Numerical Aperture
Measurement Method

CORNING
Discovering Beyond Imagination

Optical
Fiber

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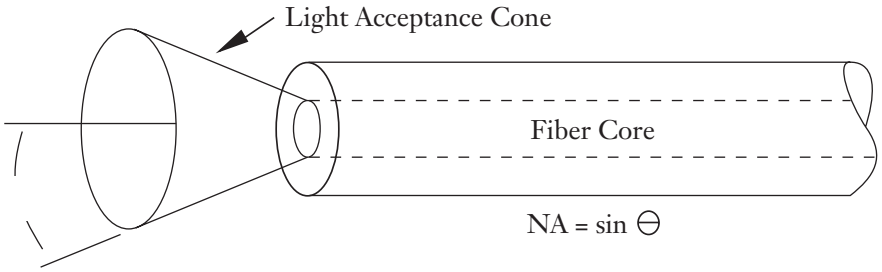
Scope

This information describes the current reference methods for measuring the numerical aperature of Corning® multimode optical fibers.

General

NA is defined as the sine of half the angle of a fiber's light acceptance cone (see Figure 1). All modes of light entering the fiber at angles less than that which correspond to the NA, will be bound or confined to the core of the fiber. The larger the NA of a fiber, the larger the light acceptance cone. NA is determined from the measurements of the far-field optical power distribution exiting from a two-meter length of fiber.

Figure 1



Measurement Description

The measurement consists of launching a narrow spectral band of light into the fiber and measuring the far-field intensity distribution emitted from the end of the fiber with the indicated optics in Figure 3. The detector and detector aperture are stepped linearly across the far-field distribution and the intensity, at a distance y from the axis of the spatial field pattern, is measured. The detector and aperture are moved linearly across a transformed spatial representation of the far field and not radially across the direct far-field. Therefore, the angular intensity is corrected by the following equation:

$$I(\Theta) = E(y) \cos \Theta$$

where: y = distance from axis of spatial-field pattern and is related to the emission angle (Θ) by:
$y = f \sin \Theta$, where f is the focal length of the transform lens

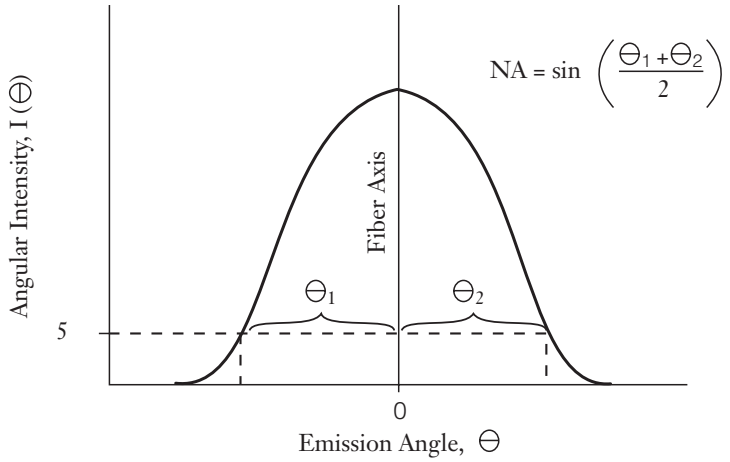
E(y) = irradiance at a distance y from the axis of the spatial-field pattern

(Θ) = angle with respect to axis of the fiber

The data are normalized to the peak angular intensity and plotted versus emission angle ( ). The spatial distance between the 5 percent intensity levels shall be noted and the sine of half the angle between the points represents the numerical aperture (see Figure 2).

Far-Field Distribution

Figure 2



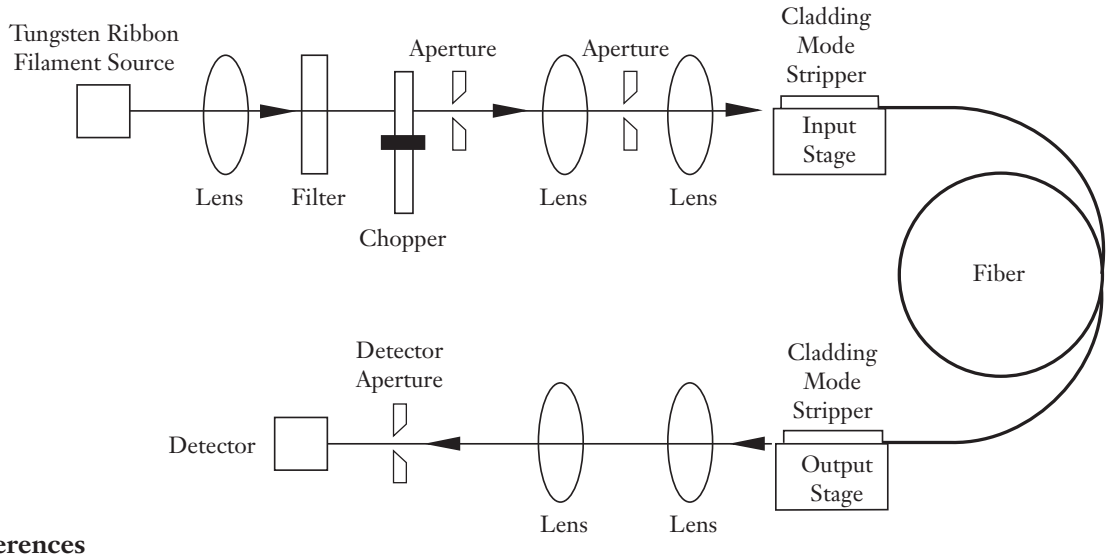
Measurement Conditions

Two meters of fiber are loosely deployed with no bends less than 36 cm radius to provide a measurement condition which will not influence the accuracy of the measurement result. The fiber ends are stripped of coating and prepared with end angles less than 2° with near perfect mirror surfaces. Mode stripping is also provided to assure the removal of cladding modes.

- Fiber Length: 2.0 ± 0.2 meters
- Launch Spot Size: ≥ 100 μm
- Launch Numerical Aperture: ≥ 0.30
- Source Spectral Width: ≤ 100 nm Full Width at Half Maximum (FWHM)
- Measurement Wavelength: 850 ± 10 nm

Apparatus to Measure NA
Figure 3

Figure 3 shows the apparatus used to determine the numerical aperture of Corning® multimode fiber.



References

EIA/TIA-455-47B (FOTP-47), Output Far-Field Radiation Pattern Measurement, Method C.

EIA/TIA-455-177A (FOTP-177), Numerical Aperture Measurement of Graded-Index Optical Fibers, Method A.

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