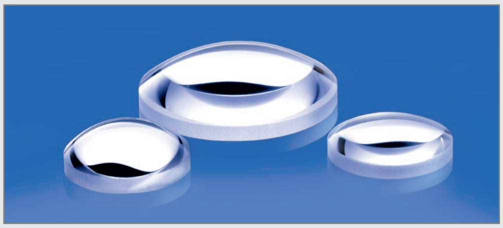
Edmund optics | america

UTILIZING ASPHERES IN OPTICAL DESIGN



Improving image quality, reducing the number of elements needed and lowering costs are all now achievable through the use of aspheres in optical design. From digital cameras and CD players to high-end microscope objectives and fluorescence microscopy, aspheres are proliferating into every facet of the optics industry due to the distinct advantages that they offer.

ABERRATIONS CORRECTION:

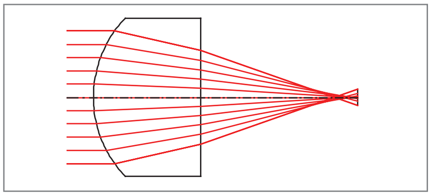


Figure 1: Plano-convex spherical lenses showing spherical aberration. Rays from the center focus at a different location than rays exiting from the edges.

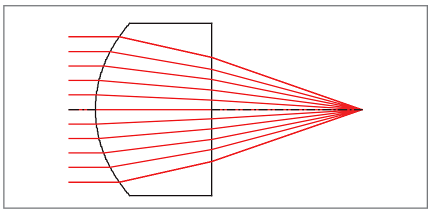


Figure 2: A single aspheric lens can correct for spherical aberration vastly reducing the focused spot size.

Spherical Aberration

Utilizing aspheres in design allows for straight-forward aberration correction. When compared to traditional spherical optics, it takes significantly fewer lenses to design out the large number of aberrations present in lens systems. A single asphere offers the same amount of correction that two or more spherical lenses can accomplish. Aspheres, by their very nature, are without the spherical aberration that is inherent in traditional Plano-Convex and Double-Convex spherical lenses (see Figures 1 and 2).

Axis Aberration

In addition to spherical aberration, aspheres are also very powerful in correcting off-axis/field dependent aberrations. This includes not only field curvature but astigmatism and distortion as well. This benefit can reduce complicated and hard to align, 10 element systems, into comparatively simple 4 or 5 lens systems that are considerably less sensitive to alignment issues. In addition to easier alignment, the size and weight of the lens system is also significantly reduced. Cutting the weight and size of a lens system in half, by using fewer elements, makes implementation easier and more practical. Using a shorter system is much more attractive to customers from both a space and mounting perspective.

BENEFITS OF ASPHERES IN DESIGN:

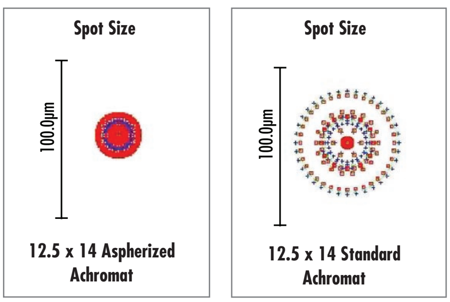
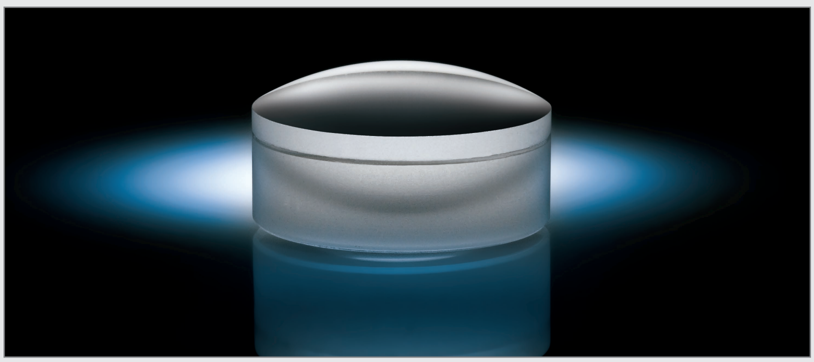


Figure 3: EO TECHSPEC® Aspherized Achromats offer reduced spot sizes when compared to standard achromats



EO TECHSPEC® Aspherized Achormats Lenses offer color correction in conjunction with an aspheric surface

Aspheres offer advantages beyond just aberration correction. Since they are able to be manufactured with higher numerical apertures (NA's) than traditional lenses, much lower F/#'s are achievable. This is especially useful in laser collimating and focusing applications. The focused spot size can be brought down to the diffraction limit, or significantly closer than a single PCX or achromatic lens (see Figure 3).

The low F/# capabilities produce lenses that provide much higher throughput through an optical system. This advantage is often utilized in fluorescence microscopy, where the amount of light is often minimal.

The high NA lenses also offer a better alternative for coupling light into fibers. Unlike ball lenses, aspheres provide NA's higher then that of the fiber without suffering from spherical aberration.

DESIGN AND MANUFACTURING

Aspheres are able to be manufactured out of a variety of materials, from glasses and plastics to crystalline materials and metals. The material chosen must be appropriate for the method with which the asphere will be created.

For high volume production, molding is the most economical method. The material used must have a low transformation temperature and coefficient of thermal expansion. This prevents the optic from changing size and shape from that of the mold. While molds are very expensive to create, they greatly lower the cost per asphere in volume production

Machine grinding an asphere is done for low to mid volume production. While time consuming, this method allows precise control and consistent results. Choosing a high index glass reduces the needed deviation from spherical, speeding up manufacturing and lowering cost.

For a small number of high precision aspheres, diamond turning is the most common method. Often used with plastics and crystals, this method has mostly been used for infrared optics, but can be used for visible optics due to the advent of magnetorheological finishing (MRF). MRF is often used to finalize the surface, immensely improving surface quality and overall accuracy.

CHOOSING THE RIGHT ASPHERE

Choosing the right asphere for your application can be based on several simple factors. For a low power, single wavelength application, a simple molded plastic asphere will suffice. A small spot size is readily attainable making molded plastic aspheres an excellent choice for use with laser diode modules.

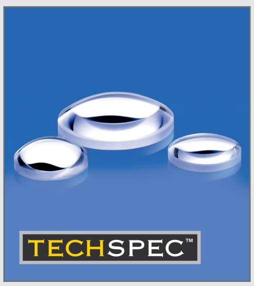
If you require the broadband color correction of an achromat in addition to the small spot size of an asphere, then our Aspherized Achromatic Lenses are the best choice. These lenses are created by molding an aspheric surface onto a glass achromat. Although this results in a lower maximum operating temperature, the substantial increase in performance makes Aspherized Achromats the perfect broadband solution for the visible spectrum. They provide a cost effective solution for lower power systems, while maintaining the high standards our Precision Glass Aspheres.

Our Precision Glass Aspheres, offered with L-BAL35 or UV Fused Silica substrates, provide diffraction limited performance and offer the most uniform performance of all our aspheres. They are completely glass, so they can withstand higher temperatures then that of plastic and cemented optics and they do not suffer from the expansion and contraction that molded aspheres experience with temperature differences. They are also the perfect solution for UV and NIR applications. Our Precision Glass Aspheres are offered both uncoated and coated for a variety of applications to fit your needs.

The advantage of using aspheric optics has been known since parabolic mirrors were first used in telescopes. Not only correcting for aberration, but improving the image quality with far fewer elements, aspheres are rapidly replacing spherical optics in lens systems used in every industry. Dramatic cost reduction and emerging technologies now allow designers to routinely specify aspheres into their designs.

AVAILABLE OFF-THE-SHELF

Aspherized Achromats



Precision Aspheric Lenses

UV Grade Fused Silica Precision Aspheres

Molded Acrylic Aspheres

Aspheric Condensers