



# National Institute of Standards & Technology

## Certificate of Analysis

### Standard Reference Material® 1920a

#### Near Infrared Reflectance Wavelength Standard from 740 nm to 2000 nm

This Standard Reference Material (SRM) is intended primarily for use in establishing the accuracy of the wavelength scale of reflectance spectrophotometers or reflectometers using hemispherical geometry in the spectral range from 740 nm to 2000 nm. SRM 1920a is a mixture of three rare earth oxides, dysprosium oxide ( $\text{Dy}_2\text{O}_3$ ), erbium oxide ( $\text{Er}_2\text{O}_3$ ), and holmium oxide ( $\text{Ho}_2\text{O}_3$ ), that has been pressed into a cavity and sealed behind an infrared-transmitting window. The outer dimensions of the black anodized aluminum holder are 51 mm in diameter by 12 mm in height. Its interior design consists of a cavity 30 mm in diameter by 6 mm in depth, a sapphire window, and a retaining ring (see Figure 1). The reflectance spectrum of SRM 1920a is illustrated in Figure 2.

**Certified Reflectance Values:** The SRM was measured at NIST on a high precision spectrophotometer. The certified wavelengths of minimum reflectance are given in Table 1 for spectral bandwidths of 2 nm, 3 nm, 4 nm, 5 nm, and 10 nm for each of the reflectance bands. The wavelengths of the lines listed in Table 1 are certified with an expanded uncertainty of 1 nm (coverage factor  $k = 2$ ), calculated in accordance with the ISO and NIST Guides [1].

**Expiration of Certification:** The certification of this SRM is valid indefinitely within the uncertainty specified, provided the SRM is handled and stored in accordance with the instructions given and the sealed cavity containing the pressed rare earth oxides has not been opened or compromised. However, certification becomes invalid if the SRM is damaged or contaminated.

**Maintenance of Certification:** NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification, NIST will notify the purchaser. Registration (see attached sheet) will facilitate notification.

The overall direction and coordination of the technical measurements leading to certification were performed under the direction of R.D. Saunders of the NIST Optical Technology Division.

The technical measurements leading to certification were performed by P.Y. Barnes of the NIST Optical Technology Division.

The initial research and development of this SRM were conducted by V.R. Weidner, P.Y. Barnes, and K.L. Eckerle at the NIST Optical Technology Division [2,3].

The support aspects involved in the issuance of this SRM were coordinated through the NIST Measurement Services Division.

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Optical Technical Division

Robert L. Watters, Jr., Chief  
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Gaithersburg, MD 20899  
Certificate Issue Date: 02 February 2006  
*See Certificate Revision History on Last Page*

## NOTICE AND WARNING TO USER

**Storage:** SRM 1920a is fragile and must be handled with care so that nothing touches the sapphire window. When not in use, the SRM should be stored in its original container.

**Handling:** Improper handling of SRM 1920a will cause contamination that cannot be removed without adversely affecting the standard. The SRM cannot be restored to its original condition by cleaning. All fingers/thumbs must be covered with a lint-free glove or finger cots (nylon or latex), to prevent fingerprints on the sapphire window surface. It is strongly recommended that a facemask be worn to prevent contaminating the SRM with vapors or particles from the mouth or nose. Extreme care must be exercised when removing dust from the SRM. Gently use a very clean air bulb so that a static electrical charge is not produced.

## INSTRUCTIONS FOR USE

To calibrate an instrument's reflectance (radiometric) scale, place SRM 1920a securely against the sample port, select the desired instrument parameters, scan the band(s) of interest, and then determine the wavelength of minimum reflectance for each band. Evaluate and compare the results to the certified values in Table 1.

## PREPARATION AND CERTIFICATION MEASUREMENTS<sup>1</sup>

**Source and Preparation of Material:** This SRM was fabricated by the NIST Optical Technology Division from rare earth oxides supplied by Research Chemicals, a Division of NUCOR Corporation, (Phoenix, AZ). The three rare earth oxides were mixed in equal parts by mass [2]. The purity of each oxide was indicated by the manufacturer to be 99.999 %. The specimens are identified by lot numbers Er-0-4-039 for erbium oxide, Ho-0-4-015 for holmium oxide, and Dy-0-4-019 for dysprosium oxide.

**NIST Determination of Spectral Reflectance:** A high precision spectrophotometer, Varian Cary 5E, was used to calibrate SRM 1920a. Measurements were made over the wavelength range 740 nm through 2010 nm using 6°/hemispherical geometry. In this configuration, the measurement direction was 6° from the normal of the diffuser. The reflectometer uses a tungsten-halogen source in conjunction with a photomultiplier detector over the spectral range from 740 nm to 800 nm and a tungsten-halogen source in conjunction with a lead sulfide detector over the spectral range from 800 nm to 2010 nm.

Wavelength calibration consisted of comparing the wavelength indicated by the monochromator to the corresponding true wavelength from the emission line of spectral line source.

The laboratory environment was maintained at a temperature of 20 °C ± 0.6 °C with a relative humidity of 40 % ± 10 %.

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<sup>1</sup>Certain commercial materials and equipment are identified in order to adequately specify the experimental procedure. Such identification does not imply a recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment are necessarily the best available for this purpose.

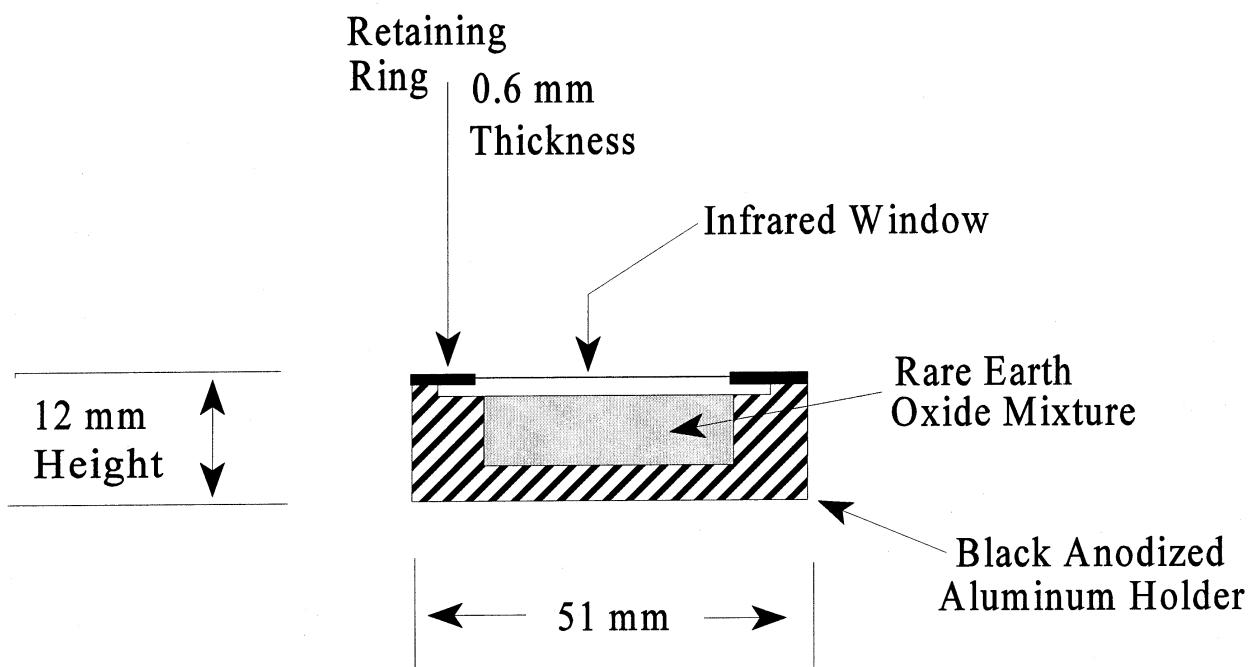


Figure 1. Cross-Section of SRM 1920a Holder

**SRM 1920a NIR Wavelength Standard**

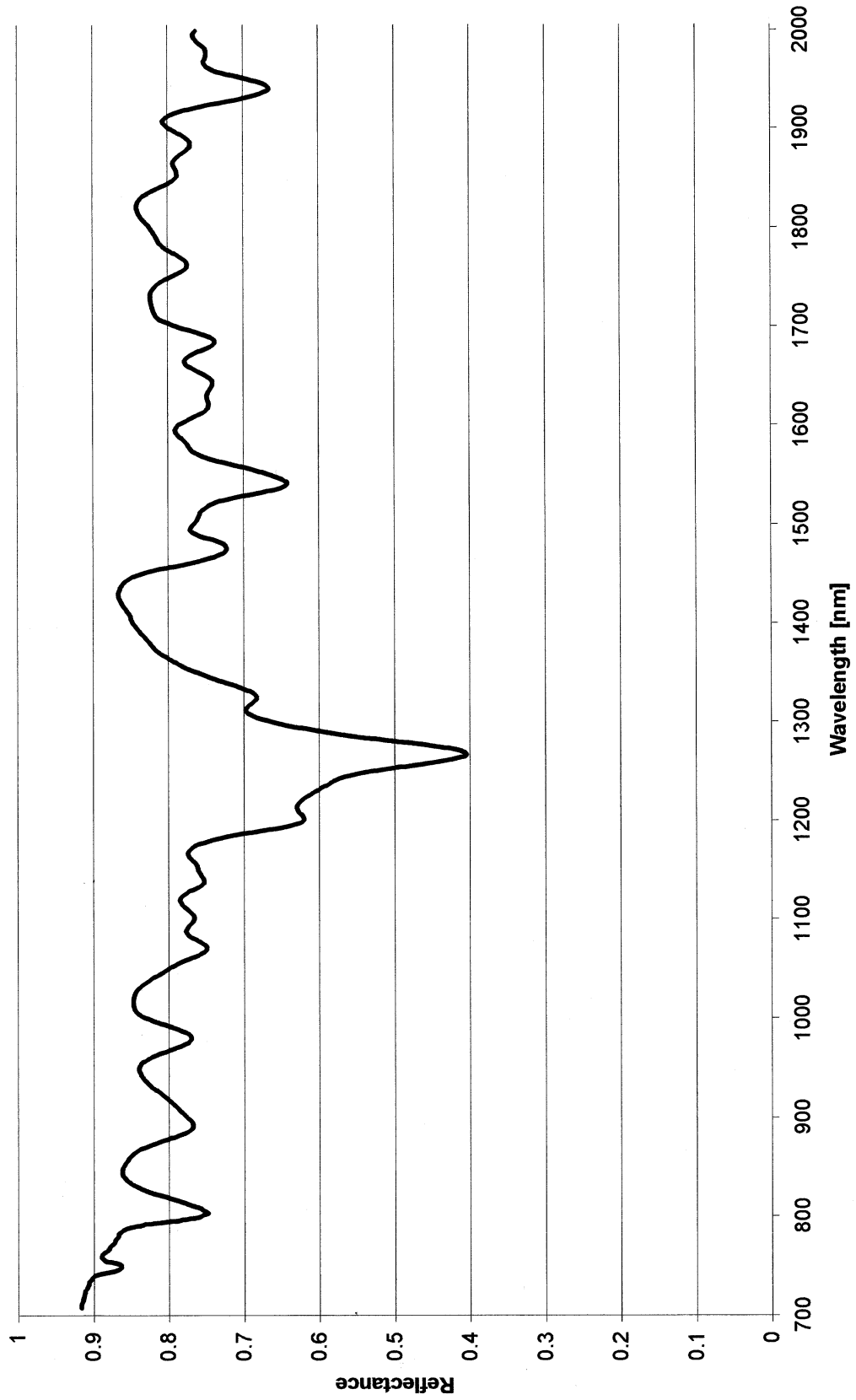


Figure 2. Reflectance Spectrum of SRM 1920a

Table 1. SRM 1920a Reflectance Minima for Spectral Bandwidths (SBW) of 2, 3, 4, 5, and 10 nm

Rare Earth Oxide	Band Number	SBW 2 nm	SBW 3 nm	SBW 4 nm	SBW 5 nm	SBW 10 nm
Dy <sub>2</sub> O <sub>3</sub>	1	---	743.0	743.4	743.4	---
"	2 <sup>2</sup>	---	799.0	799.0	798.6	798.0
"	3 <sup>2</sup>	887.2	886.9	886.7	886.7	886.5
"	4	906.3	906.8	907.5	907.3	---
Er <sub>2</sub> O <sub>3</sub>	5	970.6	971.3	971.6	971.6	---
"	6	979.6	980.8	980.8	980.8	---
"	7	1012.9	1013.2	1012.9	1012.8	---
Dy <sub>2</sub> O <sub>3</sub>	8	1064.7	1065.0	1065.0	1064.9	---
"	9	1095.6	1096.0	1096.2	1096.4	---
Ho <sub>2</sub> O <sub>3</sub>	10	1132.2	1132.3	1132.4	1132.9	1132.9
"	11	1148.1	1148.4	1148.5	1148.7	1148.6
Dy <sub>2</sub> O <sub>3</sub>	12	1192.9	1192.7	1192.9	1192.9	---
"	13	1230.2	1230.2	1230.2	1230.3	---
"	14	1261.0	1260.9	1260.8	1260.8	1261.8
"	15	1320.7	1320.7	1320.8	1320.7	1320.2
Er <sub>2</sub> O <sub>3</sub>	16	1456.2	1456.4	1456.7	---	---
"	17	1461.7	1461.9	1462.2	---	---
"	18	1471.2	1471.6	1471.6	---	---
"	19	1477.4	1477.6	1477.5	---	---
"	20	1494.8	1494.9	1495.0	1495.0	---
"	21	1503.4	1503.5	1503.5	---	---
"	22	1516.0	1516.0	1515.9	1515.7	--
"	23 <sup>2</sup>	1535.5	1535.6	1535.6	1535.4	1534.6
"	24	1544.7	---	---	---	---
"	25	1548.1	---	---	---	---
"	26	1555.1	1555.0	1554.8	---	---
"	27	1577.1	1577.2	1577.2	---	---
Dy <sub>2</sub> O <sub>3</sub>	28	1611.8	1611.7	1611.7	1611.9	---
"	29	1642.7	1642.7	1642.5	1642.5	---
"	30 <sup>2</sup>	1682.6	1682.3	1682.2	1682.2	1681.4
"	31 <sup>2</sup>	1757.6	1757.8	1757.9	1757.8	1757.6
Ho <sub>2</sub> O <sub>3</sub>	32 <sup>2</sup>	1847.5	1847.3	1846.9	1847.0	1847.3
"	33	1874.3	1874.0	1873.8	1874.0	---
"	34	1885.0	1885.3	1885.7	1885.5	---
"	35 <sup>2</sup>	1930.9	1931.6	1932.2	1932.5	1935.5
"	36 <sup>2</sup>	---	1970.6	1970.7	1970.8	1970.8
"	37	---	2004.5	2005.9	2005.8	2006.3

**NOTE:** The uncertainty in the wavelengths of minimum reflectance is no greater than 1 nm.

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<sup>2</sup> preferential bands

## REFERENCES

- [1] ISO; *Guide to the Expression of Uncertainty in Measurement*, ISBN 92-67-10188-9, 1st ed. International Organization for Standardization: Geneva, Switzerland (1993); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of the NIST Measurement Results*; NIST Technical Note 1297, U.S. Government Printing Office: Washington, DC (1994); available at <http://physics.nist.gov/Pubs/>.
- [2] Weidner, V.R.; Barnes, P.Y.; Eckerle, K.L.; *A Wavelength Standard for the Near Infrared Based on the Reflectance of Rare-Earth Oxides*; NBS Journal of Research, Vol. 91, No. 5, pp. 243–253 (September-October 1986).
- [3] Barnes, P.Y.; Early, E.A.; Parr, A.C.; NIST Measurement Services: *Spectral Reflectance*; NIST Special Publication 250-48; U.S. Government Printing Office: Washington, DC (1998); Weidner, V.R.; Hsia, J.J.; NBS Measurement Services: *Spectral Reflectance*; NBS Special Publication 250-8; U.S. Government Printing Office: Washington, DC (1987).

**Certificate Revision History:** 02 February 2006 (This revision reflects an editorial change); 20 February 2004 (Certification extended and editorial changes); 22 February 2001 (Revision to extend expiration date); 17 May 1999 (This revision reflects corrections in Table 1 values); 6 February 1998 (Original certificate date).

*Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-6776; fax (301) 926-4751; e-mail [srminfo@nist.gov](mailto:srminfo@nist.gov); or via the Internet at <http://www.nist.gov/srm>.*