National Institute of Standards & Technology

Certificate

Standard Reference Material 2030a

Glass Filter for Transmittance Measurement

This Standard Reference Material (SRM) is intended for use in the one-point verification of the transmittance and absorbance scales of spectrophotometers at the given wavelength and measured transmittance. It consists of one glass filter in its holder and one empty filter holder. The exposed surface of the glass is approximately 29 x 8 mm, measuring from a point 1.5 mm above the base of the filter holder (see figure 1). The filter bears an identification number. For protection, the metal holder is provided with two shutters that should be removed during measurements.

Certified Transmittance Values: The certified transmittance value at a wavelength of 465.0 nm and for a maximum spectral bandpass of 2.7 nm is given in Table 1. The relative uncertainty of the certified transmittance value is $\pm$ 0.5% at 21 $\pm$ 2 °C for a period of two years from the date of certification specified in Table 1. This uncertainty includes the effects of the random and systematic errors of the calibration procedure, as well as estimated systematic errors associated with alignment of the filter and material properties (e.g., aging of the glass which may cause some filters to change transmittance by about + 0.25% over the two-year period). Uncertainty estimation is described in the NIST Special Publication 260-116. [1]

Transmittance Density: The transmittance density given in Table 1 is calculated from the certified transmittance (T) as $-\log_{10} T$. This value should be indicated by the absorbance (A) scale of the spectrophotometer if the filter is measured against air. The overall uncertainty in transmittance density is $\pm$ 0.002 absorbance units (AU) for a period of two years from the date of certification in Table 1.

The research, development, and initial production of this SRM were conducted in the NIST Inorganic Analytical Research Division by R. Mavrodineanu and J.R. Baldwin.

The transmittance measurements were performed in the NIST Inorganic Analytical Research Division by J.C. Travis, M.V. Smith, and N.K. Winchester.

The overall direction and coordination of technical measurements leading to certification were performed in the NIST Inorganic Analytical Research Division by J.C. Travis and R.L. Watters, Jr.

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

Gaithersburg, MD 20899
October 18, 1993
(Revision of certificate dated 8-11-93)

Thomas E. Gills, Acting Chief
Standard Reference Materials Program

(over)

NOTICE AND WARNING TO USERS

Storage and Handling: SRM 2030a is stored in a black anodized aluminum container fitted with a threaded cap made of the same metal. Contamination of the glass surface with particulate matter due to static charge is minimized by the metallic nature of the container. The filter is placed in a cylindrical cavity to prevent any contact between the filter face and the walls of the storage container. The filter holder is provided with a flat leaf spring which is inserted into the cylindrical cavity to minimize damage during transportation. This spring can be removed during normal use in the laboratory. Improper storage or handling of the filter may cause changes in the transmittance. [1] It is recommended that the filter in the holder be handled only by the edges with soft plastic (polyethylene) gloves and optical lens tissue. When not in use it should be stored in the holder and in the container provided for this purpose. Extended exposure to laboratory atmosphere and dusty surroundings should be avoided. Should the surface of the glass filter become contaminated, no attempt should be made to clean it unless the user has the facilities to demonstrate that the cleaning treatment has not altered the glass surface or compromised the certified values. As this SRM is a transfer standard, the only means available to verify its integrity is by remeasuring its transmittance with a primary standard instrument similar to that used in this certification. [2,4]

Expiration of Certification: This certification is valid for 2 years from the date of certification specified in Table 1.

Recalibration: The filter should be returned to NIST for cleaning and recalibration at two-year intervals to revalidate the filter. For recalibration, please contact M.V. Smith at (301) 975-4115 or N.K. Winchester at (301) 975-3152. SRM 2030a should be shipped for recalibration to M.V. Smith, NIST, Bldg. 222, Rm. B222, Gaithersburg, MD 20899.

Instrument Dependence Warning: Some samples of SRM 2030a may cause a small (<0.02 AU) increase in the apparent absorbance, resulting from a minor deviation of the optical axis, in instruments for which wavelength dispersion occurs after the light has passed through the filter. If such effects are detected or suspected, the user should contact J.C. Travis, NIST Inorganic Analytical Research Division at (301) 975-4117, for assistance and instructions.

Source and Preparation of Material: The neutral glass for the filter was provided by Schott of Mainz, Germany, and is designated as "Jena Color and Filter Glass." Glass material of type NG-5 was selected for best homogeneity and a minimum of inclusions and striae. The filter was cut from a plate which was ground and polished in the NIST optical shop to an appropriate thickness to achieve the nominal transmittance of 0.3. [1,5] Prior to certification measurements, the glass filter was aged at NIST for at least six months and was examined for surface defects and thoroughly cleaned. [1]

Determination of Transmittances: The transmittance measurements were made against air (an empty filter holder) at an ambient temperature of 21.0 ± 1.0 °C using the high-accuracy spectrophotometer designed and built in the NIST Inorganic Analytical Research Division. [2] This instrument represents the primary transmittance standard; its transmittance accuracy was established using the double-aperture method of linearity testing. [1,2,6,7] The effective spectral bandpass used to determine the certified values was 0.8 nm. The transmittance measurements were made by producing the vertical image of the slit (about 8 mm by 1 mm), using a convergent beam geometry with an aperture ratio f:10, in the middle of the entrance face of the glass filter. The filter is mounted in a multiple-filter carousel in the spectrophotometer. Each transmittance value reported in Table 1 is the average of three transmittances determined over an eight-min period required for three carousel rotations. The transmittance is measured in this way several times during an aging period of at least six months, and only the final measurement is reported. Each transmittance measurement is calculated from a measurement of the intensity transmitted through the filter and bracketing measurements of the intensity transmitted through an empty filter holder, with a settling time of approximately 5 s and a signal integrating time of approximately 1 s for each measurement. The filter was measured in the spectrophotometer in a position perpendicular to the incident light beam as shown in figure 1.

Uniformity: The transmittance uniformity of the filter comprising SRM 2030a was established over an area 5 mm wide by 24 mm long and located symmetrically about the center face of each filter. The transmittance was required to vary by less than the estimated systematic error component for uniformity of 0.3%, relative, over the specified area.

Instructions for Use: The transmittance of the filter depends upon the intrinsic properties of the material, wavelength, spectral bandpass, geometry of the optical beam, and can be affected by other factors such as stray light, temperature, and positioning of the filter. A change of ambient temperature of $\pm$ 2 °C from 21.0 °C will not significantly affect the calibration. [1] Changes in the transmittance may be caused by changes in surface conditions, aging of the glass, exposure to a harmful atmosphere or careless handling as indicated under "Storage and Handling". [1,3,5,6] The spectral bandpass value indicated in this certificate is a maximum value that should not be exceeded when accurate measurements are contemplated. The empty filter-holder is provided to be used in the reference beam of the spectrophotometer so that approximately equivalent conditions of stray radiation are achieved for both beams. The shutters provided with the filter must be removed at the time of measurement and be replaced after the measurements have been completed. Measurements performed outside of the specified conditions, and the optical geometry described under "Determination of Transmittance", will produce transmittance values that might differ from the certified data.

The cooperation of G.N. Bowers, Jr., M.D., of Hartford Hospital, Hartford, CT; R.N. Rand, Ph.D., of the Eastman Kodak Co., Research Laboratories, Rochester, NY; D.S. Young, M.D. and Ph.D., of the Mayo Clinic, Rochester, MN; and B. Mueller, Ph.D., of Hewlett-Packard GmbH, Waldbronn, Germany, are gratefully acknowledged.

REFERENCES

[1] Mavrodineanu, R., et al., Glass Filters as a Standard Reference Material for Spectrophotometry - Selection, Preparation, Certification, and Use, SRM 930 and SRM 1930, NIST Spec. Publ. 260-116, (1993).

[2] Mavrodineanu, R., An Accurate Spectrophotometer for Measuring the Transmittance of Solid and Liquid Materials, NBS Journal of Research 76A, No. 5, pp. 405-425, (1972).

[3] Collected Papers from NBS Conference on Accuracy in Spectrophotometry and Luminescence Measurements, NBS Journal of Research 76A, No. 5, pp. 375-510, (1972).

[4] Burke, R.W., and Mavrodineanu, R., Accuracy in Analytical Spectrophotometry, NBS Special Pub. 260-81, (1983).

[5] Mavrodineanu, R., Solid Materials to Check the Photometric Scale of Spectrophotometers, NBS Tech. Note 544, Menis, O., and Shultz, J.I., eds., pp. 6-17, (Sept. 1970); ibid, NBS Tech. Note 584, pp. 2-21, (December 1971).

[6] Gibson, K.D., Spectrophotometry, NBS Circ. 484, (Sept. 1949).

[7] Mielenz, K.D., and Eckerle, K.L., Spectrophotometer Linearity Testing Using the Double-Aperture Method, Appl. Optics 11, pp. 2294-2303, (1972).

Figure 1. Metal Holder for the Colored Glass Filter