APPLICATION NOTE

Aspheric Glass Condenser Lenses

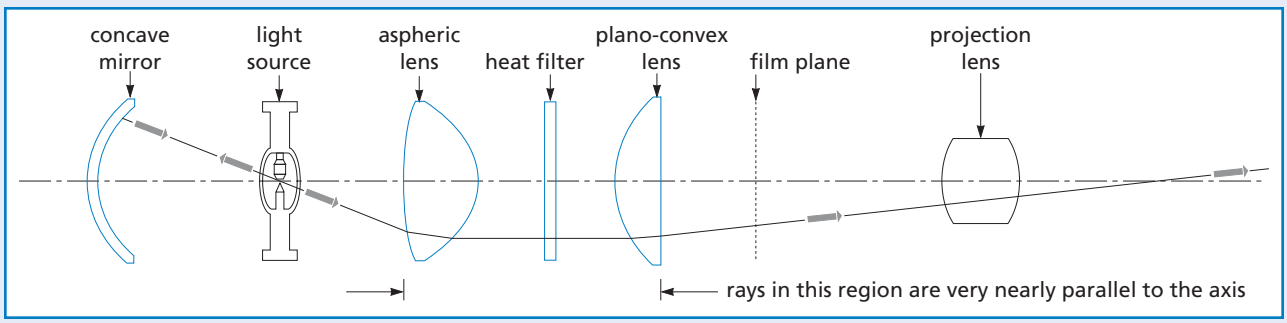
The aspheric lens is designed to have a much shorter focal length than can be attained with a spherical glass lens of equal diameter and spherical aberration. These lenses have only one aspheric surface; the other surface is either plano, spherical convex, or spherical concave. A correctly formed aspheric lens surface cancels spherical aberration, or it reduces both spherical aberration and coma to insignificance, in which case the system is said to be aplanatic. Thus, more energy can be concentrated into a smaller area, such as the entrance pupil of a projection lens system or the sensitive area of a detector. Without the aspheric surface, marginal rays (which enter or exit the lens near its edge) may be severely aberrated and fail to illuminate the desired target. The aspheric surface puts marginal rays on target and allows the potential collecting area of the system to be fully utilized at f-numbers as low as 0.6.

Aspheric lenses are ideal for low f-number, high throughput applications, particularly where elements are adjacent to the light source, as in condensing, projecting, and illuminating systems. Other applications include optical communications equipment; smoke, fire (turbulence), and intrusion alarms; pollution monitors; and chemical vapor alarms. They should be considered whenever highly efficient use of either sources or detectors is important, or whenever space is limited and short focal lengths or low f-numbers are advantageous.

The schematic drawing of a typical projection system shows an aspheric lens used in combination with a plano-convex spherical lens. The aspheric surface faces the long conjugate (in this case, away from the source), making ray deviations at two surfaces nearly equal. This minimizes reflection loss. For this orientation, the aspheric surface contour minimizes the aberration of combined aspheric and plano-convex lenses, concentrating maximum power into the projection lens entrance pupil.

Lens combination conjugate ratios can be adjusted, with aberration minimized, by changing the focal length of the spherical plano-convex element. For ratios near unity, the plano-convex lens should be replaced by a second aspheric element, oriented so that the aspheric surfaces face each other. For ratios much less than unity, the position of the aspheric and plano lenses should be interchanged.

Aspheric lenses are used in lens combinations, as shown, or alone at large or infinite conjugate ratio, for example, in a radiometer detector or in a narrow-beam spot lamp. Where sharp focus is required, plano aspherics, alone or in combination, are especially effective because they form extremely small focal spots and sharp axial imagery, even at full aperture.



Aspheric lens used in a projection system. Both lenses and the filter in the condenser are sometimes antireflection coated.