National Institute of Standards & Technology

Certificate

Standard Reference Material 705a

Polystyrene

(Narrow Molecular Weight Distribution)

This Standard Reference Material (SRM) is intended for use in the calibration of instruments used in polymer science and technology for the determination of molecular weight and for use in checking dynamic thermal analytical instruments. The SRM is supplied as small white slender rodlets of polystyrene in a 5 gram unit.

Property	Value	Standard deviation of the mean	Degrees of freedom
Number-average molecular weight, M_n, g/mol (Measured by membrane osmometry)	170,900[a]	580	12
Weight-average molecular weight, M_w, g/mol:			
Measured by light scattering	179,300[b]	740	9
Measured by sedimentation equilibrium	189,800[b]	2,100	22
Limiting viscosity number, mL/g:			
at 25 °C in benzene	74.3[b]	0.18	5
at 25 °C in benzene	74.5[c]	0.23	13
at 25 °C in cyclohexane	35.4[b]	0.24	6
Ratios of molecular weight (Based on fractionation)	M_z: M_w: M_n = 1.12:1.07:1		
Heat capacity	See Table		

[a] The value reported includes results from the pooled sample and from a separate study made to determine possible heterogeneity of the lot. It was found that samples taken from different locations showed slightly more variability than samples taken from adjacent locations. The standard deviation of the mean includes the effect of lot heterogeneity.

[b] Average of individual determinations made on a pooled sample combining portions of material taken from the entire lot.

[c] The value reported was obtained from a study made on samples taken from six locations in the lot to determine possible heterogeneity. Samples taken from different locations showed slightly more variability than samples taken from adjacent locations. The standard deviation of the mean includes the effect of lot heterogeneity.

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

Gaithersburg, MD 20899
July 10 , 1990

William P. Reed, Acting Chief
Standard Reference Materials Program

Notice and Warnings to Users:

Expiration of Certification: This certification will be valid for four years from date of shipment.

Storage: SRM 705a should be stored under normal laboratory conditions in the original bottle tightly closed.

The original analysis was done by Donald McIntyre and S.S. Chang of the Polymers Division. A new rebottling of the material was checked for homogeneity by Size Exclusion Chromatography (SEC). The rebottled SRM was found to have a SEC that is identical, within experimental error, to the material in the earlier bottling. Work on the rebottled material was done by J.R. Maurey and C.M. Guttman of the Polymers Division.

Heat capacity per mole (104.152 g) of [-C_8H_8-]

T	C_p	T	C_p	T	C_p
K	J/(mol•K)	K	J/(mol•K)	K	J/(mol•K)
10	3.34	110	51.07	250	105.6
15	7.01	120	54.59	260	110.1
20	10.76	130	57.94	270	114.6
25	14.36	140	61.44	280	119.1
30	17.70	150	65.01	290	123.7
35	20.76	160	68.66	300	128.3
40	23.56	170	72.39	310	132.9
45	26.14	180	76.22	320	137.6
50	28.53	190	80.14	330	142.2
60	32.90	200	84.17	340	146.9
70	36.90	210	88.28	350	151.6
80	40.67	220	92.50		
90	44.26	230	96.79	273.15	116.0
100	47.71	240	101.2	298.15	127.5

The polystyrene was prepared by the polymerization of styrene in benzene using butyllithium as an initiator. Ash content is 0.05%. Volatile content is about 0.5%. Determinations of molecular weight and intrinsic viscosity are based on weights of the polystyrene rodlets uncorrected for volatiles. Each rodlet weighs approximately 10 mg. Several rodlets were always used in the above determinations.

The osmotic pressure measurements were made with #600 gel cellophane membranes. The light scattering and sedimentation molecular weight determinations were calculated using the following constants for polystyrene-cyclohexane solutions at 35 °C: 0.1705 mL/g for the refractive index increment at 546 nm and 0.930 mL/g for the partial specific volume. The maximum rate of shear in the Ubbelohde viscometers used to determine the intrinsic viscosities was about 1500 s^{-1} for water. The z-average (M_z), weight-average (M_w), and number-average (M_n), molecular weight ratios are based upon a complete viscometric analysis and selected osmometric analysis of 36 fractions.

The heat capacity measurements were obtained by adiabatic calorimetry. The heat capacity values listed in the table make possible the use of SRM 705a as a working standard in dynamic thermal analysis instruments from 10 to 350 K, when the heating rate approaches zero. These values are estimated to be within 0.2% of the heat capacity values of SRM 705a, provided the material has not been heated above 350 K[1].

Reference

[1] Chang, S.S. and Bestul, A.B., J. Polymer Science, A-2, 6, 849-860 (1968).