National Institute of Standards and Technology

Certificate

Standard Reference Material® 2523

Optical Fiber Ferrule Geometry Standard

Serial Number:

This Standard Reference Material (SRM) is intended primarily for calibrating instruments used for diameter measurements of artifacts such as optical fiber ferrules. Each SRM unit is individually calibrated and bears a unique serial number. The SRM consists of a single ceramic optical fiber ferrule with a notch etched into one end to identify the 0° plane used for positioning. The outer diameter of the ferrule has been measured in the center, parallel to the notch. The condition of the 0.126 µm hole has been preserved. The roundness data in figure 1 have been included for information in future measurement applications or for measurement equipment where the roundness of the artifact is an important consideration.

Certified Outer Diameter (for the central 2 mm region)

mm ± 0.000 050 mm

Expiration of Certification: The certification of this SRM is valid indefinitely within the measurement uncertainties specified, provided the SRM is used in accordance with the Instructions for Use and Handling and Care sections of this certificate. The SRM may wear with repeated use. If excessive wear is suspected, the SRM may be returned to NIST for verification. To verify certification of this SRM 2523 unit, contact the NIST Calibration Program Office at (301) 975-2002.

Discussion of Uncertainties: Uncertainties were calculated according to the procedures described in reference [1]. Readily measured (Type A) uncertainties were assumed to be normally distributed. Estimated (Type B) uncertainties were assumed to be described by a rectangular probability distribution function and uncorrelated. The uncertainties were combined by adding their variances, where the variance of a rectangular distribution is one-third the square of its half-width. Table 1 lists all identifiable sources of uncertainty.

The ferrules used for SRM 2523 were donated by the Coors Ceramics Company, Electronic Products Group, Golden, CO.

The technical direction, measurement process development and analysis, and physical measurements leading to certification of this SRM were provided by J.R. Stoup and T.D. Doiron of the NIST Precision Engineering Division, and M. Young of the NIST Optoelectronics Division.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by R.J. Gettings.

Gaithersburg, MD 20899
Certificate Issue Date: 15 August 1997

Thomas E. Gills, Chief
Standard Reference Materials Program

Instructions for Use: Use of this SRM is relatively straightforward; it can be used to set comparator type instruments or to calibrate absolute measuring instruments. The SRM should be used within the central 2 mm region that defines the certified area. Measurements should be made radially within five degrees of the location of the notch. To extend the life of the SRM, measurements should be made randomly within this certified area. Repeated use of the exact same position on the ferrule is not recommended as it will cause wear at this position and will not correctly sample the variations in diameter of the ferrule in the resulting measurements.

CAUTION: The use of measurement forces exceeding 1.1 N (4 oz) may induce an uncorrected compression of the ferrule due to the existence of the 0.126 µm diameter hole through the center of the ferrule. At lower forces, the ferrule behaves as a solid artifact and the resulting deformation can be calculated from standard deformation formulas outlined in reference [2]. This SRM should not be subjected to measurement configurations that may result in application of large instantaneous forces exceeding 2.2 N or permanent damage may result.

Handling and Care: Handle the SRM carefully. Take care when moving the ferrule around the laboratory and positioning it in the test equipment to avoid losing it or mistaking it for a common test ferrule. The notched end face has been intentionally left unbeveled to aid in the identification of the SRM.

Follow standard laboratory practice to extend the life of the ferrule and to maintain the integrity of the results. Clean the ferrule carefully with ethanol, isopropyl alcohol or acetone before each use. Lightly blow the ferrule dry with compressed air, and allow to thermalize before use. Reclean and store the SRM in the supplied case when not in use. Keep the case in a clean laboratory environment or inside a dust-free plastic bag.

Certification of Ferrule Diameter: The outer diameter of each SRM was measured using a micrometer combined with a laser displacement interferometer. Multiple diameter measurements were made in the center of each ferrule in the plane defined by the notch and the center line of the ferrule. This measurement was repeated at various measurement forces and the final undeformed diameter was determined by projecting the total results to zero force. These measurements sampled only the effects of taper in the central 2 mm and did not sample the effects of roundness. No attempt was made to locate the maximum or minimum diameter positions on each ferrule.

Table 1. Uncertainty Budget

Source of Uncertainty	Analysis Method (L = length = 2.5 mm)	1 σ Equivalent Value (in nm)
Ferrule Geometry: central 2 mm	rect. dist of data	14.4
central 5 mm	rect. dist. of data	28.8
Elastic Deformation Correction	slope analysis	5.8
Laser Wavelength	2×10^{-8} m	<0.1
Index of Refraction of Air	uncertainty of calculation	0.1
Air Temperature Measurement	± 0.05 °C	0.1
Air Pressure Measurement	± 10 Pa	0.7
Vapor Pressure Measurement	± 5 %	<0.1
Instrument Motion Error	$(0.5 \times 10^{-6})(L)$	1.3
Abbe Offset	1 mm x <0.1"	0.5
Micrometer Contact Geometry	rect. dist. of contact form errors	11.5
Thermal Expansion Uncertainty	$[(0.5 \times 10^{-6})(0.1\ °C)(L)] = 0.05 \times 10^{-6}$ (L)	0.1
Temperature Measurement of Part	(CTE)(± 0.05 °C)(L)	1.3
Thermometer Calibration	rect. dist. of 0.02 °C range	0.1
Combined Standard Uncertainty	u_c (central 2 mm)	19.4
Combined Standard Uncertainty	u_c (central 5 mm)	31.6
Expanded Uncertainty	$k = 2$ (central 2 mm)	39
Expanded Uncertainty	$k = 2$ (central 5 mm)	63

REFERENCES

[1] Taylor, B.N. and Kuyatt, C.E.,"Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," NIST Technical Note 1297, U.S Government Printing Office, Washington DC, (1994).

[2] Puttock, M.J. and Thwaite, E.G., Elastic Compression of Spheres and Cylinders at Point and Line Contact, CSIRO, National Standards Laboratory Technical Paper No. 25, (1969).

It is the responsibility of users of this SRM to assure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: Phone: (301) 975-6776 (select "Certificates"), Fax: (301) 926-4751, e-mail: srminfo@nist.gov, or WWW: http://ts.nist.gov/srm.