	$895.00	$805.50	
25.4	50.8	0.25	49.35	3.50	2.38	#39-495	$795.00	$715.50		#39-517	$895.00	$805.50	
50.8	50.8	0.50	48.10	6.50	2.08	#39-496	$1,695.00	$1,525.50		#39-518	$1,895.00	$1,705.50	



TECHSPEC® Silicon Aspheric Lenses

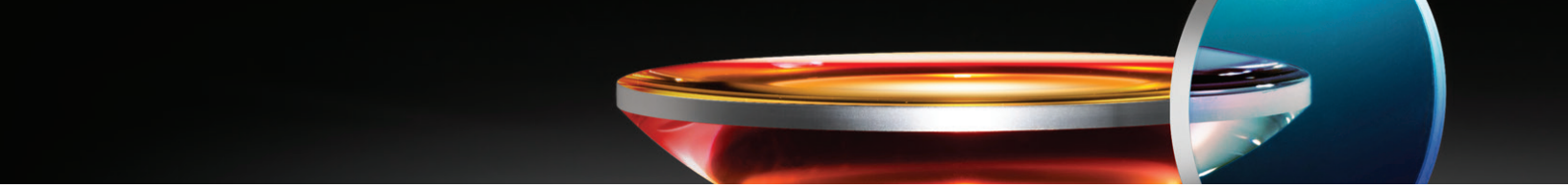
- Diffraction-Limited Performance
- Low Density and Dispersion
- Ideal for Weight Sensitive IR Applications

TECHSPEC® Silicon Aspheric Lenses are high performance, lightweight solutions for MWIR applications, and are ideal alternatives for costly ZnSe lenses and brittle Germanium lenses. TECHSPEC Silicon Aspheric Lenses feature the mechanical and thermal properties required to withstand many of the effects of harsh environments including fluctuations in temperature and pressure. Because silicon is a low density material, these lenses are also ideal for weight-sensitive systems, such as those found in many defense applications.

Substrate:	Silicon	**Center Thickness Tolerance:**	±0.10mm	**Edges:**	Diamond Turned
Design Wavelength:	4.0µm	**Surface Quality:**	60-40	**Centering:**	ETD <21.8µm
Clear Aperture:	90%	**Asphere Surface Accuracy:**	<0.3µm PV	**Coating:**	R_{avg} <3% @ 3 - 5µm
Diameter Tolerance:	+0/-0.10mm				

TECHSPEC® Silicon Aspheric Lenses

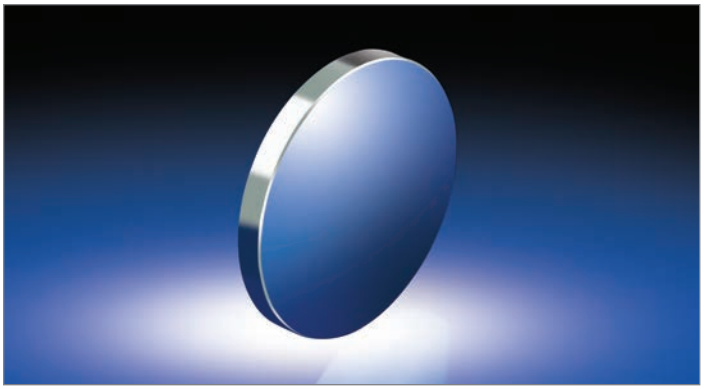
Diameter (mm)	EFL (mm)	Numerical Aperture	BFL (mm)	CT (mm)	Lens Shape	Stock No. Uncoated	Price – Uncoated			Stock No. 3-5µm	Price – 3 - 5µm		
							1-5	6-25	26+		1-5	6-25	26+
25.00	**12.5**	1.00	10.70	4.75	Meniscus	#89-357	$550.00	$445.00	Call	#89-362	$650.00	$525.00	Call
25.00	**25.0**	0.50	22.50	3.80	Meniscus	#89-358	$495.00	$395.00		#89-617	$595.00	$495.00	
25.00	**50.0**	0.25	47.78	3.00	Meniscus	#89-359	$495.00	$395.00		#89-618	$595.00	$495.00	



TECHSPEC® Germanium IR Aspheric Lenses

- Diffraction Limited Performance
- Variety of Coating Options
- Full Prescription Data Available

Our TECHSPEC® Germanium IR Aspheric Lenses provide diffraction limited focusing performance over a broad spectral range in the Mid- and Long Wave infrared regions. Ideal for monochromatic light sources, such as quantum cascade lasers, these lenses offer a high performance alternative to standard plano-convex lenses. See our website for focusing performance comparison curves between PCX lenses and our TECHSPEC® aspheres at various f/# ratios.



Substrate:	Germanium	**Center Thickness Tolerance (mm):**	±0.10	**Edges:**	Diamond Turned
Design Wavelength (µm):	4.0	**Surface Quality:**	60-40	**Centering (arcmin):**	3 - 5
Clear Aperture (%):	90	**Asphere Figure Error:**	0.3µm P-V	**Coating (as noted):**	R_{avg} <3% @ 3 - 5µm
Diameter Tolerance (mm):	+0.0/-0.1				R_{avg} <5% @ 3 - 12µm R_{avg} <3% @ 8 - 12µm

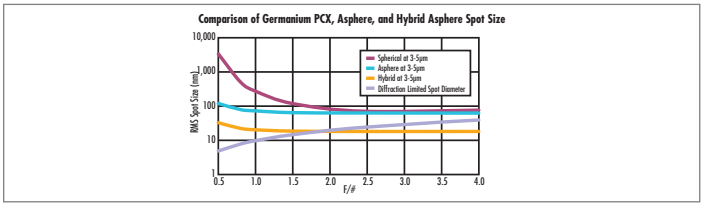
TECHSPEC® Germanium IR Aspheric Lenses

Diameter (mm)	EFL (mm)	Numerical Aperture	BFL (mm)	CT (mm)	Lens Shape	Stock No. Uncoated	Price – Uncoated 1-5	Price – Uncoated 6-25	Price – Uncoated 26+	3 - 5µm Coated	3 - 12µm Coated	8 - 12µm Coated	Price – Coated 1-5	Price – Coated 6-25	Price – Coated 26+
25.0	12.5	1.00	11.61	4.24	DCX	#68-235	$635.00	$508.00	Call For OEM Qty. Pricing	#68-243	#89-607	#68-251	$735.00	$588.00	Call For OEM Qty. Pricing
25.0	15.0	0.83	14.00	4.00	PCX	#68-236	$585.00	$468.00		#68-244	#89-608	#68-252	$685.00	$548.00	
25.0	20.0	0.63	19.08	3.70	PCX	#68-237	$535.00	$428.00		#68-245	#89-609	#68-253	$635.00	$508.00	
25.0	25.0	0.50	22.51	3.45	Meniscus	#68-238	$505.00	$404.00		#68-246	#89-610	#68-254	$605.00	$484.00	
25.0	30.0	0.42	27.52	3.25	Meniscus	#68-239	$505.00	$404.00		#68-247	#89-611	#68-255	$605.00	$484.00	
25.0	40.0	0.31	37.89	3.10	Meniscus	#68-240	$505.00	$404.00		#68-248	#89-612	#68-256	$605.00	$484.00	
25.0	50.0	0.25	48.44	3.00	Meniscus	#68-241	$505.00	$404.00		#68-249	#89-613	#68-257	$605.00	$484.00	
25.0	75.0	0.17	72.30	2.80	Meniscus	#68-242	$505.00	$404.00		#68-250	#89-614	#68-258	$605.00	$484.00	
50.0	25.0	1.00	20.64	7.75	Meniscus	#87-993	$1,005.00	$804.00		#87-995	#89-615	#87-997	$1,205.00	$964.00	
50.0	50.0	0.50	45.92	5.10	Meniscus	#87-994	$1,005.00	$804.00		#87-996	#89-616	#87-998	$1,205.00	$964.00	

TECHSPEC® Germanium IR Hybrid Aspheric Lenses

- Color Corrected for 3 - 5µm
- Near Diffraction Limited Focusing Performance
- Full Prescription Data Available

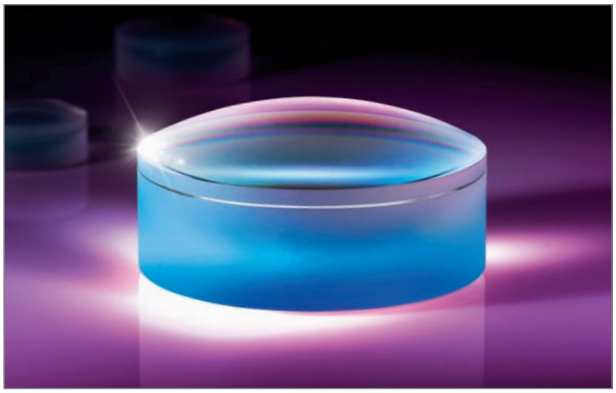
Our TECHSPEC® Germanium Infrared (IR) Hybrid Aspheric Lenses provide diffraction limited focusing performance at any wavelength in the 3 - 5µm region, and near diffraction limited performance when used over the entire 3 - 5µm spectral range. They are ideal for integration into imaging applications, FTIR spectrometers, or any Mid-Wave IR application utilizing a broad band light source.



Substrate:	Germanium	**Surface Quality:**	60-40		
Design Wavelength (µm):	4.0	**Asphere Surface Accuracy:**	0.3µm P-V		
Clear Aperture (mm):	24.0	**Edges:**	Diamond Turned		
Diameter Tolerance (mm):	+0.0/-0.1	**Centering (arcmin):**	3 - 5		
Center Thickness Tolerance (mm):	±0.10	**Coating:**	R_{avg} <3% @ 3 - 5µm		

TECHSPEC® Germanium IR Hybrid Aspheric Lenses

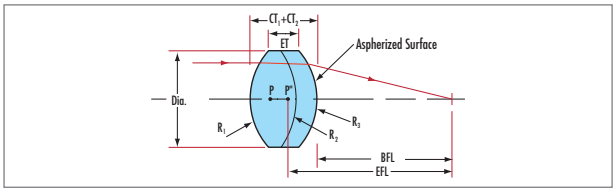
Diameter (mm)	EFL (mm)	Numerical Aperture	BFL (mm)	CT (mm)	Lens Shape	Stock No.	Price – 3 - 5µm Coated 1-5	Price – 3 - 5µm Coated 6-25	Price – 3 - 5µm Coated 26+
25.0	12.5	1.00	11.56	4.22	DCX	#68-259	$785.00	$628.00	Call For OEM Qty. Pricing
25.0	15.0	0.83	14.01	4.00	PCX	#68-260	$735.00	$588.00	
25.0	20.0	0.63	18.21	2.80	Meniscus	#68-261	$685.00	$548.00	
25.0	25.0	0.50	23.03	2.46	Meniscus	#68-262	$660.00	$528.00	
25.0	30.0	0.42	28.00	2.50	Meniscus	#68-263	$660.00	$528.00	
25.0	40.0	0.31	38.32	2.10	Meniscus	#68-264	$660.00	$528.00	
25.0	50.0	0.25	47.91	2.60	Meniscus	#68-265	$660.00	$528.00	
25.0	75.0	0.17	72.79	2.80	Meniscus	#68-266	$660.00	$528.00	
25.0	100.0	0.13	97.73	2.50	Meniscus	#68-267	$660.00	$528.00	



TECHSPEC® Aspherized Achromatic Lenses

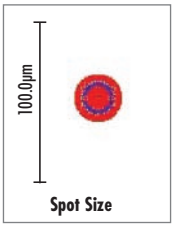
- Low Cost, Color-Corrected Asphere
- Better Color Correction than Standard Achromatic Lenses
- Similar Spherical Aberration Correction to Machined Aspheres

TECHSPEC® Aspherized Achromats bridge the performance gap between color-corrected achromats and spherical aberration corrected aspheres, resulting in cost effective, color corrected aspheric components. The TECHSPEC® doublet lenses consist of two cemented elements that are matched for their color-correction ability and small RMS spot size. The back surface of the doublet is fused with a molded polymer aspheric surface. These molds create a stable aspheric contour, removing or reducing wavefront errors present in typical achromats while boosting numerical aperture. Typical applications include: fiber optic focusing or collimation, image relay, inspection, scanning and high numerical aperture imaging.

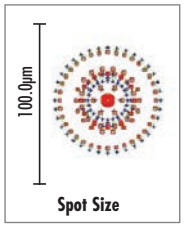


For complete prescription data, visit www.edmundoptics.com/aspherized

Clear Aperture (%):	90
Diameter Tolerance (mm):	+0.0/-0.05
Center Thickness Tolerance (mm):	±0.2
Surface Quality:	60-40, glass surfaces only
Centering (arcmin):	3 - 5
Operating Temperature (°C):	-20 to 80
Design Wavelength (nm):	587.6
Coating:	VIS 0° on First Surface



12.5 x 14 Aspherized Achromat



12.5 x 14 Standard Achromat

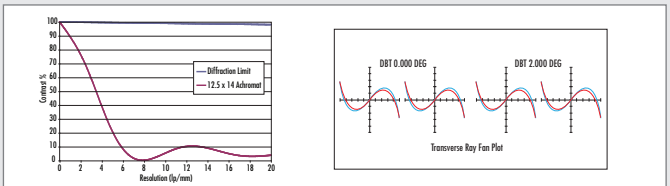
TECHSPEC® Aspherized Achromatic Lenses

Dia. (mm)	EFL (mm)	BFL (mm)	CT_1 (mm)	CT_2 (mm)	ET (mm)	Glass Type	Stock No.	Price 1-5	Price 6-25	26+
9.0	12.0	8.16	4.50	1.50	4.66	N-LaK8/N-SF57	#49-656	$99.00	$79.20	Call For OEM Qty. Pricing
9.0	18.0	14.30	4.50	1.50	4.98	N-LaK8/N-SF57	#49-657	$99.00	$79.20	
12.5	14.0	9.89	6.50	1.50	4.28	S-FSL5/N-SF57	#49-658	$119.00	$95.20	
12.5	20.0	16.07	5.00	1.50	4.62	N-LaK8/N-SF57	#49-659	$119.00	$95.20	
12.5	25.0	21.69	4.00	1.50	4.28	N-LaK8/N-SF57	#49-660	$119.00	$95.20	
25.0	30.0	23.21	9.00	2.50	7.11	N-LaK14/N-SF57	#49-662	$129.00	$103.20	
25.0	35.0	28.14	9.00	2.50	7.90	N-LaK8/N-SF57	#49-663	$129.00	$103.20	
25.0	40.0	33.53	9.00	2.50	7.54	N-SK14/N-SF57	#49-664	$129.00	$103.20	
25.0	50.0	44.08	9.00	2.50	7.42	S-FSL5/S-TIH13	#49-665	$129.00	$103.20	

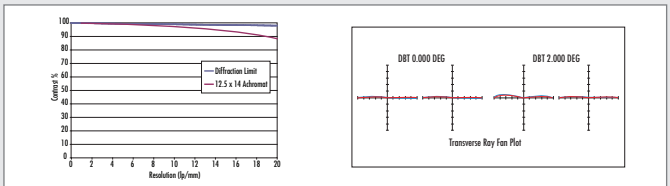
TECHNICAL NOTE

Aspherized Achromatic Lenses

Aspherized Achromatic Lenses are award winning, cost-effective lenses featuring excellent correction for both chromatic and spherical aberrations. By combining Edmund Optics' world-class spherical polishing capabilities with a unique polymer molding process, these lenses combine the superior image quality of aspheric lenses with the precision color correction of achromatic lens designs. This results in an economical means of meeting the stringent demands of today's optical and visual systems. By incorporating Aspherized Achromatic Lenses into lens system designs, performance can be greatly increased in applications such as relays, condensing systems, high numerical aperture imaging systems, and beam expanders.

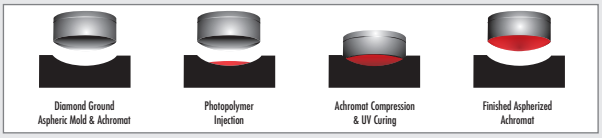


MTF and Aberration Plot of #45-209, 12.5mm diameter, 14mm Focal Length TECHSPEC® Achromatic Lens

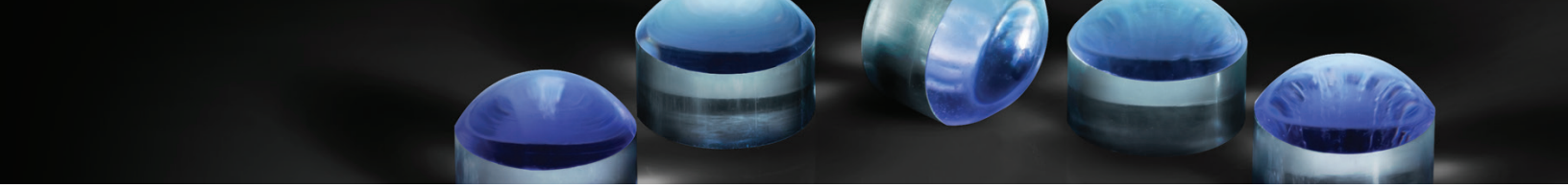


MTF and Aberration Plot of #49-658, 12.5mm diameter, 14mm Focal Length TECHSPEC® Aspherized Achromatic Lens

Aspherized Achromats are composed of glass optical lens elements bonded with a photosensitive polymer. The polymer is applied only on one face of the doublet and can be easily replicated in a short amount of time, providing the flexibility associated with typical multi-element components.



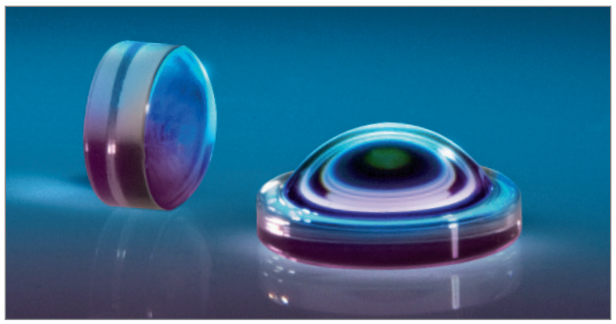
Unlike glass elements, however, Aspherized Achromatic lenses have a smaller operating temperature range of -20°C to +80°C. The material of the Aspherized Achromatic lens blocks DUV transmission, making Aspherized Achromatic lenses unsuitable for some applications. These lenses should be handled with care since they are not scratch resistant, but can be replaced easily due to EO's large selection of in-stock components. Despite these limitations, the benefits of Aspherized Achromatic lenses remain substantial for a large variety of applications.



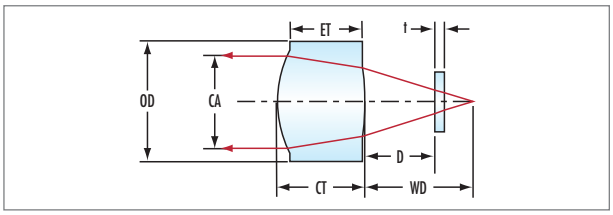
Precision Molded Aspheric Lenses

- Eliminate Spherical Aberration
- Multiple Coating Options Available
- Range of Numerical Apertures

Precision Molded Aspheric Lenses are used to eliminate spherical aberration and improve focusing and collimating accuracy in a variety of laser applications. Low NA Precision Molded Aspheric Lenses are designed to maintain beam shape, while high NA lenses gather all available light to maintain beam power over long distances. Precision Molded Aspheric Lenses are ideal for applications including sighting systems, bar code scanners, laser diode-to-fiber coupling, optical data storage, or biomedical lasers.



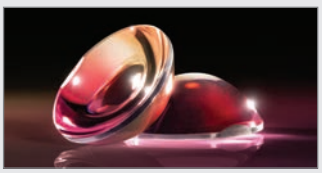
Diameter Tolerance (mm):	±0.020	**Coating Specifications:**	
Clear Aperture (CA):	Reference Value	**VIS:**	R_{avg} <0.5% @ 350 - 700nm
EFL Tolerance (%):	±1	**NIR:**	R_{abs} <1.0% @ 600 - 1050nm
Transmitted Wavefront Error:	<Diffraction Limit	**IR:**	R_{abs} <1.0% @ 1050 - 1600nm
Optimum Operating Temperature (°C):	≤200		



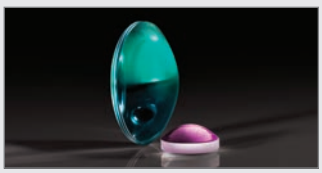
Precision Molded Aspheric Lenses — *R_{avg} <0.5% @ 350 - 500nm See website for complete prescription data.

NA	OD (mm)	EFL (mm)	CA (mm)	WD (mm)	CT (mm)	Design λ (nm)	Glass Type	t (mm)	D (mm)	VIS Coated	NIR Coated	IR Coated	Price – Coated 1-10	Price – Coated 11-49
0.13	6.33	**22.00**	5.50	20.4	2.66	670	D-ZK3	0.250 (BK7)	19.157	#83-543	#83-544	–	$75.00	$67.50
0.15	2.00	**5.00**	1.60	4.4	0.99	1550	D-ZK3	–	–	#83-546	#48-145	#48-158	$75.00	$67.50
0.15	6.50	**18.40**	5.50	17.1	2.18	780	D-ZK3	0.250 (BK7)	15.856	#87-113	#87-114	#87-115	$75.00	$67.50
0.16	6.50	**15.29**	5.38	14.0	2.21	780	D-ZK3	0.250 (BK7)	12.727	#37-098	#37-099	#37-100	$66.50	$59.90
0.18	6.33	**13.86**	5.10	12.1	2.77	650	D-ZK3	–	–	#83-556	#46-372	#48-160	$75.00	$67.50
0.20	6.00	**11.00**	5.40	9.3	3.10	633	D-ZK3	0.250 (BK7)	8.706	#37-109	#37-110	#37-111	$62.50	$56.25
0.25	7.20	**11.00**	5.50	7.9	5.03	633	D-ZK3	0.250 (BK7)	6.909	#87-117	#87-118	#87-119	$75.00	$67.50
0.30	6.51	**7.50**	4.54	5.8	3.19	780	D-ZLAF52LA	0.250 (BK7)	5.151	#87-129	#87-130	#87-131	$50.00	$45.00
0.30	7.20	**11.00**	6.68	10.0	1.95	670	D-ZLAF52LA	0.275 (BK7)	9.346	#87-121	#87-122	#87-123	$50.00	$45.00
0.40	7.20	**6.24**	5.00	3.5	5.16	780	D-ZLAF52LA	0.275 (BK7)	2.682	#87-125	#87-126	#87-127	$85.00	$76.50
0.43	4.70	**4.50**	3.70	2.2	3.65	980	D-ZK3	–	–	#83-578	#83-579	#83-580	$50.00	$45.00
0.50	1.00	**0.55**	0.70	3.0	0.66	1550	D-ZLAF52LA	–	–	#37-112	#37-113	#37-114	$75.00	$67.50
0.50	2.00	**1.41**	1.52	1.20	0.500	488	D-LaK6	0.250 (BK7)	0.700	#37-108*	–	–	$75.00	$67.50
0.50	3.00	**2.00**	2.00	1.0	1.89	780	D-ZLAF52LA	0.250 (BK7)	0.479	#83-582	#83-583	–	$50.00	$45.00
0.50	6.33	**6.70**	6.00	4.9	2.85	515	H-FK61	0.250 (BK7)	2.408	#37-101	–	–	$75.00	$67.50
0.50	9.94	**8.00**	8.20	5.9	3.43	780	D-ZK3	0.250 (BK7)	4.911	#37-102	#37-103	#37-104	$85.00	$76.50
0.50	11.00	**10.00**	10.00	7.8	3.64	633	D-ZK3	0.250 (BK7)	7.173	#33-425	#33-426	#33-427	$129.00	$116.10
0.52	4.70	**2.76**	4.12	2.7	3.83	980	D-ZLAF52LA	0.250 (BK7)	1.962	#87-133	#87-134	#87-135	$75.00	$67.50
0.55	4.00	**2.73**	3.00	2.4	1.43	780	D-ZLAF52LA	1.200 (PC)	1.170	#83-605	#83-606	#83-607	$50.00	$45.00
0.55	4.50	**2.75**	3.60	2.2	1.90	830	D-ZLAF52LA	–	–	#83-616	#66-926	#66-927	$50.00	$45.00
0.55	6.33	**4.51**	5.07	3.1	2.71	780	D-ZLAF52LA	0.250 (BK7)	2.834	#87-153	#87-154	#87-155	$75.00	$67.50
0.55	6.00	**4.60**	4.80	2.7	3.14	655	D-ZK3	0.275 (BK7)	2.049	#87-157	#87-158	#87-159	$50.00	$45.00
0.56	7.20	**5.50**	6.00	3.7	2.94	633	D-ZK3	0.250 (BK7)	3.091	#87-145	#87-146	#87-147	$85.00	$76.50
0.58	2.40	**1.45**	1.60	0.8	1.02	780	D-ZK3	–	–	#83-613	#83-614	#83-615	$50.00	$45.00
0.60	6.33	**4.02**	4.80	2.4	2.90	405	D-LaK6	0.250 (BK7)	1.863	#83-990*	–	–	$85.00	$76.50
0.61	6.33	**4.00**	4.80	2.4	2.92	488	D-LaK6	0.250 (BK7)	1.815	#83-681*	–	–	$85.00	$76.50
0.62	2.75	**1.42**	1.70	0.9	1.08	488	L-LaL12	0.250 (BK7)	0.366	#83-679*	–	–	$85.00	$76.50
0.60	15.00	**10.00**	13.00	7.0	5.38	850	D-ZLAF52LA	–	–	#37-105	#37-106	#37-107	$66.50	$59.90
0.64	4.00	**2.75**	3.60	1.5	2.24	830	D-ZLAF52LA	–	–	#83-626	#83-627	#83-628	$50.00	$45.00
0.64	6.33	**4.03**	5.10	2.7	3.10	685	D-ZK3	1.200 (K3)	1.483	#87-161	#87-162	#87-163	$75.00	$67.50
0.66	4.00	**2.54**	3.30	1.6	1.82	405	L-LaL12	0.250 (BK7)	0.914	#83-677*	–	–	$85.00	$76.50
0.68	6.33	**3.10**	5.00	1.8	3.21	830	D-ZK3	–	–	#87-165	#87-166	#87-167	$75.00	$67.50

So Much More Online...



Plastic Aspheric Lenses
Search 3225 on website



Molded Aspheric Condenser Lenses
Search 3815 on website

Plano-Convex Axicons
Search 3364 on website

Techspec® Cylindrical Lenses
Search 3816 on website

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Single Point Diamond Turning

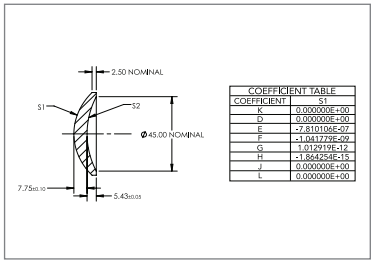
Edmund Optics (EO) utilizes single point diamond turning to manufacture a wide variety of precision optics in crystalline and plastic materials, producing complex geometries where traditional grinding and polishing techniques face limitations. This type of precision lathing can create optical components with surface figure accuracy better than λ/4 and surface roughness lower than 30Å. EO offers a range of standard diamond turned spherical and aspheric lenses available for immediate shipping in addition to custom manufacturing to meet your specific application needs.

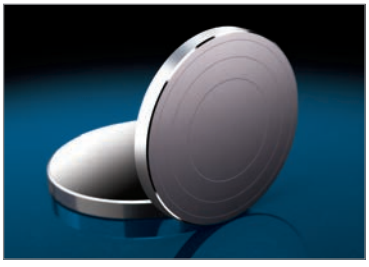
Diamond Turning Cell Capabilities for Crystal and Plastic

		Commercial	Precision	High Precision
Figure Accuracy:	**Sphere & Plano (P-V @ 632nm):**	>1λ	>1λ	<λ/4
	Asphere (P-V @ 632nm):	1λ	λ/2	λ/4
Surface Roughness (Å):	**Diameter: < 1":**	>50	30	<30
	Diameter: > 1":	>125	100	>50
Surface Quality (S/D):		80/50	60/40	<60/40
Center Thickness (mm):		+/- 0.100	+/- 0.005	<0.005
Surface SAG (mm):		+/- 0.050	+/- 0.025	<+/- 0.025
Clear Aperture:		90%	95%	>98%
Radius (Spherical):		<+/- 0.3%	+/- 0.10%	<+/- 0.10%
Vertex Radius (Asphere):		<+/- 1.0%	+/- 0.50%	<+/- 0.50%
Power (P-V) - Plano:		3λ	1λ	<1λ
Centering (arcmin):		3	1	<1
OD Tolerance (mm):		+/- 0.100	+/- 0.010	<+/- 0.010
Geometries:		Plano, Spherical, Aspheric, Diffractive, and Freeform		
Diameter Range (mm):		6.35 - 254		
Materials:		Germanium, Silicon, Zinc Selenide, Zinc Surface, Cleartran, Calcium Fluoride, Barium Fluoride, Acrylic, and Zeonex		
Coating:		UV to Far IR		

Built-to-Print Manufacturing

EO provides build-to-print manufacturing capabilities and can diamond turn a range of crystalline and plastic materials to exact your required specifications, creating a range of component geometries such as aspheric, planar, spherical, and freeform surfaces. Our experienced team of engineers helps guide designs from initially establishing design requirements all the way to volume production, providing support throughout the entire process.





www.edmundoptics.com/aspheres