

Certificate of Analysis



Agilent Technologies, Inc. acquired Polymer Standards Service GmbH (PSS) on August 01st, 2022.

The Quality Certificate / Certificate of Analysis generated by PSS attached to this Letter is valid for the Product stated in the Certificate sold to You by Agilent Technologies, Inc or its subsidiaries.

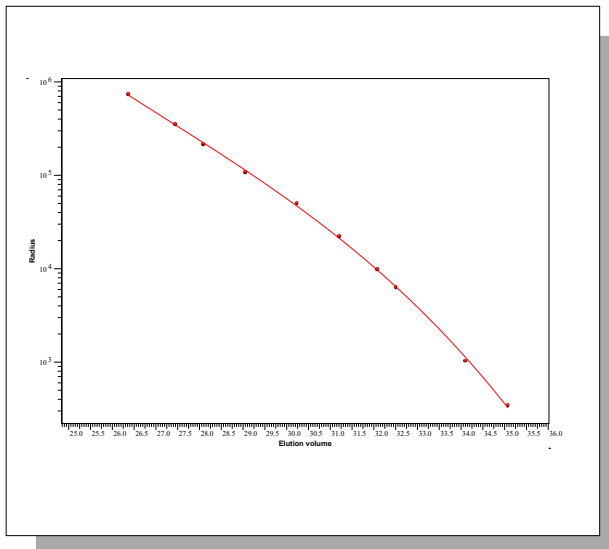
Patrick Kunzweiler

Quality Manager
Liquid Phase Separation Division

Certificate of Analysis

Product: Kit Pullulan
 Part No: PSS-PULKIT
 Lot No: PULKIT-18

GPC/SEC - Calibration Curve



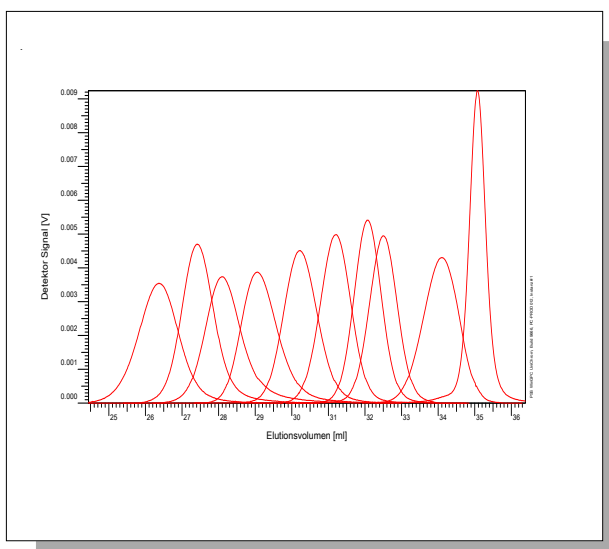
GPC/SEC - Calibration Table

Elution volume [ml]	Mp [Da]	Polymer Lot No:	Polymer Part No:
26,37	739000	P-800-4	PSS-PUL800K
27,44	348000	P-400-6	PSS-PUL400K
28,10	216000	P-200-5	PSS-PUL200K
29,05	107000	P-100-5	PSS-PUL110K
30,24	49700	P-50-4	PSS-PUL50K
31,22	22000	P-20-3	PSS-PUL22K
32,08	9800	P-10-3	PSS-PUL10K
32,51	6300	P-5-4	PSS-PUL6K
34,11	1030	P-1-3	PSS-PUL1.3K
35,08	342	P-0.3	PSS-PUL342

Note:

Mp = Molar mass at the peak maximum

GPC/SEC - Polymer Overlay



GPC/SEC - Calibration Conditions

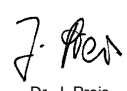
Solvent: Water, Sodium azide 0.5g/L
 Flow rate: 1,00 ml/min
 Precolumn [8 x 50 mm]: PSS SUPREMA 10µm
 Columns [8 x 300 mm]: PSS SUPREMA 10µm ultrahigh / ultrahigh / ultrahigh
 Temperature: 23 °C
 Inject volume: 20 µl
 Internal standard: Ethylene glycol at 37,21 ml
 Data Acquisition Software: PSS WinGPC
 Calibration by: A.Klein

Fit quality

Fit-type: Polynomial 3
 R: 0,999818

Storage: Store the tightly recapped polymer standards in a dry, dark, cool area; e.g. a refrigerator (4 °C).
 Date of expiry: 2028/02/29 (See also product label.)
 Date of approval: 2023/02/21

Manufacture control according to PSS method of analysis

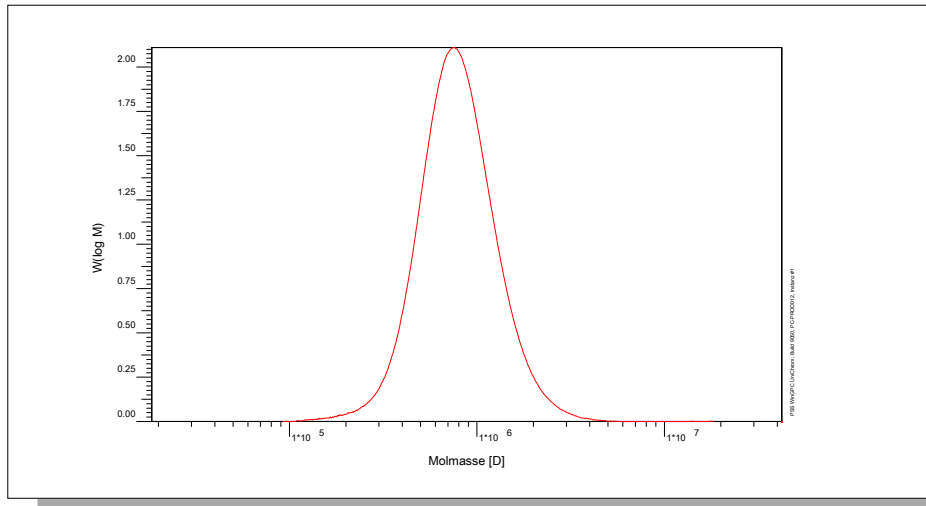

 Dr. J. Preis
 production manager



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Polymer type: Pullulan
 Part No: PSS-PUL800K
 Lot No: P-800-4

Molar Mass Distribution



GPC/SEC - Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Solvent	Water, Sodium azide 0.5g/L	Flow rate	1,00 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 10µm	Temperature	23 °C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 10µm ultrahigh / ultrahigh / ultrahigh		
Data Acquisition Software	PSS WinGPC	Operator	A.Klein

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]	PDI [Mw/Mn]
PSS SECurity RI	894000	722000	739000	1,24

Additional Methods - Results

Method	Mw [Da]
Light Scattering, on-line (SLD7x00)	847000

Mw = Weight average molecular weight
 Mn = Number average molecular weight
 Mp = Molar mass at the peak maximum
 PDI= Polydispersity Index

Light Scattering run on-line.

System and instrument validation based on Pullulan Lot No: p-100-5.

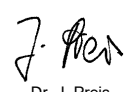
Sample concentration	0.9984 g/L
Inject volume	100µL
Sample dn/dc	0.149mL/g

Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).

Date of expiry: 2028/02/29 (See also product label.)

Date of approval: 2023/02/21

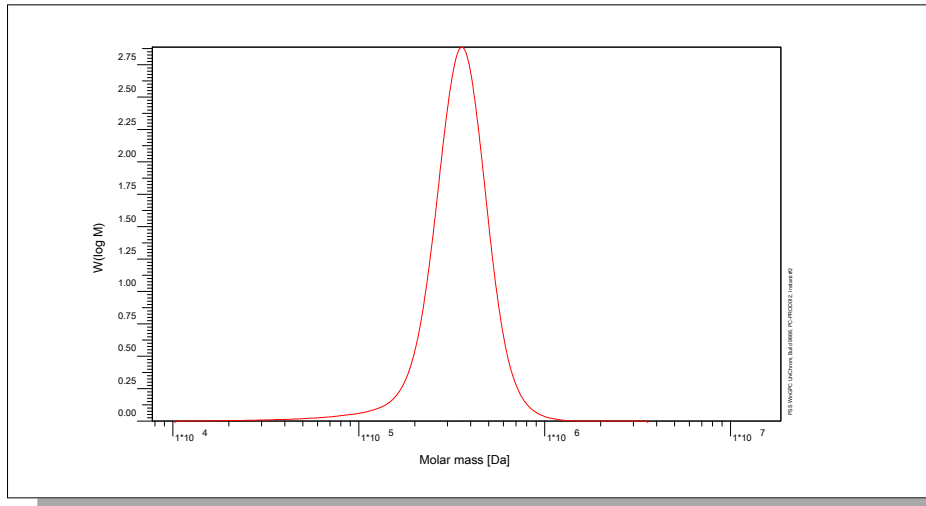
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 Dr. J. Preis
 production manager

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Polymer type: Pullulan
 Part No: PSS-PUL400K
 Lot No: P-400-6

Molar Mass Distribution



GPC/SEC - Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Solvent	Water, Sodium azide 0.5g/L	Flow rate	1,00 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 10µm	Temperature	23 °C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 10µm ultrahigh / ultrahigh / ultrahigh		
Data Acquisition Software	PSS WinGPC	Operator	A.Klein

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]	PDI [Mw/Mn]
PSS SECcurity RI	356000	267000	348000	1,33

Additional Methods - Results

Method	Mw [Da]
Light Scattering, on-line (SLD7x00)	364000

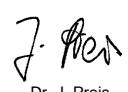
Mw = Weight average molecular weight
 Mn = Number average molecular weight
 Mp = Molar mass at the peak maximum
 PDI = Polydispersity Index

Light Scattering run on-line.
 System and instrument validation based on Pullulan Lot No: p-100-5

Sample concentration	0,9984 g/L
Inject volume	100µL
Sample dn/dc	0.149mL/g

Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).
Date of expiry: 2028/02/29 (See also product label.)
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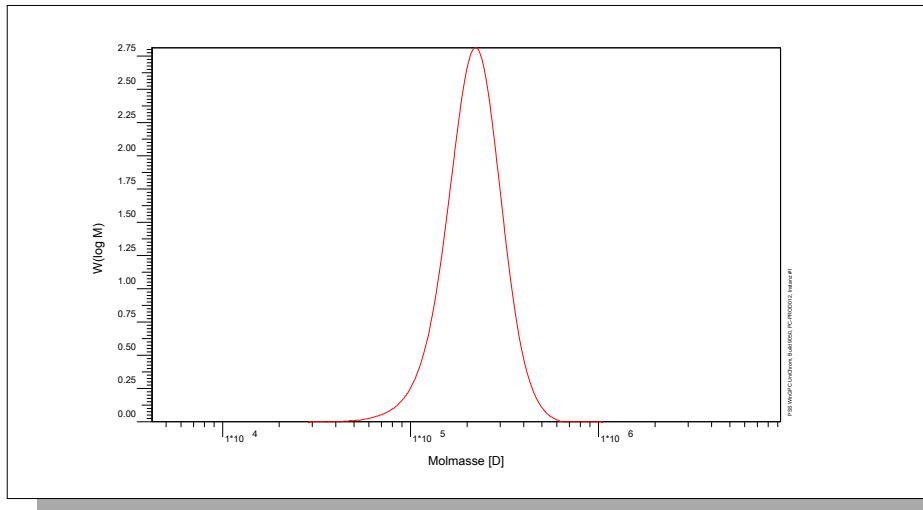
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 Dr. J. Preis
 production manager

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Polymer type: Pullulan
 Part No: PSS-PUL200K
 Lot No: P-200-5

Molar Mass Distribution



GPC/SEC - Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Solvent	Water, Sodium azide 0.5g/L	Flow rate	1,00 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 10µm	Temperature	23 °C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 10µm ultrahigh / ultrahigh / ultrahigh		
Data Acquisition Software	PSS WinGPC	Operator	A.Klein

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]	PDI [Mw/Mn]
PSS SECcurity RI	224000	184000	216000	1,22

Additional Methods - Results

Method	Mw [Da]
Light Scattering, on-line (SLD7x00)	234000

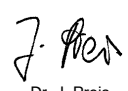
Mw = Weight average molecular weight
 Mn = Number average molecular weight
 Mp = Molar mass at the peak maximum
 PDI = Polydispersity Index

Light Scattering run on-line.
 System and instrument validation based on Pullulan Lot No: p-100-5

Sample concentration	0,9962 g/L
Inject volume	100µL
Sample dn/dc	0.149mL/g

Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).
Date of expiry: 2028/02/29 (See also product label.)
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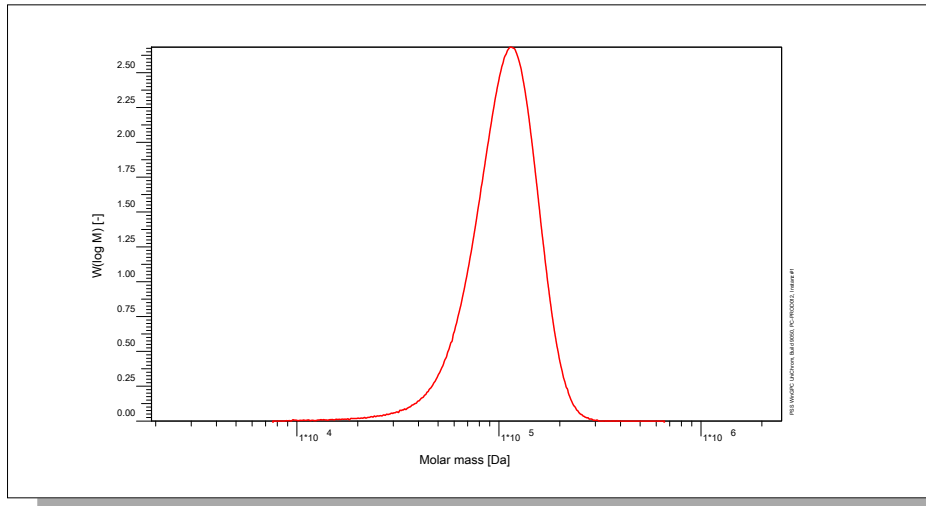
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 Dr. J. Preis
 production manager

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Polymer type: Pullulan
 Part No: PSS-PUL110K
 Lot No: P-100-5

Molar Mass Distribution



GPC/SEC - Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Solvent	Water + 0,5g/L Sodium azide	Flow rate	1,00 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 10µm	Temperature	23 °C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 10µm ultrahigh / ultrahigh / ultrahigh		
Data Acquisition Software	PSS WinGPC	Operator	J. Preis

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]	PDI [Mw/Mn]
PSS SECcurity RI	110000	98000	107000	1,12

Additional Methods - Results

Method	Mw [Da]
Light Scattering, on-line (SLD7x00)	112000

Mw = Weight average molecular weight
 Mn = Number average molecular weight
 Mp = Molar mass at the peak maximum
 PDI = Polydispersity Index

Light Scattering run on-line.

System and instrument validation based on Pullulan Lot No: p-100-3di.

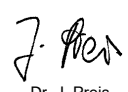
Sample concentration	1.0103 g/L
Inject volume	100µL
Sample dn/dc	0.149mL/g

Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).

Date of expiry: 2028/02/29 (See also product label.)

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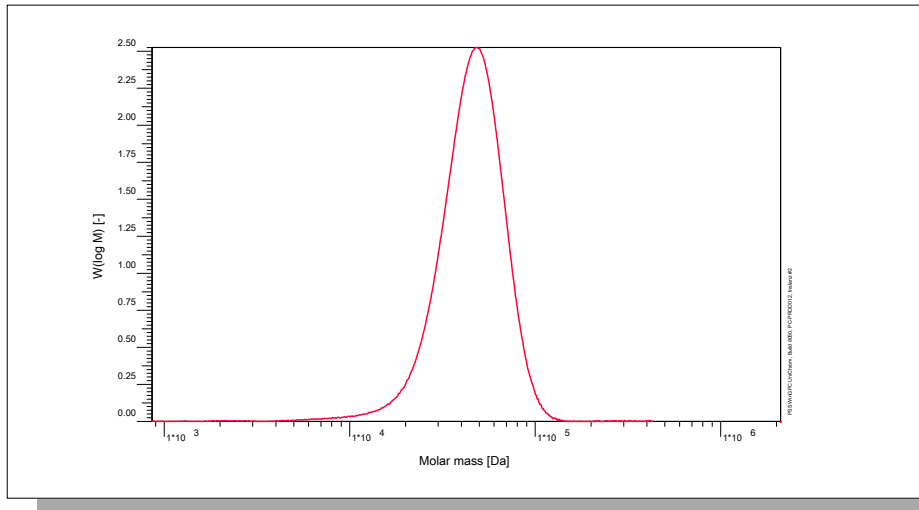
Manufacture control according to PSS method of analysis


 Dr. J. Preis
 production manager

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Polymer type: Pullulan
 Part No: PSS-PUL50K
 Lot No: P-50-4

Molar Mass Distribution



GPC/SEC - Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Solvent	Water, Sodium azide 0,05%	Flow rate	1,00 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 10µm	Temperature	23 °C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 10µm ultrahigh / ultrahigh / ultrahigh		
Data Acquisition Software	PSS WinGPC	Operator	J.Preis

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]	PDI [Mw/Mn]
PSS SECcurity RI	50700	46600	49700	1,09

Additional Methods - Results

Method	Mw [Da]
Light Scattering, on-line (SLD7x00)	50500

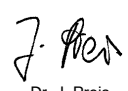
Mw = Weight average molecular weight
 Mn = Number average molecular weight
 Mp = Molar mass at the peak maximum
 PDI = Polydispersity Index

Light Scattering run on-line.
 System and instrument validation based on Pullulan Lot No: p-100-5

Sample concentration 3.0251 g/L
 Inject volume 100µL
 Sample dn/dc 0.149mL/g

Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).
Date of expiry: 2028/02/29 (See also product label.)
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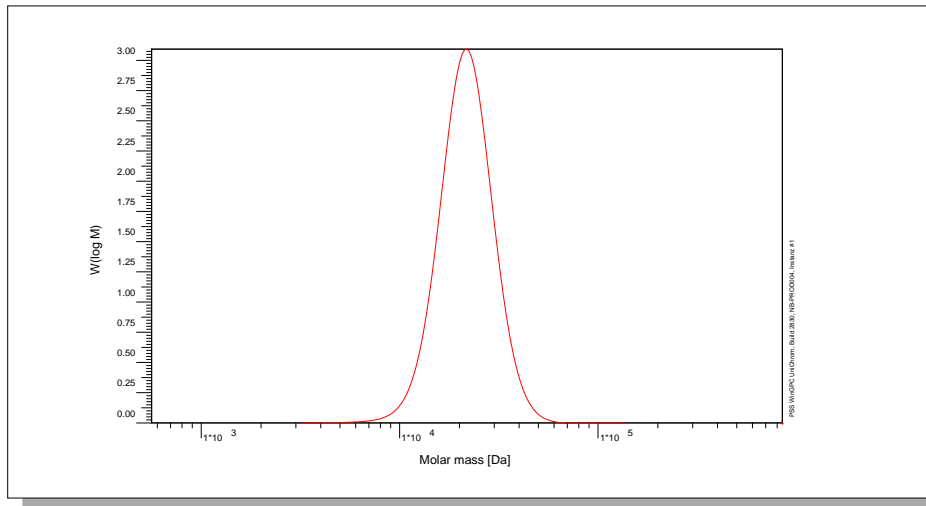
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 Dr. J. Preis
 production manager

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Polymer type: Pullulan
 Part No: PSS-PUL22K
 Lot No: P-20-3

Molar Mass Distribution



GPC/SEC - Conditions

Sample concentration	1.00 g/l	Inject volume	20 µl
Solvent	Water, Sodium azide 0.5g/L	Flow rate	1.00 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 10µm	Temperature	23 °C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 10µm 100Å / 100Å / 10 000Å / 10 000Å		
Data Acquisition Software	PSS WinGPC	Operator	J.Preis

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]	PDI [Mw/Mn]
PSS SECcurity RI	23000	21300	22000	1,08

Additional Methods - Results

Method	Mw [Da]
Light Scattering, on-line (SLD7x00)	22700

Mw = Weight average molecular weight
 Mn = Number average molecular weight
 Mp = Molar mass at the peak maximum
 PDI = Polydispersity Index

Light Scattering run on-line.
 System and instrument validation based on DIN-Pullulan Lot No: p-100di.

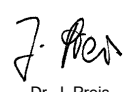
Sample concentration	2.262 g/L
Inject volume	100µL
Sample dn/dc	0.149mL/g

Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).

Date of expiry: 2028/02/29 (See also product label.)

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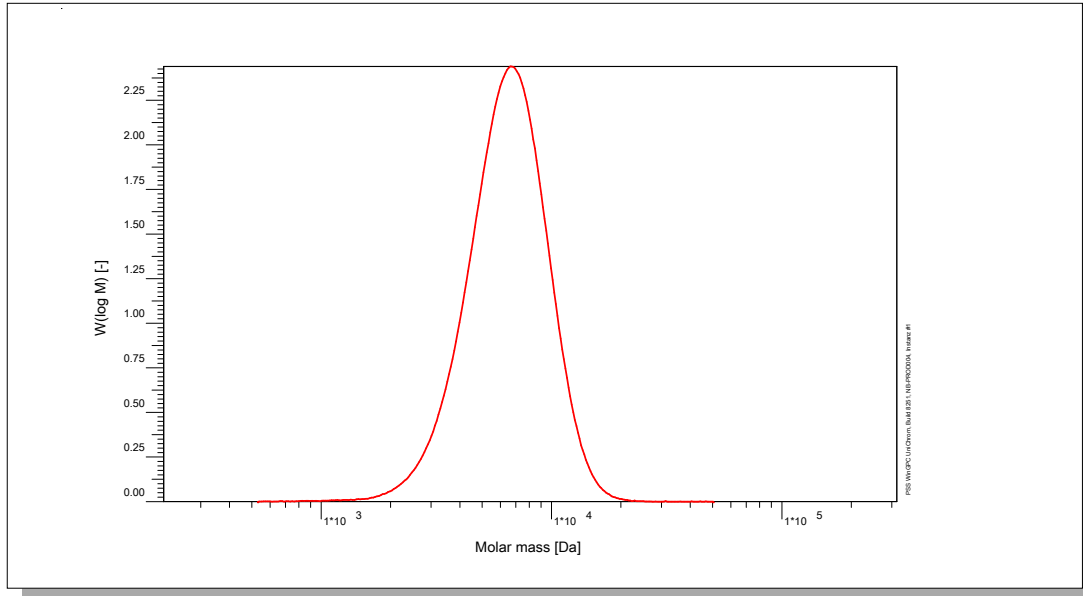
Manufacture control according to PSS method of analysis


 Dr. J. Preis
 production manager

Certificate of Analysis

Polymer type: Pullulan
 Part No: PSS-PUL6K
 Lot No: P-5-4

Molar Mass Distribution



GPC/SEC - Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Flow rate	1,00 ml/min	Temperature	23 °C
Solvent	Water, Sodium azide 0.5g/L		
Precolumn [8 x 50 mm]	PSS SUPREMA 10µm		
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 10µm ultrahigh / ultrahigh / ultrahigh		
Data Acquisition Software	PSS WinGPC	Operator	J.Preis

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]	PDI [Mw/Mn]
PSS SECcurity RI	6600	6000	6300	1,09

Additional Methods - Results

Method	Mw [Da]
Light Scattering, on-line (SLD7x00)	6700

Mw = Weight average molecular weight
 Mn = Number average molecular weight
 Mp = Molar mass at the peak maximum
 PDI = Polydispersity Index

Light Scattering run on-line.
 System and instrument validation based on DIN-Pullulan Lot No: p-100di.

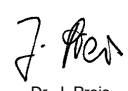
Sample concentration	6.9822 g/L
Inject volume	100µL
Sample dn/dc	0.149mL/g

Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).

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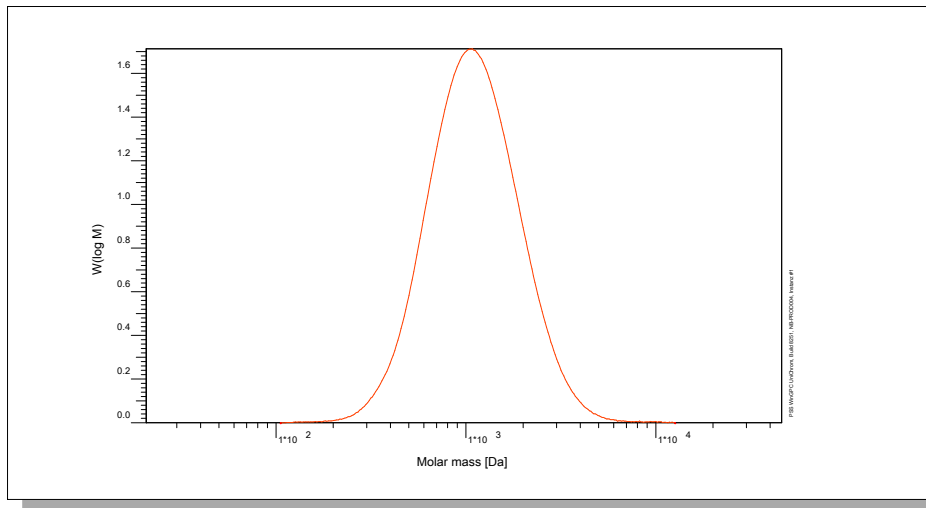
Manufacture control according to PSS method of analysis


 Dr. J. Preis
 production manager

Certificate of Analysis

Polymer type: Pullulan
 Part No: PSS-PUL1.3K
 Lot No: P-1-3

Molar Mass Distribution



GPC/SEC - Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Solvent	Water, Sodium azide 0.5g/L	Flow rate	1,00 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 10µm	Temperature	23 °C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 10µm ultrahigh / ultrahigh / ultrahigh		
Data Acquisition Software	PSS WinGPC	Operator	J.Preis

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]*	PDI [Mw/Mn]
PSS SECcurity RI	1260	946	1030	1,33

*The observed Mp value is dependent on the SEC chromatographic resolution, a function of the pore size distribution (slope of calibration) and particle size (dispersion); examples are shown on the next page. The Mp values of the oligomers are 504Da, 666Da, 828Da, 990Da, 1152Da, 1314Da 1476Da and 1638Da and can be used as additional calibration points.

Additional Methods - Results

Method	Mw [Da]
Light Scattering, on-line (SLD7x00)	1390

Mw = Weight average molecular weight
 Mn = Number average molecular weight
 Mp = Molar mass at the peak maximum
 PDI = Polydispersity Index

Light Scattering run on-line.

System and instrument validation based on DIN-Pullulan Lot No: p-100di.

Sample concentration 16.4358 g/L
 Inject volume 100µL
 Sample dn/dc 0.145mL/g

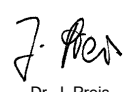
Please note: The GPC molar mass data are based on a set of dextran reference samples with a different degree of branching. The light scattering result represents the molar mass based on the branching of the sample.

Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).

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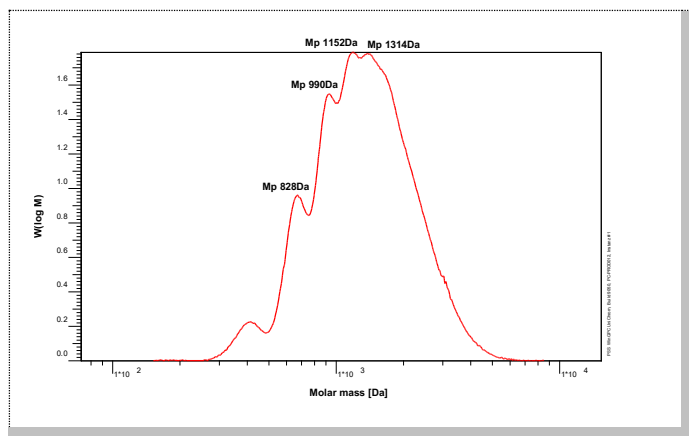
Manufacture control according to PSS method of analysis


 Dr. J. Preis
 production manager

Examples for oligomeric resolution

Polymer type: Pullulan
 Part No: PSS-PUL1.3K
 Lot No: P-1-3

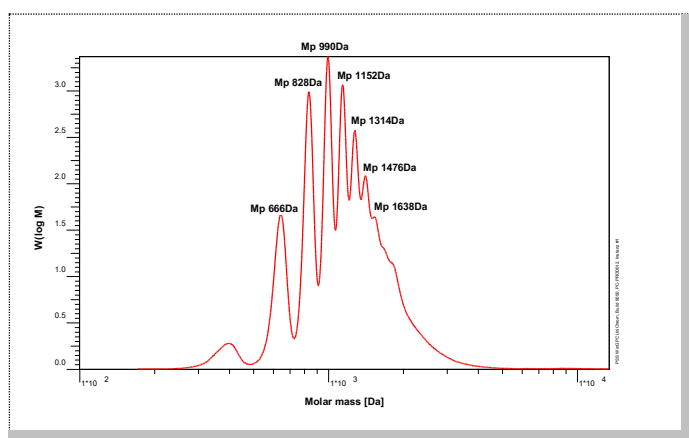
Molar Mass Distribution



GPC/SEC – Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Solvent	Water, sodium azide 0,05%	Flow rate	1.00 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 5µm	Temperature	23°C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 5µm 30Å / 1 000Å / 1 000Å	Operator	A.Klein
Data Acquisition Software	PSS WinGPC		

Molar Mass Distribution



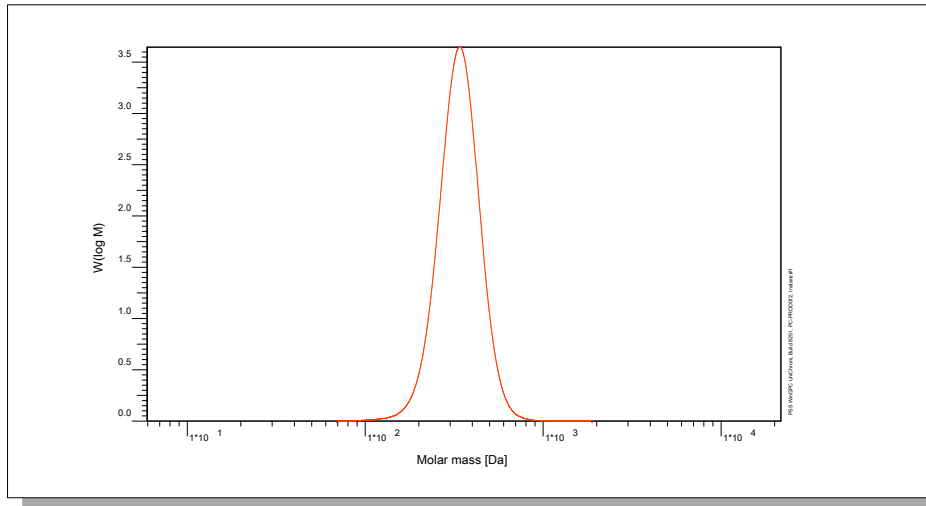
GPC/SEC – Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Solvent	Water, sodium azide 0,05%	Flow rate	0.50 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 3µm	Temperature	23°C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 3µm 30Å / 30Å / 30Å	Operator	A.Klein
Data Acquisition Software	PSS WinGPC		

Certificate of Analysis

Polymer type: Pullulan
 Part No: PSS-PUL342
 Lot No: P-0.3

Molar Mass Distribution



GPC/SEC - Conditions

Sample concentration	1,00 g/l	Inject volume	20 µl
Solvent	Water, Sodium azide 0.5g/L	Flow rate	1,00 ml/min
Precolumn [8 x 50 mm]	PSS SUPREMA 10µm	Temperature	23 °C
Columns [analytical, each 8 x 300 mm]	PSS SUPREMA 10µm ultrahigh / ultrahigh / ultrahigh		
Data Acquisition Software	PSS WinGPC	Operator	J.Preis

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]	PDI [Mw/Mn]
PSS SECcurity RI	342	342	342	1,00

Additional Methods - Results

Method	Mn [Da]
Nuclear Magnetic Resonance spectroscopy	342

¹H-NMR (400MHz, D₂O)

Mw = Weight average molecular weight
 Mn = Number average molecular weight
 Mp = Molar mass at the peak maximum
 PDI = Polydispersity Index

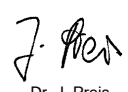
Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).

Date of expiry: 2028/02/29 (See also product label.)

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Manufacture control according to PSS method of analysis


 Dr. J. Preis
 production manager

