

GRADIUM® Lenses Overview

ASPHERIC PERFORMANCE FOR HIGH POWER LASER DELIVERY

- Gradient index lenses for high power laser delivery
- Aspheric performance
- Smaller focused spot size
- Single lens replacement for conventional doublets
- High performance, cost effective
- Standard designs with diameters from 5 mm to 80 mm

In high performance optical systems, spherical aberration, chromatic aberration, and astigmatism induce sweat on the brows of optical designers. These aberrations can prevent optical systems from reaching their full potential.

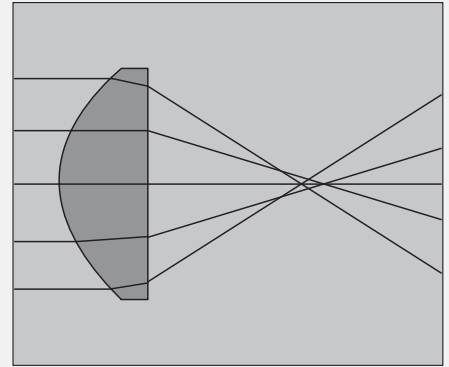
Avoiding these factors in optical systems is often difficult without using multiple lens elements. LightPath's unique line of GRADIUM® optics makes correcting these aberrations a practical reality.

GRADIUM® lenses are made from LightPath's proprietary axial gradient index glass. Its unique refractive qualities can be exploited to reduce spherical aberrations resulting in performance similar to single-term aspheres.

GRADIUM® lenses have been applied as simple singlets or doublets in complex multi-element systems. They have been very well received for use in high-power industrial laser systems; many of the world's largest Nd:YAG and fiber laser manufacturers now incorporate GRADIUM® optics in their laser delivery systems.

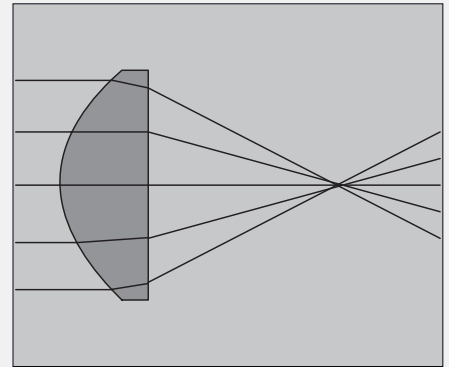
Standard Spherical Lens

Standard spherical lenses suffer from spherical aberration, which artificially limits the focused spot size.



GRADIUM® Lens

GRADIUM's® unique refractive index profile bends rays while traveling through the lens resulting in a better focused, smaller spot.



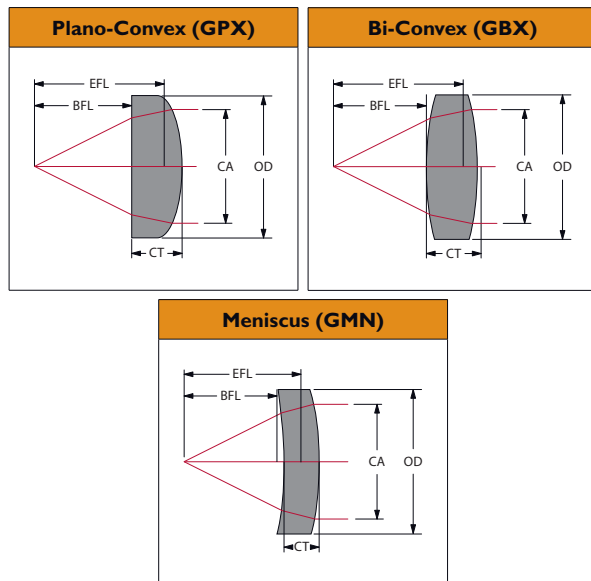
General GRADIUM® Lens Specifications

Design Wavelength	546 nm
Operating Temperature	-20°C to +200°C
Storage Temperature	-40°C to +300°C
Outer Diameter (OD) Tolerance	± 0.250 mm
Center Thickness (CT) Tolerance	± 0.100 mm
Effective Focal Length (EFL) for GPX, GBX, and GMN Series	± 1%
Working Distance (WD) for GPX, GBX, and GMN Series	± 1%
Surface Quality	40/20 Scratch/Dig

	Lens Code	Outer Diameter (mm)	Clear Aperture (mm)	F/#	Effective Focal Length (mm)	Center Thickness (mm)	Back Focal Length (mm)
Plano-Convex	GPX-5-5	5.00	4.00	1.00	5.00	2.90	3.09
	GPX5-10	5.00	4.50	2.20	10.00	3.00	8.23
	GPX5-12.5	5.00	4.00	2.80	12.50	2.00	11.30
	GPX6.3-6.19	6.30	5.67	1.00	6.19	2.60	4.65
	GPX6.35-12.5	6.35	5.72	2.20	12.50	2.00	11.31
	GPX10-10	10.00	9.00	1.10	10.00	3.00	8.00
	GPX10-12.5	10.00	9.00	1.40	12.50	3.00	10.68
	GPX10-18	10.00	9.00	2.00	18.00	2.50	16.52
	GPX10-22	10.00	9.00	2.50	22.00	2.50	20.54
	GPX10-25	10.00	9.00	2.80	25.00	2.50	23.55
	GPX10-30	10.00	9.00	3.30	30.00	2.50	28.53
	GPX10-40	10.00	9.00	4.50	40.00	2.00	38.84
	GPX15-15	15.00	13.00	1.10	15.00	4.20	12.24
	GPX15-25	15.00	13.50	1.80	24.14	3.00	22.42
	GPX15-40	15.00	13.00	3.00	40.00	2.00	38.83
	GPX20-50	20.00	18.00	2.80	50.00	3.00	48.24
	GPX20-60	20.00	18.00	3.30	60.00	6.00	56.49
	GPX25-40	25.00	22.50	1.80	40.08	6.00	36.55
	GPX25-50	25.00	22.50	2.20	50.16	6.00	46.62
	GPX25-60	25.00	22.00	2.60	60.00	6.00	56.46
	GPX25-80	25.00	22.00	3.50	80.00	4.00	77.69
	GPX25-125	25.00	22.50	5.60	125.00	6.00	121.50
	GPX27-70	27.00	24.30	2.80	66.63	6.00	63.13
	GPX27-100	27.00	24.30	4.00	96.46	6.00	93.02
	GPX27.82-65	27.82	25.04	2.60	63.97	6.00	60.47
	GPX30-60	30.00	27.00	2.20	60.00	6.00	56.44
	GPX30-70	30.00	27.00	2.60	70.00	6.00	66.47
	GPX30-80	30.00	27.00	3.00	80.00	4.00	77.68
	GPX30-100	30.00	27.00	3.70	100.00	6.00	96.53
	GPX40-80	40.00	36.00	2.20	80.00	6.00	76.47
	GPX40-100	40.00	36.00	2.80	100.00	6.00	96.56
	GPX40-125	40.00	36.00	3.50	125.00	6.00	121.52
	GPX40-150	40.00	36.00	4.20	150.00	6.00	146.49
	GPX50-100	50.00	45.00	2.20	100.00	8.00	94.90
GPX50-125	50.00	45.00	2.80	125.00	8.00	120.37	
GPX50-150	50.00	45.00	3.30	150.00	8.00	145.25	
GPX50-160	50.00	45.00	3.60	160.00	8.00	155.25	
GPX50-200	50.00	45.00	4.50	200.00	8.00	195.27	
GPX80-125	80.00	72.00	1.70	125.00	12.25	116.91	
Bi-Convex	GBX20-40	20.00	18.00	2.20	40.00	4.60	37.54
	GBX25-40	25.00	22.00	1.80	40.00	4.60	37.51
	GBX30-40	30.00	27.00	1.50	40.00	5.76	36.72
	GBX50-80	50.00	45.00	1.80	80.00	8.00	75.46
	GBX80-225	80.00	72.00	3.38	241.37	10.00	236.72
ME	GMN30-50	30.00	27.00	1.90	50.00	5.00	46.82

GRADIUM® lenses take advantage of advances in the manufacturing of axial gradient glass. Large diameter blanks are fabricated with index changes (Δn) of up to 0.15, about 100 times that available from radial GRIN (GRadient INdex) technology. The large range in Δn available provides a substantial ability to correct aberrations, especially spherical.

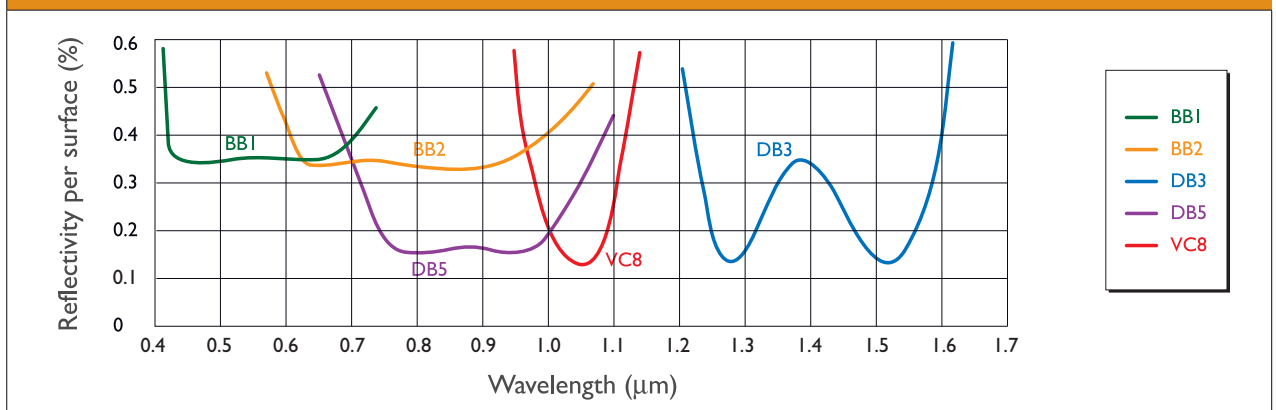
The process used to produce the GRADIUM® glass turns a series of SF glass layers into a single piece of gradient material. Unlike radial GRIN lenses, this process provides large diameter optical blanks with controlled index and dispersion profiles.



Standard Anti-Reflective Coatings			
	Coating Code	Wavelength	Reflectivity per Surface %
Broad Band	-BB2	650-1000 nm	< 0.5 Average
Dual Band	-DB3	1310/1550 nm	< 0.25 Maximum
VC	-VC8	1064 nm	< 0.25 Maximum

Available Anti-Reflective Coatings			
	Available Coatings*	Wavelength	Reflectivity per Surface %
Broad Band	-BB1	400-700 nm	< 0.50 Average
	-BB3	1000-1600 nm	< 0.50 Average
	-BB4	1500-2500 nm	< 0.50 Average
Dual Band	-DB1	633/1064 nm	< 0.25 Maximum
	-DB2	532/1064 nm	< 0.25 Maximum
	-DB4	530/670 nm	< 0.25 Maximum
	-DB5	808/940 nm	< 0.25 Maximum
	-DB6	1064/1550 nm	< 0.25 Maximum
	VC	-VC1	488 nm
-VC2		532 nm	< 0.25 Maximum
-VC3		633 nm	< 0.25 Maximum
-VC4		670 nm	< 0.25 Maximum
-VC5		780 nm	< 0.25 Maximum
-VC6		830 nm	< 0.25 Maximum
-VC7		980 nm	< 0.25 Maximum
-VC9		1300 nm	< 0.25 Maximum
-VC10		1550 nm	< 0.25 Maximum
-VC11		2000 nm	< 0.25 Maximum

Standard Coating Curves



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