National Institute of Standards & Technology

Certificate

Standard Reference Material® 717a

Borosilicate Glass

This Standard Reference Material (SRM) is intended primarily to check test methods and to calibrate equipment for the determination of the viscosity of glass in accordance with ASTM Procedure C 965-81 [1]. A unit of SRM 717a consists of a borosilicate glass block with nominal dimensions: 40 mm x 40 mm x 150 mm, and a nominal mass of 570 g.

The certified viscosity values as a function of temperature were obtained from the results of seven cooperating laboratories, used to calculate a consensus fit of the Fulcher equation as follows:

$$\log_{10} [\text{viscosity (Pa·s)}] = -2.5602 + 4852.2/(t - 192.462)$$

where t is the temperature expressed in °C.

Expiration of Certification: This SRM has an indefinite room temperature shelf life. The certification of this SRM is deemed to be indefinite, provided the SRM is handled in accordance with information provided under the Cautions to User section. However, the certification will be nullified if the SRM is remelted, contaminated, or otherwise modified.

Cautions to User: This SRM, like many borosilicates, is susceptible to volatilization at high temperature, especially above 1400 °C. Care should be taken to ensure that the SRM not be exposed for prolonged periods of time to temperatures near or above 1400 °C since there may be some time dependence to the volatilization. Experience has shown that volatilization will also occur with repeated remelting of the glass, remelting will invalidate the certification.

The glass for this SRM was obtained from Corning Inc., Corning, NY. The interlaboratory measurements leading to certification were performed under the auspices of ASTM Subcommittees C14.04 on Physical and Mechanical Properties of Glass and C14.91 on Glass Reference Materials.

Technical coordination of the certification of this SRM was performed by M.J. Cellarosi of the NIST Ceramics Division with the support of A.E. Siefert, ASTM C14.91 Research Associate.

Statistical evaluation was performed by L.M. Gill of the NIST Statistical Engineering Division.

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

Gaithersburg, MD 20899
Certificate Issue Date: September 18, 1996
(Revision of certificate dated 8-7-95)

Thomas E. Gills, Chief
Standard Reference Materials Program

From the consensus fit of the Fulcher equation on page 1, the certified viscosity values versus temperature were calculated and are listed below in Table 1. The certified uncertainties are the 95 % simultaneous confidence intervals for the Fulcher equation. Noncertified viscosity values for the temperature range of 834 °C to 540 °C and borosilicate glass fixpoint temperatures are given for information only in Tables 2 and 3.

Table 1. Certified Viscosity

$\log_{10}$ [viscosity (Pa·s)][a]	Temperature (°C)
1.00 ± 0.06	1555
1.25 ± 0.06	1466
1.50 ± 0.07	1388
1.75 ± 0.08	1318
2.00 ± 0.10	1256
2.25 ± 0.11	1201
2.50 ± 0.12	1151
2.75 ± 0.13	1106
3.00 ± 0.14	1065
3.25 ± 0.14	1028
3.50 ± 0.15	993
3.75 ± 0.15	961
4.00 ± 0.16	932
4.25 ± 0.16	905
4.50 ± 0.17	880

[a]The SI unit for viscosity is Pa·s [2]. To convert to poise from Pa·s multiply by ten. The viscosity in Table 1 is expressed in the customary manner as $\log_{10}$ viscosity. If $\log_{10}$ [viscosity (Pa·s)] = 1.0 ± 0.06 then $\log_{10}$ [viscosity (poise)] = 2.0 ± 0.06.

INFORMATION VALUES

The following laboratory data provided by one of the round robin participants is given for information purposes and is not certified. Fulcher fit of beam bending [3] and parallel plate viscometry [4] data using a 5 °C/min heating rate for the range 1 x 10^{11} Pa·s through 1 x 10^{5} Pa·s was:

$$\log_{10} [\text{viscosity (Pa·s)}] = -3.012 + 5495.3/(t\text{-}148.1)$$

From the fit to that laboratory data, the following viscosity values were calculated:

Table 2. Noncertified Viscosity

$\log_{10}$ [viscosity (Pa·s)]	Temperature (°C)
5	834
6	758
7	697
8	647
9	606
10	570
11	540

The fixpoint temperatures as measured by ASTM Test Methods C 336 [5], C 338 [6], and C 598 [7] are:

Table 3. Fixpoint

Fixpoint	Temperature (°C)
Softening Point	719 ± 5
Annealing Point	513 ± 6
Strain Point	470 ± 9

The uncertainties given for the fixpoint temperatures are the 95 % confidence intervals of the interlaboratory mean temperatures.

Table 4. Glass Nominal Composition

Element	Mass Fraction (%)
SiO_2	68.0
B_2O_3	18.5
K_2O	8.0
Na_2O	1.0
Al_2O_3	3.5
Li_2O	1.0

Index of Refraction N_D = 1.487

Cooperating Laboratories:

Corning Inc., Corning, NY
Ferro Corp., Independence, OH
Monarch Analytical Laboratories Inc., Toledo, OH
OSRAM/Sylvania Inc., Danvers, MA
Owens Corning Fiberglass, Granville, OH
PPG Industries Inc., Pittsburgh, PA
Schuller Corp., Littleton, CO

REFERENCES

[1] ASTM Standard C 965-81, "Standard Practice for Measurement of Viscosity of Glass Above the Softening Point," Annual Book of ASTM Standards, Vol. 15.02, ASTM, Philadelphia, PA, (1990).

[2] Taylor, B.N., Guide for the Use of the International System of Units (SI), NIST Special Publication 811, 1995 Ed., (April 1995).

[3] Hagy, H.E., "Experimental Evaluation of Beam-Bending Method of Determining Glass Viscosities in the Range 10^8 to 10^{15} Poise," J. Am. Ceram. Soc., **46 (2)**, p. 93, (1963).

[4] Fontana, E.H., "A Versatile Parallel-Plate Viscometer for Glass Viscosity Measurements to 1000 °C," Bull. Am. Ceram. Soc., **49 (6)**, p. 594, (1970).

[5] ASTM Standard C 336-71, "Standard Test Method for Annealing Point and Strain Point of Glass by Fiber Elongation," Annual Book of ASTM Standards, Vol. 15.02, (1991).

[6] ASTM Standard C 338-93, "Standard Test Method for Softening Point of Glass," Annual Book of ASTM Standards, Vol. 15.02, (1993).

[7] ASTM Standard C 598-93, "Test Method for Annealing Point and Strain Point of Glass by Beam Bending," Annual Book of ASTM Standards, Vol. 15.02, (1993).