The Language Of Prisms

Brandon Light
Optimax Systems, 6367 Dean Parkway, Ontario, NY USA

This paper will explain terms unique to prism manufacturing, explaining when they are useful.

PRISMS AS A UNIQUE OPTICAL TOOL

Prisms are optical components with at least two polished plano surfaces separated by a wedge angle. These elements are used to reflect or refract light. With no spherical surfaces and a lack of an axis of symmetry, these items differ from one's conventional image of a lens. Their distinctive characteristics give rise to its own language, the language of prisms. The terms here include:

Flatness

While spherical lenses are expected to have surface curvature, the plano surfaces of a prism are not. Form error specifications for spheres typically draw a distinction between radius error and irregularity (deviation from perfect), but form error specifications for prisms can be given as flatness, combined power and irregularity. Radius errors are not expected as they are for spheres, and flatness emphasizes this. Figure 1 shows how power and irregularity combine to show flatness.

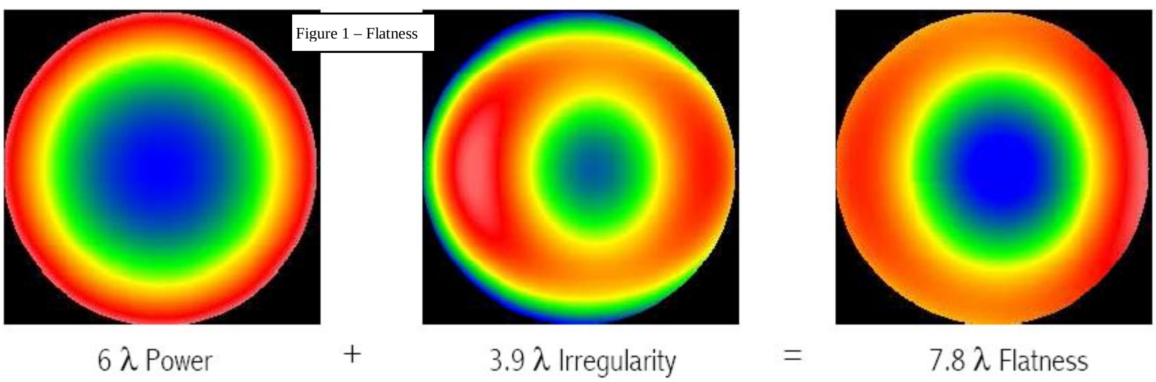

Figure 1 – Flatness

Flatness is typically measured in double-pass using a reflected wavefront, where the magnitude of the wavefront error is twice the flatness. Fringe analysis software accounts for the double-pass, dividing the value for the user[1].

Pyramidal Error

Prisms use intersecting plano surfaces to perform an optical function. The intersection is intended to occur along one axis, but fabrication errors may cause the intersection to lean a little, with intersection occurring in two axes[2]. The resulting form looks like the side of an Egyptian pyramid, giving rise to the name. Figure 2 shows the effect of increasing amounts of pyramidal error on prism geometry.

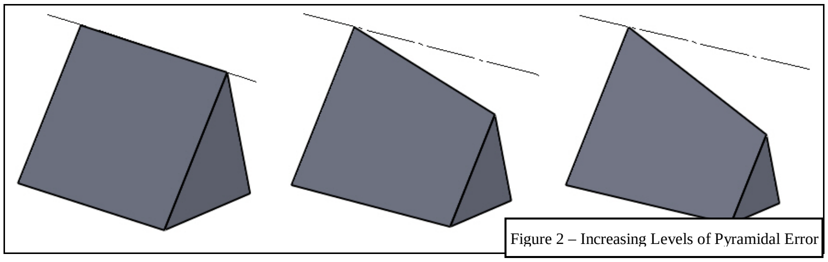

Figure 2 – Increasing Levels of Pyramidal Error

Theoretical Sharp

The plano surfaces of prisms often intersect at something other than a right angle. Applying the necessary bevel to the sharp corner will reduce the size of the two surfaces. For this reason, the mechanical dimensions of prisms are often stated “To Theoretical Sharp”, the intersection that would exist if not beveled away. Figure 3 below shows a beveled prism with length specified to a theoretical sharp with the inset showing the virtual intersection.

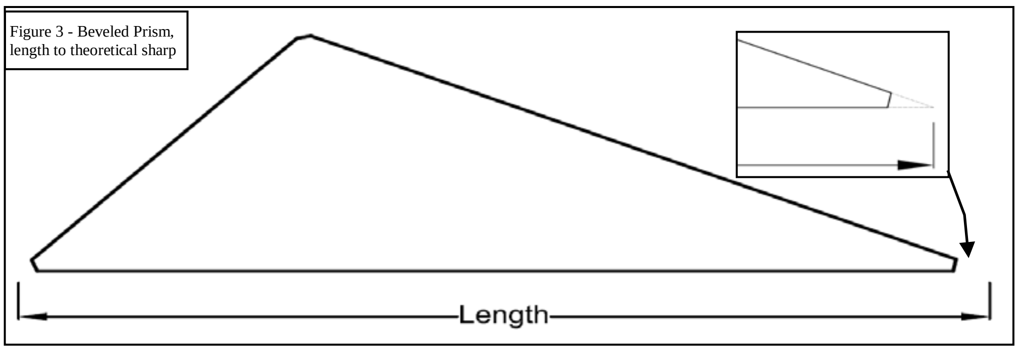

Figure 3 - Beveled Prism, length to theoretical sharp

Internal Fringes

Light striking a plano surface can transmit or reflect, and the transmitted light will continue on to the next surface, where again a portion will transmit or reflect. For parallel surfaces found in optical windows, the light transmitting through the first surface can interfere with the light reflected off the back surface, forming a fringe pattern[3] known at Optimax as internal fringes.

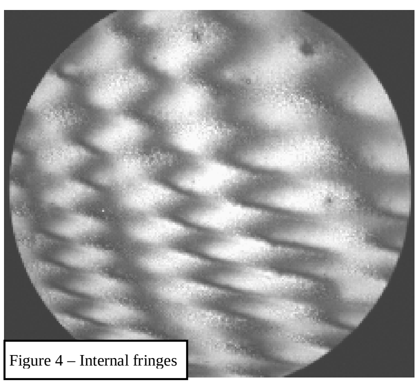

Figure 4 – Internal fringes

Also referred to as static, stationary or standing fringes, internal fringes do not move as the part is rotated or tilted, and the names used speak of immobile appearance of the fringes. While not typically an issue with prisms, it is often an issue in overall plano fabrication. Internal fringes can complicate interferometric characterization of the surface, and for this reason choosing to measure prisms and windows in transmission is often the best option. Figure 4 shows an interferogram~~s~~ of a part exhibiting internal fringes and how the measurement can be affected.

Trigonometric Terms

The language may also adopt trigonometric terms, Leg Length & Hypotenuse for example, as geometric descriptors. Cross sections are often triangular, and the similarities are quickly seen.

CONCLUSIONS

- Prisms have a distinct optical function and language.
- Key terms include Flatness, Pyramidal Error, Theoretical Sharp and Internal Fringes

- Prism language may also adopt trigonometric terms

[1] MetroPro Reference Guide OMP-0347J, Page 3-59, Zygo Corporation, Middlefield, Connecticut, 2004
[2] D. Malacara, *Optical Shop Testing*, Pg 721 - 722, John Wiley & Sons, New York City, 1992
[3] H.H. Karow, *Fabrication methods for precision optics*, Pg 602, John Wiley & Sons, New York City, 1993