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Manufacturing Considerations for Tolerancing Aspheres

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Spherical and aspherical lenses are produced using different polishing and grinding techniques to create the required surface geometry. Lens designers should understand these methods, ensuring tolerances and specifications are manufacturable and lead to the desired system performance without adding unnecessary expense.

As with spherical lenses, setting several tight tolerances on a single part can drastically increase costs. For example, if the designer requires a tight center thickness tolerance or a small irregularity specification, the manufacturer generally has no issue meeting specifications within its capabilities. However, if both tolerances are desired, problems meeting specifications may arise. Additional polishing time to achieve irregularity may result in sub-tolerance thickness, higher scrap rates, and more expensive lenses.

Irregularity and MSF Errors

The tolerancing differences between spherical and aspherical lenses result from the tools and methods used to grind and polish them. Spherical surfaces are generally processed using tools that cover, or nearly cover, the entire surface (Figure 1). Often times, a single large tool with a large surface area polishes multiple surfaces at once, resulting in a smooth surface with low-frequency figure errors.



Figure 1: Full aperture polishing of spherical surfaces

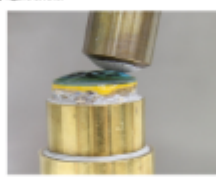


Figure 2: Sub-aperture polishing on an aspheric surface

Aspheres, due to their constantly changing local radius of curvature, are processed using sub-aperture tools that travel around the part, generally using a spiral toolpath, grinding/polishing a small portion of the lens until the entire surface is shaped (Figure 2).

Manufacturing Considerations for Tolerancing Aspheres

As aspheres become more prevalent in optical systems, it is important for lens designers to consider the various tolerances when designing an aspheric lens. The following is provided from the manufacturer's perspective on important tolerances to provide when designing an aspheric lens. Various topics discussed in this paper include irregularity and MSF errors (slope specification, maximum Zernike residual error, and spatial filtering), clear aperture, center thickness, and the dos and do nots of tolerancing aspheres.

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