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- Optimax Systems, Inc 585-265-1020

Prototype Optics in One Week

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Freeform is an optical surface with little to no symmetry.

Freeforms

Customers trust Optimax to create high-quality optics and deliver them fast, and our freeforms are no exception. Designing with freeforms requires fewer elements, lighter weight and increased flexibility for your system.

Freeform optical shapes or optical surfaces are gaining popularity with lens designers and optical system integrators. Now, there are optical fabrication processes that include generation, high-speed VIBE polishing, sub-aperture figure correction, surface smoothing and testing of freeform surfaces.

Optimax produces freeform optics from glass, fused silica, crystals and ceramics for UV, Visible and IR applications using proprietary techniques for low scatter surfaces.

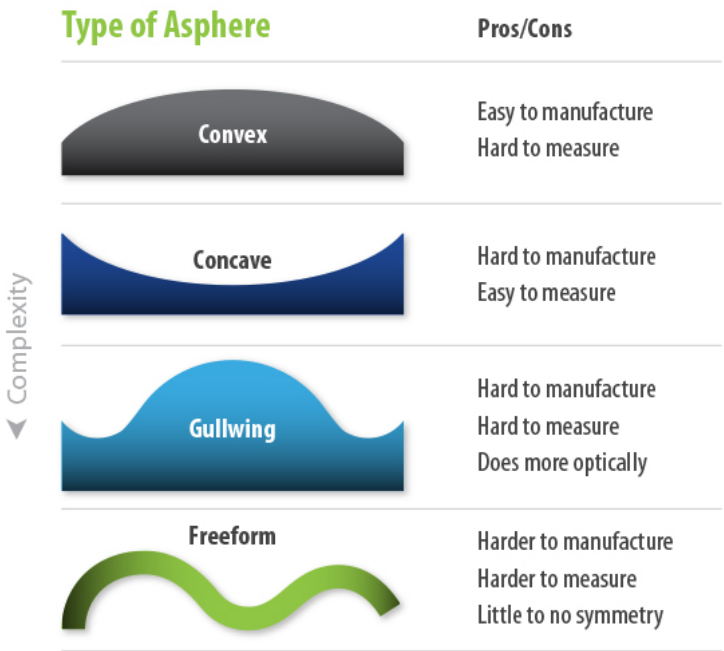
About Freeform Lens Manufacturing

Freeforms are optical shapes or optical surfaces that are designed with little to no symmetry. Manufacturing a freeform is similar to that of a highly complex asphere; surface form and local slope change are all factors that influence the complexity of the shape and the manufacturing process used.

To learn more about freeforms we invite you to visit our Resource Library and read our Technical Papers on the topic.

Specifying Freeforms

Specifying a freeform begins by defining the surface. An optical fabricator needs a clear description of the desired final optic; equation, cloud of points or a 3D model.



Manufacturing Limits for Freeform Surfaces

Optimax utilizes deterministic CNC machine tools for predictable removal rates and adherence to tight tolerances. To control centration, precision tools maintain the optical axis.

FREEFORM

COATING

ASPHERE

General Comments on Manufacturing Limits

This represents a general list of soft limits and is intended for reference only.
As requirements move closer to a min or max shown the more challenging the part will be.
Certain combinations may not be possible – Choosing Max Sag and Min Diameter on concave surfaces for example.
Interferometric testing of aspheres is extremely case specific. The slower the onset of departure, the more likely interferometric testing is possible.
During manufacturing the lens is oversized in diameter. Be aware, forms well behaved within clear aperture may turn exotic or undefined just beyond final diameter.

Manufacturing Limits for Aspheric Surfaces

Based on Form Error Tolerance

Form Error > 2µm Lower Resolution Profilometry (2-D)[1]

Attribute	Minimum	Maximum
Diameter (mm)	3	250
Local Radius (mm)	-8 (Concave)	∞
Sag (mm)	0	50[2]
Departure (mm)	0.01	20
Included Angle (°)	0	120

Form Error 0.5 – 2µm Higher Resolution Profilometry (2-D)[1]

Attribute	Minimum	Maximum
Diameter (mm)[3]	3	250
Local Radius (mm)	-12 (Concave)	∞
Sag (mm)	0	25[2]
Departure (mm)	0.01	20
Included Angle (°)	0	150

Form Error < 0.5µm Interferometry with Stitching (3-D)

Attribute	Minimum	Maximum
Diameter (mm)[3]	3	250
Local Radius (mm)	-13 (Concave)	∞
Sag (mm)	0	25[2,4]
Departure (mm)	0.002	1
Included Angle (°)	0	120+[5]

[1]Typical metrology is Zygo MetroPro plots for interferometry

[2]For concave surfaces the maximum may be smaller, limited by tool clearance first. Short radii have lower maximums

[3]Larger diameters can be accommodated using multiscan fusion

[4]Total sag allowed is a function of diameter, determined by fringe resolution of the interferometer

[5]Very basic forms (paraboloid, ellipsoid) can have higher included angles

CYLINDER

PRISM

SPHERE

Here are manufacturing limits and tolerances specific to optical aspheres, prisms, cylinders and spheres. For more detailed information on any attribute, please contact sales@optimaxsi.com.

Common Types of Freeforms

To see more Common Freeforms use the navigate arrows

Testing Freeforms

Optimax inspects 100% of all optics. Test data is provided with prototype orders.

Our metrology must match the sophistication of our manufacturing technology. Optimax offers state-of-the-art metrology, including surface profilers and interferometers to verify that parts meet the form error specification. Testing options are form specific, lenses with mild departure from a best-fit sphere have the highest potential for fractional wave precision.

Fast Delivery

Optimax manufactures a wide variety of optical components. When on-time delivery is crucial, Optimax offers an expedited delivery option with a money back guarantee.

Continued Innovation

Optimax's R&D department is continuously looking for ways to improve our fabrication process and produce higher quality optics. Our current research projects are designed to meet future market needs.

For more information please see Optimax Innovation or contact sales@optimaxsi.com.

Technical Resources

TECHNICAL PAPERS & NOTES

Integrating Optical, Mechanical and Test Software (with applications to freeform optics)

Optical systems must perform under environmental conditions including thermal and mechanical loading. To predict the performance in the field, integrated analysis combining optical and mechanical software is required. Freeform and conformal optics offer many new opportunities for optical design.

Read More

Advances in Freeform Optics Fabrication for Conformal Window and Dome Applications

Freeform optical shapes or optical surfaces that are designed with non-symmetric features are gaining popularity with lens designers and optical system integrators. This enabling technology allows for conformal sensor windows and domes that provide enhanced aerodynamic properties as well as environmental and ballistic protection. In order to provide ballistic and environmental protection, these conformal windows and domes are typically fabricated from hard ceramic materials

Read More

Conformal window manufacturing process development and demonstrations for polycrystalline materials

Conformal windows pose new and unique challenges to manufacturing due to the shape, measurement of, and requested hard polycrystalline materials. Their non-rotationally symmetric shape and high departure surfaces do not lend themselves to traditional optical fabrication processes

Read More

Metrology for the Manufacturing of Freeform Optics

Freeform optical surfaces are gaining popularity with lens designers and optical system integrators as a method to solve complex optical system design problems. Fortunately advances in optical manufacturing have opened the possibility for designers to realize these complex surfaces

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Freeform Optical manufacturing and testing processes for IR Conformal Window and Domes

Freeform optical shapes or optical surfaces that are designed with non-symmetric features are gaining popularity with lens designers and optical system integrators. This enabling technology allows for conformal sensor windows and domes that provide enhanced aerodynamic properties as well as environmental and ballistic protection. In order to provide ballistic and environmental protection, these conformal windows and domes are typically fabricated from hard ceramic materials which challenge the optical fabricator

Read More

Manufacturing and Metrology for IR Conformal Windows and Domes

Freeform and conformal optics have the potential to dramatically improve optical systems by enabling systems with fewer optical components, reduced aberrations, and improved aerodynamic performance. These optical components differ from standard components in their surface shape, typically a non-symmetric equation based definition, and material properties. Traditional grinding and polishing tools are unable to handle these freeform shapes

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Fabricating freeform multispectral-ZnS corrector lenses

For over 100 years, optical imaging systems were limited to rotationally symmetric lens elements, due to limitations in processing optics. However, the present rapid development and application of CNC machines has made fabrication of non-rotationally symmetric lenses, such as freeform surfaces, economical. The benefit of using freeform surfaces is that the lens designer has more flexibility to create innovative 3D imaging packages, while correcting for aberrations

Read More

Incorporating VIBE into precision optics manufacturing process

The VIBE™ process is a full-aperture, conformal polishing process incorporating high frequency and random motion designed to rapidly remove sub-surface damage in a VIBE pre-polish step and eliminate mid-spatial frequency (MSF) errors in a VIBE finishing step. The VIBE process has potential to be introduced in two areas of today's modern optics manufacturing process

Read More

Load more

OTHER RESOURCES

Optimax Capabilities

Freeforms Aspheres Spheres Cylinder Prisms Domes Optical Coatings Metrology

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Capabilities

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Technical Expertise

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