U.S. Department of Commerce
Juanita M. Kreps
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National Bureau of Standards
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National Bureau of Standards Certificate

Standard Reference Material 705

Polystyrene

(Narrow Molecular Weight Distribution)

Donald McIntyre and S. S. Chang

This Standard Reference Material 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.

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
Measure 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 35 °C in benzene	74.5[c]	0.23	13
at 35 °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 support aspects involved in the issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by T. W. Mears and R. K. Kirby.

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J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Heat capacity per mole (104.152g) 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	3.3_4	110	51.0_7	250	105.6
15	7.0_1	120	54.5_9	260	110.1
20	10.7_6	130	57.9_4	270	114.6
25	14.3_6	140	61.4_4	280	119.1
30	17.7_0	150	65.0_1	290	123.7
35	20.7_6	160	68.6_6	300	128.3
40	23.5_6	170	72.3_9	310	132.9
45	26.1_4	180	76.2_2	320	137.6
50	28.5_3	190	80.1_4	330	142.2
60	32.9_0	200	84.1_7	340	146.9
70	36.9_0	210	88.2_8	350	151.6
80	40.6_7	220	92.5_0		
90	44.2_6	230	96.7_9	273.15	116.0
100	47.7_1	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 pellets uncorrected for volatiles. Each pellet weighs approximately 10 mg. Several pellets 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 705 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 705, provided the material has not been heated above 350 K, see paper by S. S. Chang and A. B. Bestul, J. Polymer Science, A-2, 6, 849-860 (1968).