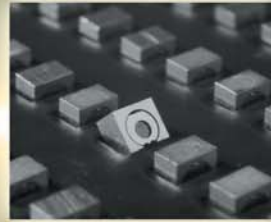


# LightPath

TECHNOLOGIES™



2006 Product Catalog  
**Gradium Lens**

*focusing on optical solutions*

# GRADIUM® LENSES

- Aspheric like performance
- Smaller focused spot size
- Low wavefront distortion
- High power handling
- Power threshold exceeds 1.3 KW/cm<sup>2</sup>\*
- Single lens can replace conventional doublets
- High performance, cost effective



Spherical aberration, chromatic aberration and astigmatism induce sweat on the brows of optical designers in many diverse application areas.

Avoiding these deviations from “perfect” optical systems is often difficult without using multiple elements. However, with utilization of LightPath’s unique line of GRADIUM® optics, correcting these aberrations using just a single optical element is now 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.

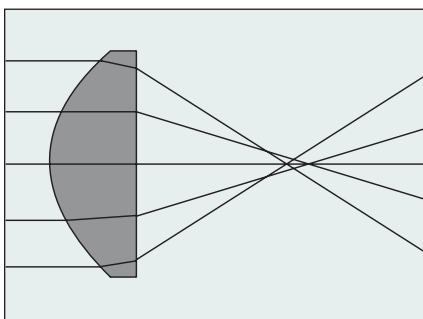
In industry, the lenses have been applied as simple singlets or doublets in complex multi-element systems. In particular, they have been very well received for use in high-power industrial lasers; many of the world’s largest Nd:YAG laser manufacturers now incorporate GRADIUM® optics in their laser systems.

LightPath’s DuraYAG assemblies provide a drop-in replacement for focusing and collimating assemblies on some of the most popular YAG laser systems. Their unique coverplate design extends the life of the assembly while the GRADIUM® lens provides a smaller focused spot size, increasing power density at the workpiece and enhancing overall system performance.

LightPath’s achromatic doublets are designed for use with collimated, polychromatic light in the visible spectrum. The GRADIUM® glass element is used to reduce the spherical aberration which is a common side effect of a cemented doublet design.

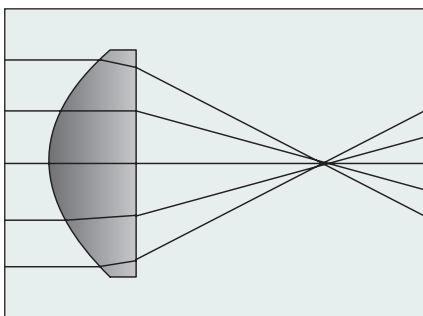
GRADIUM® lenses provide a cost-effective solution for many high-performance applications.

## 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.

\* Tested at Fraunhofer Institute, Detroit, Michigan 2003

## GENERAL LENS SPECIFICATIONS

Design Wavelength	546nm
Operating Temperature	-20°C to +200°C
Storage Temperature	-40°C to +300°C
Outer Diameter (OD) Tolerance	+/-0.250mm
Center Thickness (CT) Tolerance	+/-0.100mm
Effective Focal Length (EFL) for GAD Series	+/- 2%
Effective Focal Length for GPX, GBX, and GMN Series	+/- 1%
Working Distance (WD) for GAD Series	+/- 2%
Working Distance for GPX, GBX, and GMN Series	+/-1%
Surface Quality	40-20 Scratch-Dig
Chamfered with Safety Bevel	

# GRADIUM<sup>®</sup> LENSES

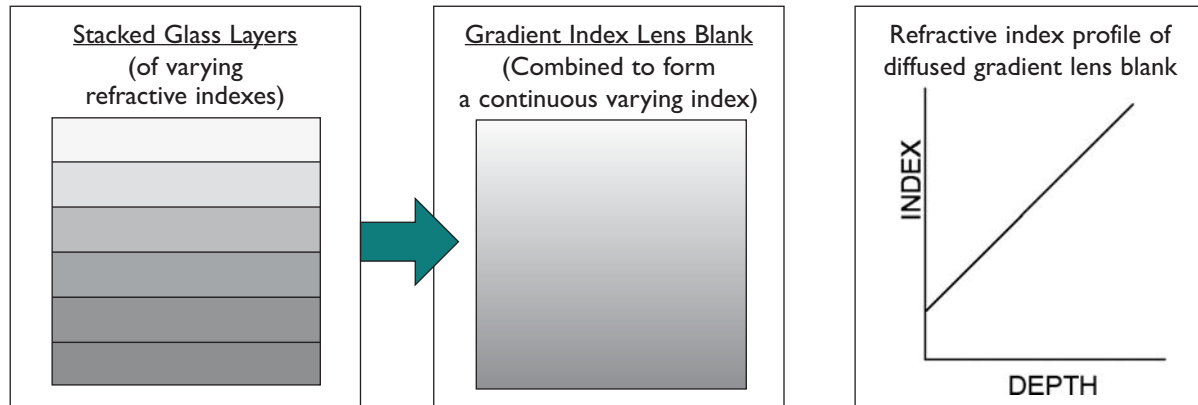
GRADIUM<sup>®</sup> lenses take advantage of recent advances in the manufacturing of axial gradient glass. Large diameter blanks are fabricated with index changes ( $\Delta n$ ) of up to 0.15, about 100 times that available from radial GRIN (GRadient INdex) technology. The large range in  $\Delta n$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

The process used to produce the GRADIUM<sup>®</sup> 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. Proper gradient profile selection allows a simple spherical lens to act as an asphere.

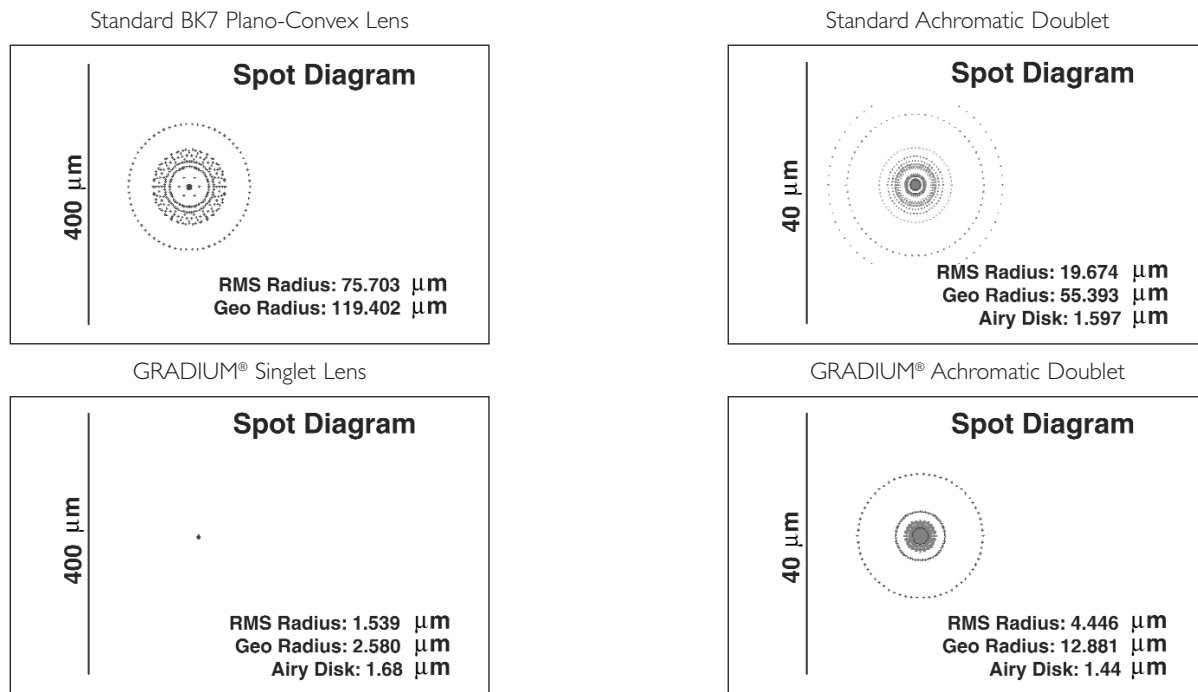
GRADIUM<sup>®</sup> lenses should be used wherever small spot size, high numerical aperture (NA), increased beam energy, or excellent wavefront quality are important. A GRADIUM<sup>®</sup> singlet does not have the limited laser damage threshold of a conventional cemented doublet, so laser power can be increased, leading to increased production throughput.

GRADIUM<sup>®</sup> glass offers the additional benefit of chromatic correction. The dispersion, as well as the optical index, varies in a controlled fashion within the lens. A finished lens can be viewed as a seamless, contiguous combination of many glass types. This continuous variation results in a transfer aberration correction not possible with homogeneous lenses. By combining GRADIUM<sup>®</sup> flint glass with a homogeneous crown glass, achromatic doublets are fabricated with superior color correction.

## The Gradium Process



## Typical Spot Diagram



# GRADIUM® LENSES

	Lens Code	Outer Diameter	Clear Aperture	F/#	Effective Focal Length	Center Thickness	Back Focal Length
Plano-Convex	GPX-5-5	5mm	4mm	1.0	5mm	2.90mm	3.09mm
	GPX-5-12.5	5mm	4mm	2.8	12.5mm	2.00mm	11.30mm
	GPX-10-10	10mm	9mm	1.1	10mm	3.00mm	8.00mm
	GPX-10-18	10mm	9mm	2	18mm	2.50mm	16.52mm
	GPX-10-22	10mm	9mm	2.5	22mm	2.50mm	20.54mm
	GPX-10-25	10mm	9mm	2.8	25mm	2.50mm	23.55mm
	GPX-10-30	10mm	9mm	3.3	30mm	2.50mm	28.53mm
	GPX-10-40	10mm	9mm	4.5	40mm	2.00mm	38.84mm
	GPX-15-15	15mm	13mm	1.1	15mm	4.20mm	12.24mm
	GPX-15-40	15mm	13mm	3	40mm	2.00mm	38.83mm
	GPX-20-50	20mm	18mm	2.8	50mm	3.00mm	48.24mm
	GPX-25-60	25mm	22mm	2.6	60mm	6.00mm	56.46mm
	GPX-25-80	25mm	22mm	3.5	80mm	4.00mm	77.69mm
	GPX-30-60	30mm	27mm	2.2	60mm	6.00mm	56.44mm
	GPX-30-70	30mm	27mm	2.6	70mm	6.00mm	66.47mm
	GPX-30-80	30mm	27mm	3.0	80mm	4.00mm	77.68mm
	GPX-30-100	30mm	27mm	3.7	100mm	6.00mm	96.53mm
	GPX-40-80	40mm	36mm	2.2	80mm	6.00mm	76.47mm
	GPX-40-100	40mm	36mm	2.8	100mm	6.00mm	96.56mm
	GPX-40-125	40mm	36mm	3.5	125mm	6.00mm	121.52mm
GPX-40-150	40mm	36mm	4.2	150mm	6.00mm	146.49mm	
GPX-50-100	50mm	45mm	2.2	100mm	8.00mm	94.90mm	
GPX-50-120	50mm	45mm	2.7	120mm	8.00mm	115.33mm	
GPX-50-125	50mm	45mm	2.8	125mm	8.00mm	120.37mm	
GPX-50-150	50mm	45mm	3.3	150mm	8.00mm	145.25mm	
GPX-50-160	50mm	45mm	3.6	160mm	8.00mm	155.25mm	
GPX-50-200	50mm	45mm	4.5	200mm	8.00mm	195.27mm	
GPX-80-125	80mm	72mm	1.7	125mm	12.25mm	116.91mm	
Bi-Convex	GBX-25-40	25mm	22mm	1.8	40mm	4.60mm	37.51mm
	GBX-30-40	30mm	27mm	1.5	40mm	5.76mm	36.72mm
	GBX-50-80	50mm	45mm	1.8	80mm	8.00mm	75.46mm
Achromat	GAD-5-15	5mm	4mm	3.3	15mm	4.00mm	13.07mm
	GAD-10-20	10mm	9mm	2.2	20mm	6.00mm	17.17mm
	GAD-25-50	25mm	22mm	2.2	50mm	11.00mm	44.37mm
ME	GMN-30-50	30mm	27mm	1.9	50mm	5.00mm	46.82mm

