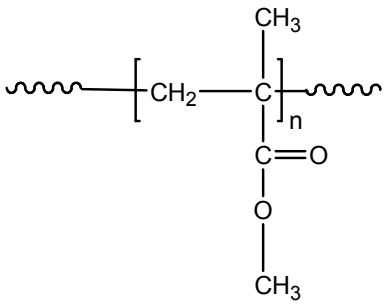
Polymer Reference Materials-Poly(Methyl Methacrylate)

Introduction

Reference materials are used for calibration and performance evaluation of instruments used as part of overall quality assurance programs of polymer. These materials support the development of new measurement methods and characterize new materials. The synthesis and characterization of our polymer reference materials are achieved meticulously. Above all, the user can be assured of receiving a well-characterized and quality product.

Chemical Structure of the poly (methyl methacrylate):



Molecular weight based reference polymers

Polymer Source offers a wide range of reference polymeric materials (RM) for both organic and aqueous phase applications. New reference polymers are added regularly. A wide range of polymers with number average molecular masses (M_n) (oligomers ***to 10 million***) have been covered.

Molecular weight values are characterized by various analytical techniques. Interfacing chromatographic methods with other analytical techniques can significantly increase the amount of information available for polymer characterization. The techniques used for characterization are: size exclusion chromatography (SEC), nuclear magnetic resonance (NMR), intrinsic viscosity, thermal analysis, and Matrix Assisted Laser Desorption Ionization-Time of Flight-Mass Spectrometry (MALDI-TOF-MS).

Organic phase soluble	Polystyrene	Polymethyl methacrylate	Polybutadiene	Polyisoprene
Aqueous phase soluble	Polyethylene oxide (PEO)	Polyacrylic acid	Polystyrene sulfonic acid	Polystyrene sodium sulfonate

The polymer standards are available either *individually* (in the widest range of molecular weights) or *as kits* containing wide range of M_n. Care has been taken to develop standards with the narrowest molecular weight distribution to ensure reliable calibrations of the instruments or for basic research. A *Certificate of analysis* that accompanies each product provides the characterization information indicating the type of end groups and microstructure of the polymer.

Purification of Polymer samples:

Purification of the polymer samples was carried out rigorously to ensure the removal of the catalyst by following steps:

1. Dissolved the polymer in $CHCl_3$ and washed with water to remove insoluble organic catalyst as side product.
2. Polymer solution in chloroform filtered and passed through a column packed with basic Al_2O_3 .
3. Solution was concentrated on rota-evaporator
4. Concentrated solution precipitated in cold methanol.
5. Dried under vacuum for 48h at 38 ^oC. Further, dissolved in dioxane; filter, and freeze dried under vacuum.
6. Polymer was packed in a clean vial in dust free environment.

Gel Permeation or Size Exclusion Chromatography

Gel permeation chromatography (GPC) also known as size exclusion chromatography (SEC) is employed to obtain number average molecular masses (M_n) and weight average molecular weight (M_w). Both these values result to obtain polydispersity index (PDI) ($PDI=M_w/M_n$). It guides the application level of reference polymers.

SEC analysis was performed on a Varian liquid chromatograph equipped with refractive and UV light scattering detectors. Three SEC columns from Supelco (G6000-4000-2000 HXL) were used with a dual detector model 270 from Viscotek Co connected on line in series with columns. Low angle and at right angle light scattering were used to determine absolute molecular weights of the polymer.
Average molecular weight by weight:

$$M_w = \frac{\sum w_i M_i}{\sum w_i}$$

Average molecular weight by number:

$$M_n = \frac{\sum n_i M_i}{\sum n_i}$$

where: w_i is the weight in fraction i; n_i is the molecular number in fraction i. M_i is the molecular weight of fraction i.

$$M_i = \frac{w_i}{n_i}$$

Due to some polymer chains distribution in polymer sample, weight average molecular weights (Mw) is always greater than number average molecular weights (Mn). The index of Mw/Mn determine the molecular distribution (polydispersity: PDI) is introduced.

$$PI = \frac{M_w}{M_n}$$

If PI=1, all the chain lengths are same. Usually, the sample prepared by living process is of narrow distribution character, the PI should be less than 1.15.

Mp is the molecular weight at peak maximum.

Intrinsic viscosity [η] is the related viscosity exploited to concentration = 0, which is related to solvent and temperature. The molecular shape is important to the intrinsic viscosity. When molecular weight is same, the [η] of multi-arm (four- or six-arm) polymer is much lower than that of linear one.

It is worth to note that all the results listed here might have about ±5% deviation.

Typical SEC of Reference Materials

Poly (methyl methacrylate) standard samples

Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n	Prices US$ 500mg	Prices US$ 1000mg
PMMA 1K	P7609	1100	1200	-	-	1.07	180	280
PMMA 3K	P9059	3100	3400	-	-	1.09	180	280
PMMA 6K	P8530	6000	6900	7000	0.0815	1.15	180	280
PMMA 26K	P9396	26600	28100	28600	0.1706	1.06	180	280
PMMA 43K	P707C	42900	44800	45400	0.2363	1.04	180	280
PMMA 85K	P5516	84500	89100	93000	0.3705	1.05	180	280
PMMA 120K	P9346	119200	128800	135300	0.4585	1.08	180	280
PMMA 230K	P9407	230500	257200	274900	0.7580	1.12	180	280
PMMA 400K	P8508	395900	431900	433600	1.2341	1.09	180	280
PMMA 1.5M	P4658	1470000	1790000	1760000	2.5247	1.22	180	280

Prices

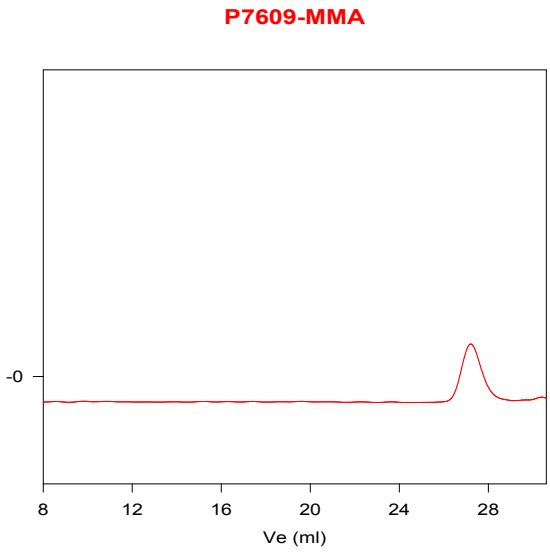
10 PMMA reference material 500mg each US$ 1400.00

10 PMMA reference material 1,000mg each US$ 2000.00

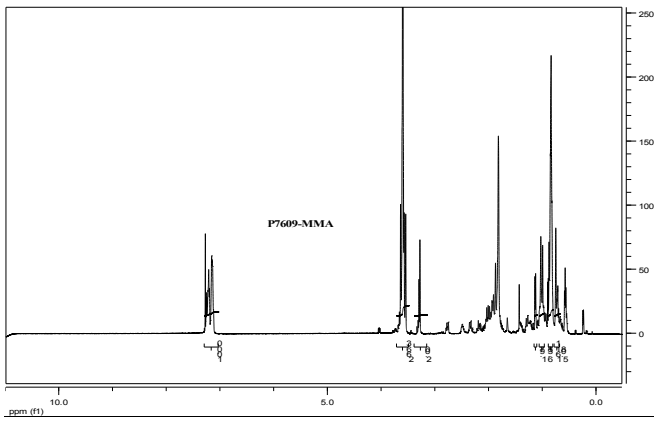
Characterization report for the each sample analysis:

PMMA: 1K lot P7609

Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n
PMMA 1K	P7609	1100	1200	-	-	1.07



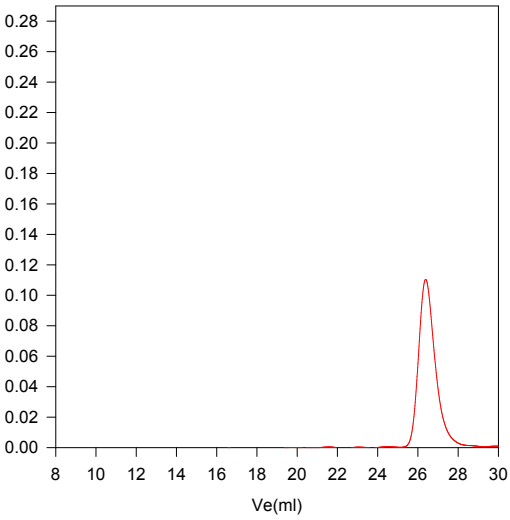
Size exclusion chromatograph of the polymer:
M_n=1100 M_w=1200, M_w/M_n=1.07 Mn by HNMR



PMMA: 3K lot 9059

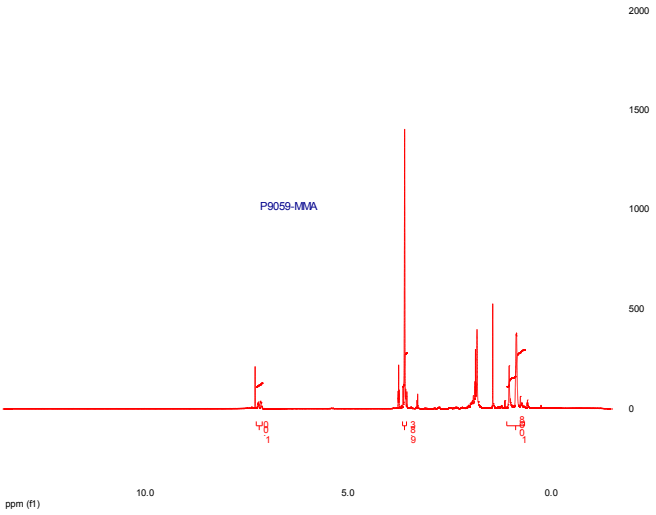
Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23^{0}C (dl/g)	M_w/M_n
PMMA 3K	P9059	3100	3400	-	-	1.09

P9059-MMA



Size exclusion chromatography of poly(methyl methacrylate):

M_n=3100, M_w=3400, M_w/M_n=1.09

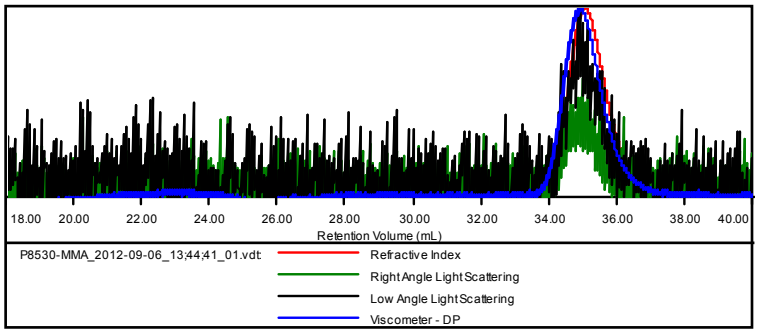


PMMA: 6K lot 8530

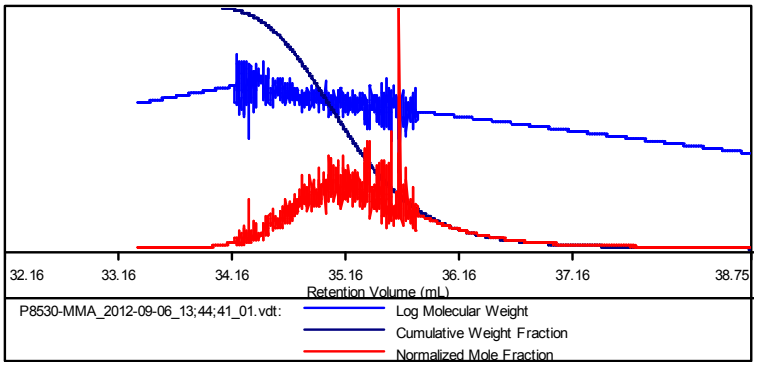
Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n
PMMA 6K	P8530	6000	6900	7000	0.0815	1.15

Sample ID: P8530-MMA

Concentration (mg/mL)	12.5303
Sample dn/dc (mL/g)	0.0840
Method File	PS80K-aug-0002.vcm
Column Set	3x PL 1113-6300
System	System 1



Sample	Mn (Da)	Mw (Da)	Mp (Da)	Mw/Mn	IV (dL/g)
P8530-MMA_2012-09-06_13;44;41_01.vdt	6,002	6,935	7,068	1.155	0.0815

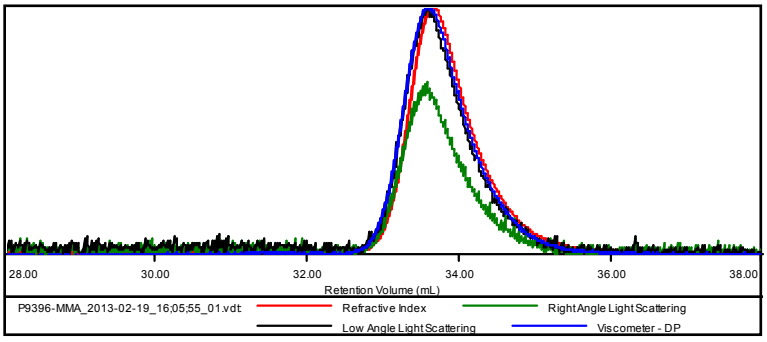


PMMA: 26K lot 9396

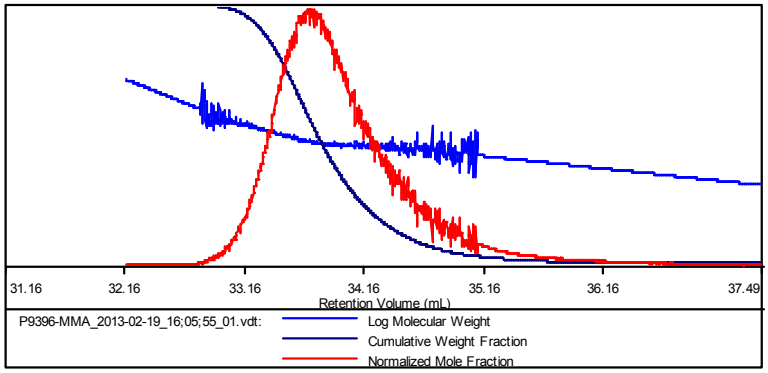
Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n
PMMA 26K	P9396	26,600	28,100	28,600	0.1706	1.06

Sample ID: P9396-MMA

Concentration (mg/mL)	7.4856
Sample dn/dc (mL/g)	0.0840
Method File	PS80K-Feb-2013-0001.vcm
Column Set	3x PL 1113-6300
System	System 1



Sample	Mn (Da)	Mw (Da)	Mp (Da)	Mw/Mn	IV (dL/g)
P9396-MMA_2013-02-19_16;05;55_01.v	26,610	28,128	28,582	1.057	0.1706

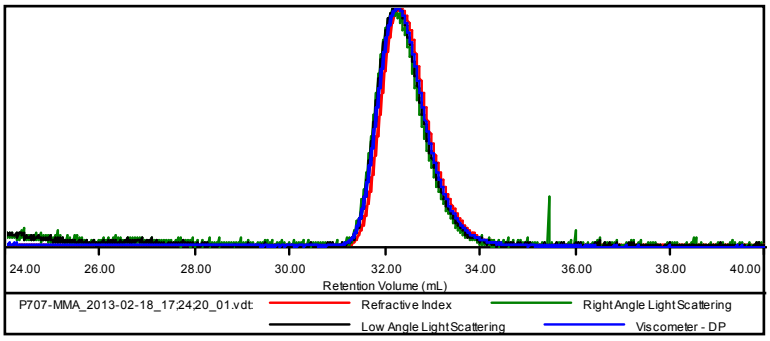


PMMA: 43K lot 707C

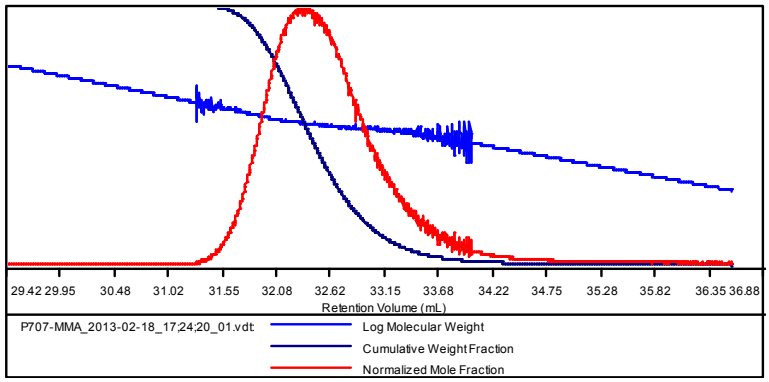
Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n
PMMA 43K	P707C	42,900	44,800	45,400	0.2363	1.04

Sample ID: P707C-MMA

Concentration (mg/mL)	12.8458
Sample dn/dc (mL/g)	0.0840
Method File	PS80K-Feb-2013-0001.vcm
Column Set	3x PL 1113-6300
System	System 1



Sample	Mn	Mw	Mp	Mw/Mn	IV
P707-MMA_2013-02-18_17;24;20_01.v	42,933	44,761	45,398	1.043	0.2363

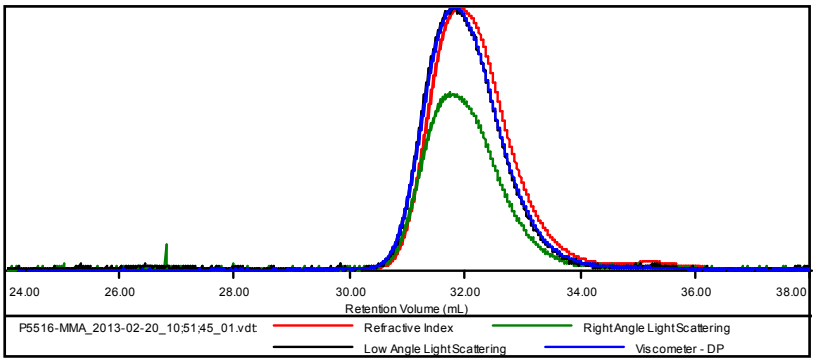


PMMA: 85K lot 5516

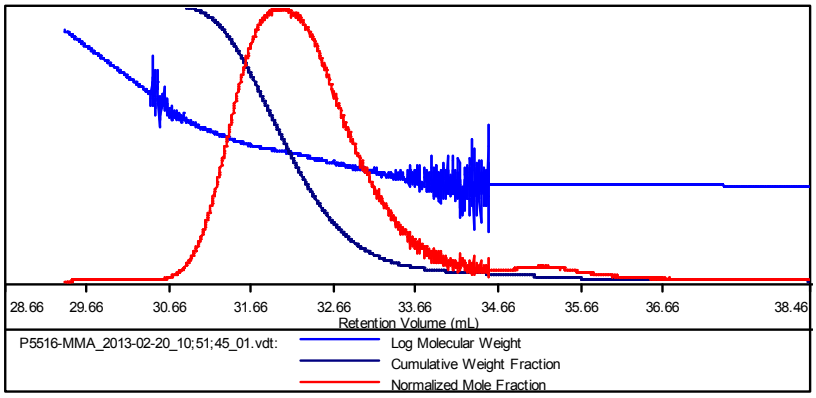
Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n
PMMA 85K	P5516	84,500	89,100	93,000	0.3705	1.05

Sample ID: P5516-MMA

Concentration (mg/mL)	15.8270
Sample dn/dc (mL/g)	0.0840
Method File	PS80K-Feb-2013-0001.vcm
Column Set	3x PL 1113-6300
System	System 1



Sample	Mn (Da)	Mw (Da)	Mp (Da)	Mw/Mn	IV (dL/g)
P5516-MMA_2013-02-20_10;51;45_01.v	84,504	89,096	93,037	1.054	0.3705

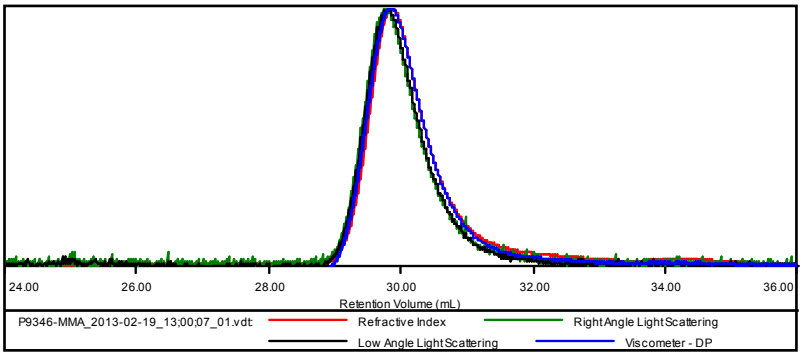


PMMA: 120K lot 9346

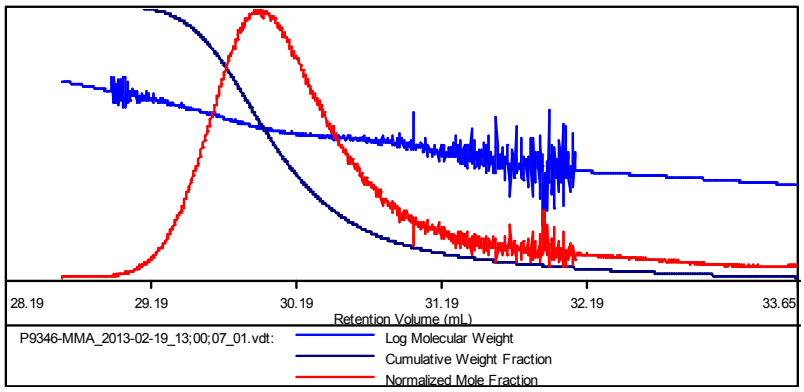
Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n
PMMA 120K	P9346	119,200	128,800	135,300	0.4585	1.08

Sample ID: P9346-MMA

Concentration (mg/mL)	4.3873
Sample dn/dc (mL/g)	0.0840
Method File	PS80K-Feb-2013-0001.vcm
Column Set	3x PL 1113-6300
System	System 1



Sample	Mn (Da)	Mw (Da)	Mp (Da)	Mw/Mn	IV (dL/g)
P9346-MMA_2013-02-19_13;00;07_01.v	119,178	128,846	135,349	1.081	0.4585

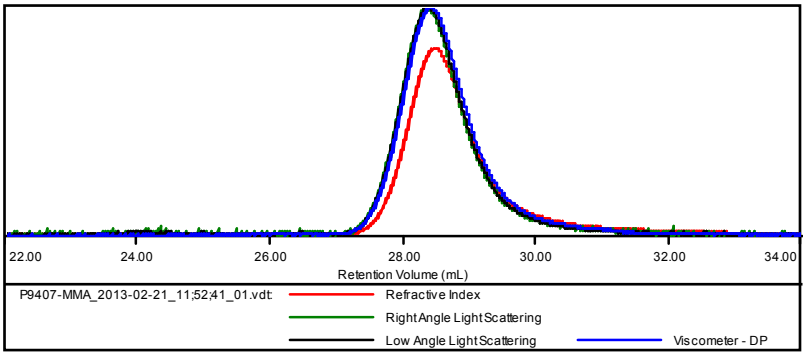


PMMA: 230K lot 9407

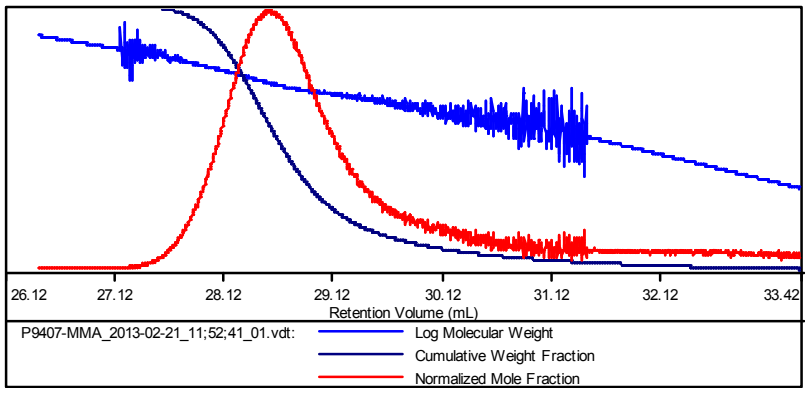
Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n
PMMA 230K	P9407	230,500	257,200	274,900	0.7580	1.12

Sample ID: P9407-MMA

Concentration (mg/mL)	4.0877
Sample dn/dc (mL/g)	0.0840
Method File	PS80K-Feb-2013-0001.vcm
Column Set	3x PL 1113-6300
System	System 1



Sample	Mn (Da)	Mw (Da)	Mp (Da)	Mw/Mn	IV (dL/g)
P9407-MMA_2013-02-21_11;52;41_01.vdt	230,549	257,235	274,947	1.116	0.7580

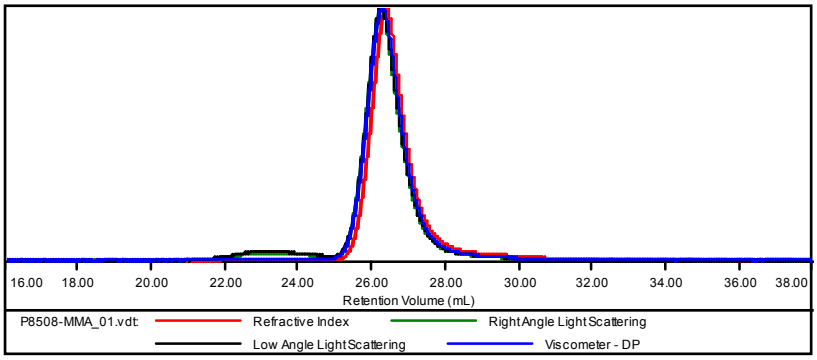


PMMA: 400K lot 8508

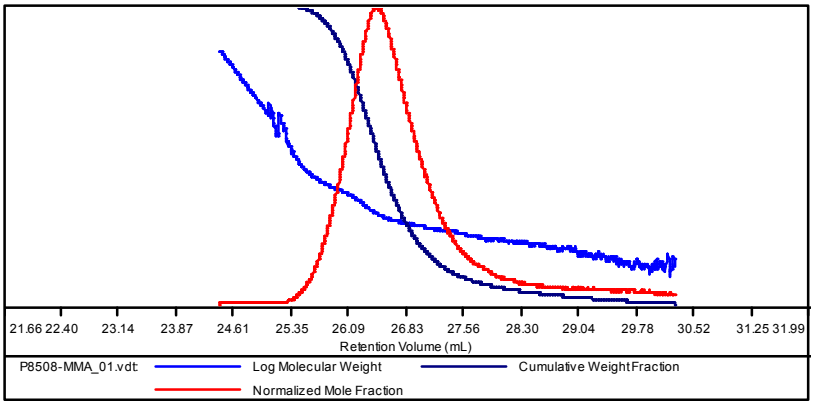
Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n
PMMA 405K	P8508	395,900	431,900	433,600	1.2341	1.09

Sample ID: P8508-MMA

Concentration (mg/mL)	4.1223
Sample dn/dc (mL/g)	0.0840
Method File	PS80K-Apr-2013-0000.vcm
Column Set	3x PL 1113-6300
System	System 1



Sample	Mn	Mw	Mp	Mw/Mn	IV
P8508-MMA_01.vdt	395,941	431,870	433,644	1.091	1.2341

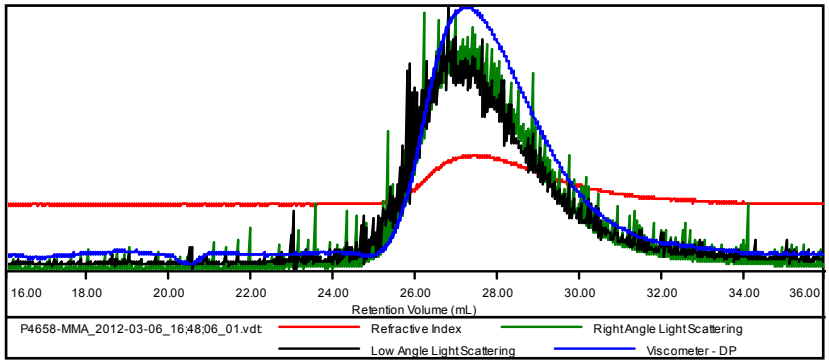


PMMA: 1.5M lot 4658

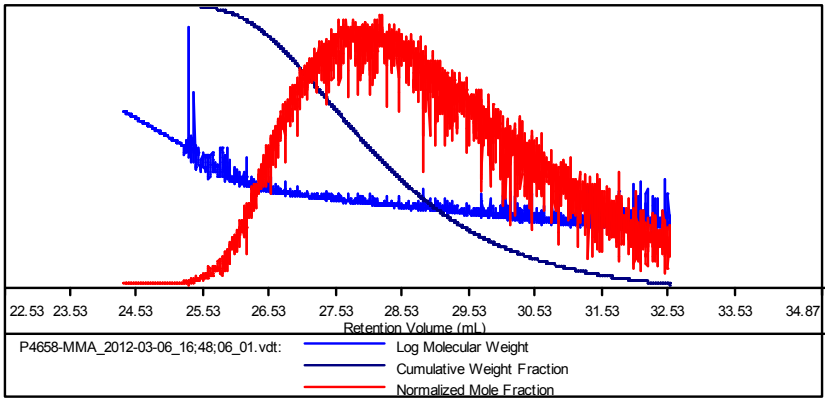
Part No.	Lot No.	M_n	M_w	M_p	[η] in THF at 23°C (dl/g)	M_w/M_n
PMMA 1.5M	P4658	1.47M	1.79M	1.76M	2.5247	1.22

Sample ID: P4658-MMA

Concentration (mg/mL)	1.7625
Sample dn/dc (mL/g)	0.0840
Method File	PS80K-Jan52012-2-0000.v cm
Column Set	3x PL 1113-6300
System	Sy stem 1



Sample	Mn (Da)	Mw (Da)	Mp (Da)	Mw/Mn	IV (dL/g)
P4658-MMA_2012-03-06_16;48;06_01.v	1.469 e 6	1.792 e 6	1.759 e 6	1.220	2.5247



Prices

10 PMMA reference material 500mg each US$ 1400.00

10 PMMA reference material 1,000mg each US$ 2000.00