

Full Report Set

TriStar II 3020 V1.03 (V1.03)

Unit 1 Port 1

Serial #: 731

Page 1

Sample: CeriaHighSurface
Operator: Karl Magnus
Submitter:
File: C:\...\AKARLM~1\CERIAH.SMP

Started: 04.10.2013 12:00:18	Analysis Adsorptive: N2
Completed: 04.10.2013 15:14:07	Analysis Bath Temp.: -195.850 °C
Report Time: 04.10.2013 21:02:58	Sample Mass: 0.1207 g
Warm Free Space: 11.5271 cm ³ Measured	Cold Free Space: 33.3766 cm ³ Measured
Equilibration Interval: 5 s	Low Pressure Dose: None
Sample Density: 1.000 g/cm ³	Automatic Degas: No

Summary Report

Surface Area

Single point surface area at P/Po = 0.199064781: 103.2969 m²/g

Pore Volume

Single point adsorption total pore volume of pores
less than 769.712 Å diameter at P/Po = 0.973412360: 0.157569 cm³/g

Pore Size

Adsorption average pore width (4V/A by BET): 59.0129 Å

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Sample Density: 1.000 g/cm ³	Automatic Degas: No

Validation errors exist for this report. Review the validation report for details.

Isotherm Tabular Report

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)	Elapsed Time (h:min)	Saturation Pressure (mmHg)
0.010144069	7.670474	19.2946	00:47	756.067444
0.029317304	22.167940	21.3469	00:53	756.153564
0.064129305	48.491062	23.3166	00:55	756.138428
0.079091925	59.804806	24.0268	00:57	756.145142
0.099559041	75.279396	24.9672	00:58	756.143005
0.119496573	90.339409	24.9672	01:00	756.128174
0.139331532	105.333328	25.8725	01:02	756.000000
0.159279821	120.407310	26.7889	01:03	755.990601
0.179140615	135.424728	27.7116	01:05	755.948303
0.199064781	150.486389	28.6601	01:07	755.968872
0.246258662	186.180176	29.6266	01:08	755.966919
0.297657290	225.035324	32.0378	01:10	756.035034
0.347932777	263.085449	34.7629	01:12	756.021545
0.397230852	300.379089	37.5916	01:15	756.138733
0.447398400	338.271393	40.7499	01:18	756.182678
0.495937060	374.970764	44.3678	01:21	756.085388
0.545522060	412.401825	48.6916	01:24	756.085388
0.600700654	454.061279	54.2658	01:28	755.976440
0.644657546	487.272614	63.6875	01:34	755.886108
0.699926687	528.926147	73.7988	01:40	755.862732
0.759432071	573.808777	89.1351	01:49	755.687927
0.812306601	613.704529	98.1178	01:54	755.576172
0.837579253	632.783508	99.9053	01:55	755.508484
0.867489472	655.445374	100.2647	01:57	755.490906
0.892711861	674.567932	100.5467	01:58	755.565796
0.899585393	679.749268	100.7982	01:59	755.639038
0.923457339	697.833557	100.8646	02:01	755.625061
0.948334619	716.692139	101.1236	02:02	755.674927
0.973412360	735.478333	101.4407	02:03	755.737610
0.979611747	740.146301	101.8678	02:05	755.567078
0.989111735	747.322876	102.0145	02:06	755.550659
0.994925285	751.649475	102.0145	02:07	755.549500
0.972917227	735.125366	102.3208	02:09	755.483337
0.934102281	705.754639	102.6806	02:10	755.588806
0.907517763	685.670105	102.1158	02:11	755.543213
0.882256548	666.583862	101.4855	02:13	755.544556
0.875382924	661.350891	101.1556	02:14	755.544250
0.851033646	643.029419	100.8878	02:15	755.498962
0.826482697	624.458374	100.8101	02:16	755.586365
0.801135326	605.326782	100.5943	02:18	755.561340
0.752614865	568.576965	100.3632	02:19	755.586182
0.702914763	531.055664	100.1455	02:20	755.468689
0.654929423	494.821045	99.7186	02:22	755.505066
0.600900795	453.885376	99.0067	02:24	755.533386
0.547167139	413.186432	97.1407	02:33	755.341614
0.500379449	377.927124	83.5140	02:45	755.137512
0.445789072	336.626038	61.6647	02:51	755.281067
0.386781211	292.046844	52.1440	02:56	755.124023
0.354040695	267.338043	45.0947	03:00	755.069885
		39.7067	03:02	755.105408
		37.6049		

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Sample Density: 1.000 g/cm³

Analysis Adsorptive: N2
Analysis Bath Temp.: -195.850 °C
Sample Mass: 0.1207 g
Cold Free Space: 33.3766 cm³ Measured
Low Pressure Dose: None
Automatic Degas: No

Isotherm Tabular Report

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)	Elapsed Time (h:min)	Saturation Pressure (mmHg)
0.304471766	229.913239	34.6811	03:05	755.121704
0.252460895	190.631012	31.8352	03:07	755.091248
0.202499662	152.889099	29.2376	03:09	755.009155
0.143380389	108.245972	26.3728	03:12	754.956604

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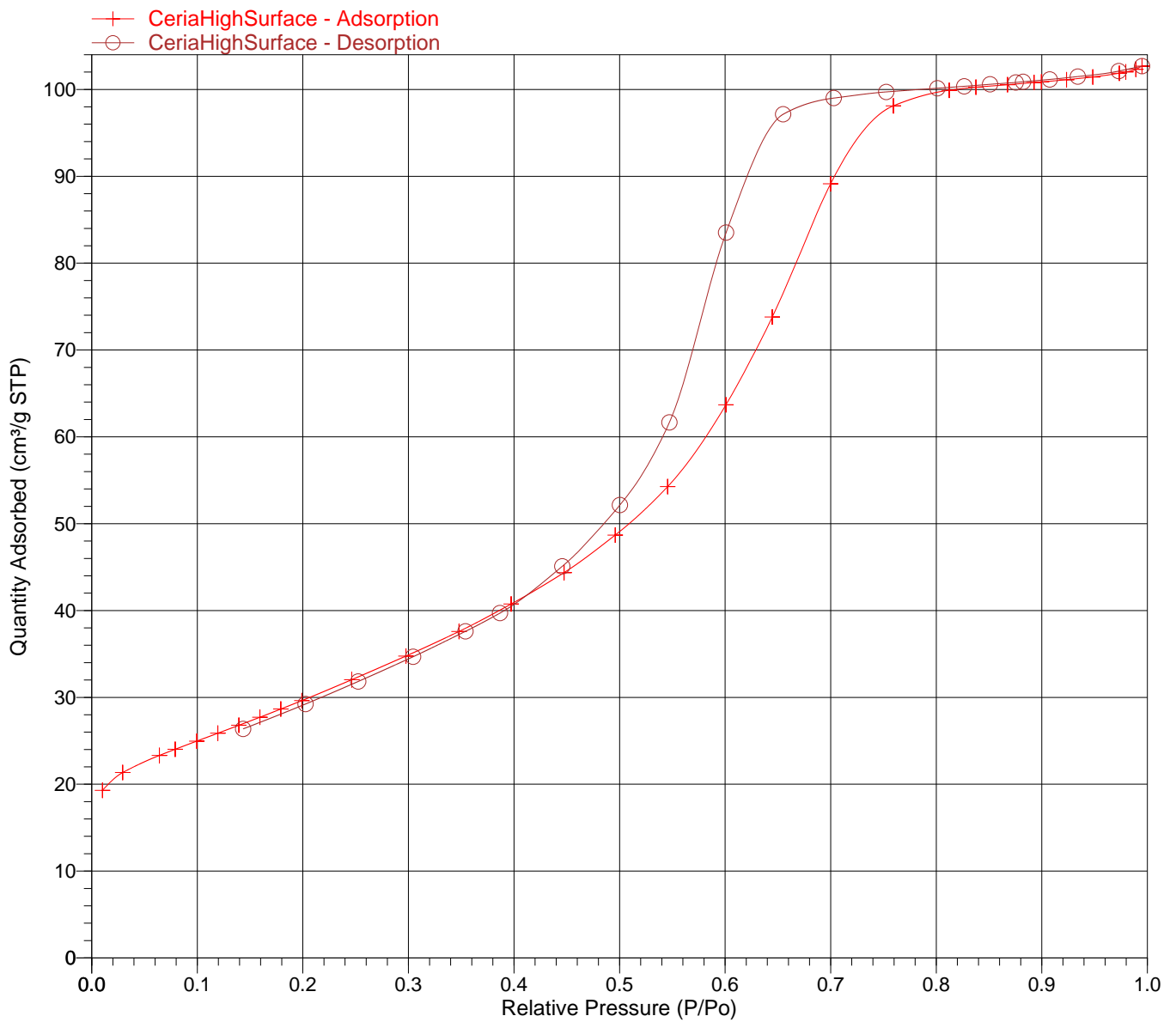
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Isotherm Linear Plot



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Low Pressure Dose: None
Automatic Degas: No

BET Surface Area Report

BET Surface Area: 106.8032 ± 0.6335 m²/g
Slope: 0.040369 ± 0.000240 g/cm³ STP
Y-Intercept: 0.000391 ± 0.000033 g/cm³ STP
C: 104.369730
Qm: 24.5344 cm³/g STP
Correlation Coefficient: 0.9998944
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm ³ /g STP)	1/[Q(Po/P - 1)]
0.064129305	23.3166	0.002939
0.079091925	24.0268	0.003575
0.099559041	24.9672	0.004428
0.119496573	25.8725	0.005245
0.139331532	26.7889	0.006043
0.159279821	27.7116	0.006837
0.179140615	28.6601	0.007615
0.199064781	29.6266	0.008389

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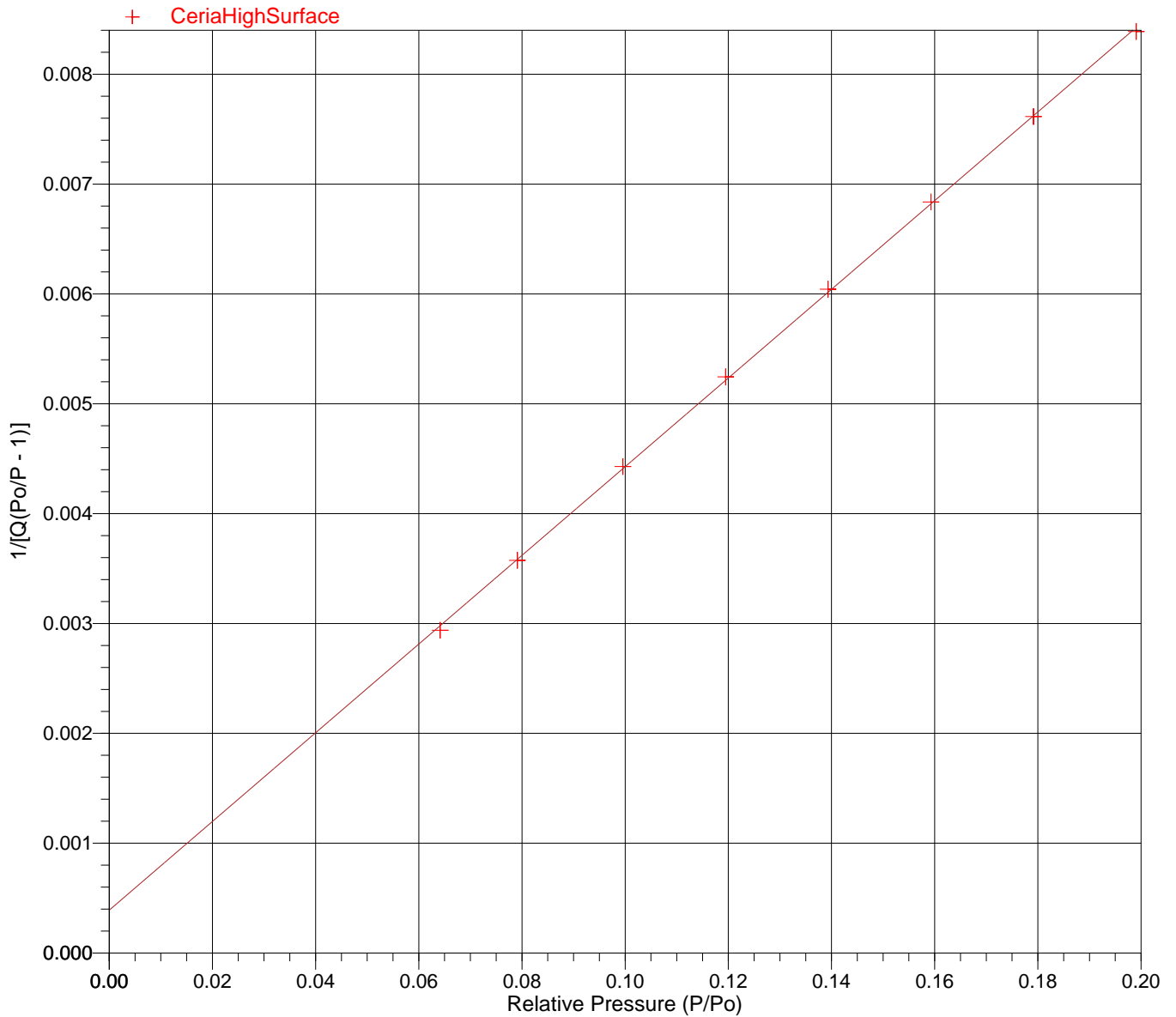
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Analysis Adsorptive: N2
Analysis Bath Temp.: -195.850 °C
Sample Mass: 0.1207 g
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Low Pressure Dose: None
Automatic Degas: No

BET Surface Area Plot



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Low Pressure Dose: None
Automatic Degas: No

Langmuir Surface Area Report

Langmuir Surface Area: 147.9155 ± 4.1962 m²/g
Slope: 0.029430 ± 0.000835 g/cm³ STP
Y-Intercept: 0.754724 ± 0.086734 mmHg·g/cm³ STP
b: 0.038995 1/mmHg
Qm: 33.9786 cm³/g STP
Correlation Coefficient: 0.997594
Molecular Cross-Sectional Area: 0.1620 nm²

Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)	P/Q (mmHg·g/cm ³ STP)
48.491062	23.3166	2.080
59.804806	24.0268	2.489
75.279396	24.9672	3.015
90.339409	25.8725	3.492
105.333328	26.7889	3.932
120.407310	27.7116	4.345
135.424728	28.6601	4.725
150.486389	29.6266	5.079

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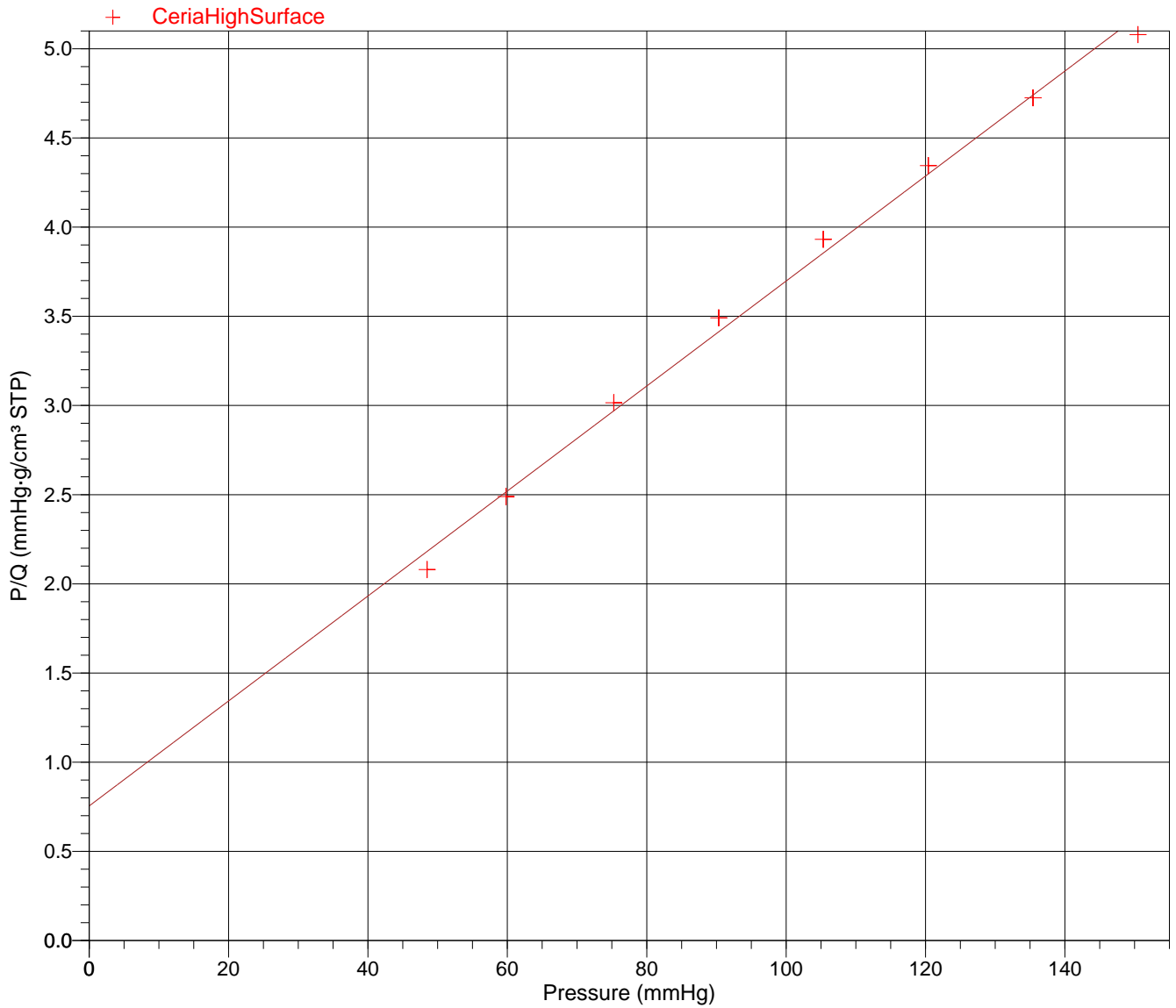
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Low Pressure Dose: None
Automatic Degas: No

Langmuir Surface Area Plot



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Equilibration Interval: 5 s	Low Pressure Dose: None
Sample Density: 1.000 g/cm ³	Automatic Degas: No

t-Plot Report

Micropore Volume: -0.002713 cm³/g
 Micropore Area: *
 External Surface Area: 111.9662 m²/g
 Slope: 7.238573 ± 0.186883 cm³/g·Å STP
 Y-Intercept: -1.753625 ± 0.779737 cm³/g STP
 Correlation Coefficient: 0.997675
 Surface Area Correction Factor: 1.000
 Density Conversion Factor: 0.0015468
 Total Surface Area (BET): 106.8032 m²/g
 Thickness Range: 3.5000 Å to 5.0000 Å
 Thickness Equation: Harkins and Jura

$$t = [13.99 / (0.034 - \log(P/P_o))] ^{0.5}$$

Relative Pressure (P/P _o)	Statistical Thickness (Å)	Quantity Adsorbed (cm ³ /g STP)	Fitted
0.010144069	2.6266	19.2946	
0.029317304	2.9881	21.3469	
0.064129305	3.3767	23.3166	
0.079091925	3.5095	24.0268	*
0.099559041	3.6749	24.9672	*
0.119496573	3.8241	25.8725	*
0.139331532	3.9648	26.7889	*
0.159279821	4.1010	27.7116	*
0.179140615	4.2329	28.6601	*
0.199064781	4.3628	29.6266	*
0.246258662	4.6659	32.0378	*
0.297657290	4.9969	34.7629	*
0.347932777	5.3297	37.5916	
0.397230852	5.6713	40.7499	
0.447398400	6.0414	44.3678	
0.495937060	6.4281	48.6916	
0.545522060	6.8611	54.2658	
0.600700654	7.4020	63.6875	
0.644657546	7.8911	73.7988	

* The micropore area is not reported because either the micropore volume is negative or the calculated external surface area is larger than the total surface area.

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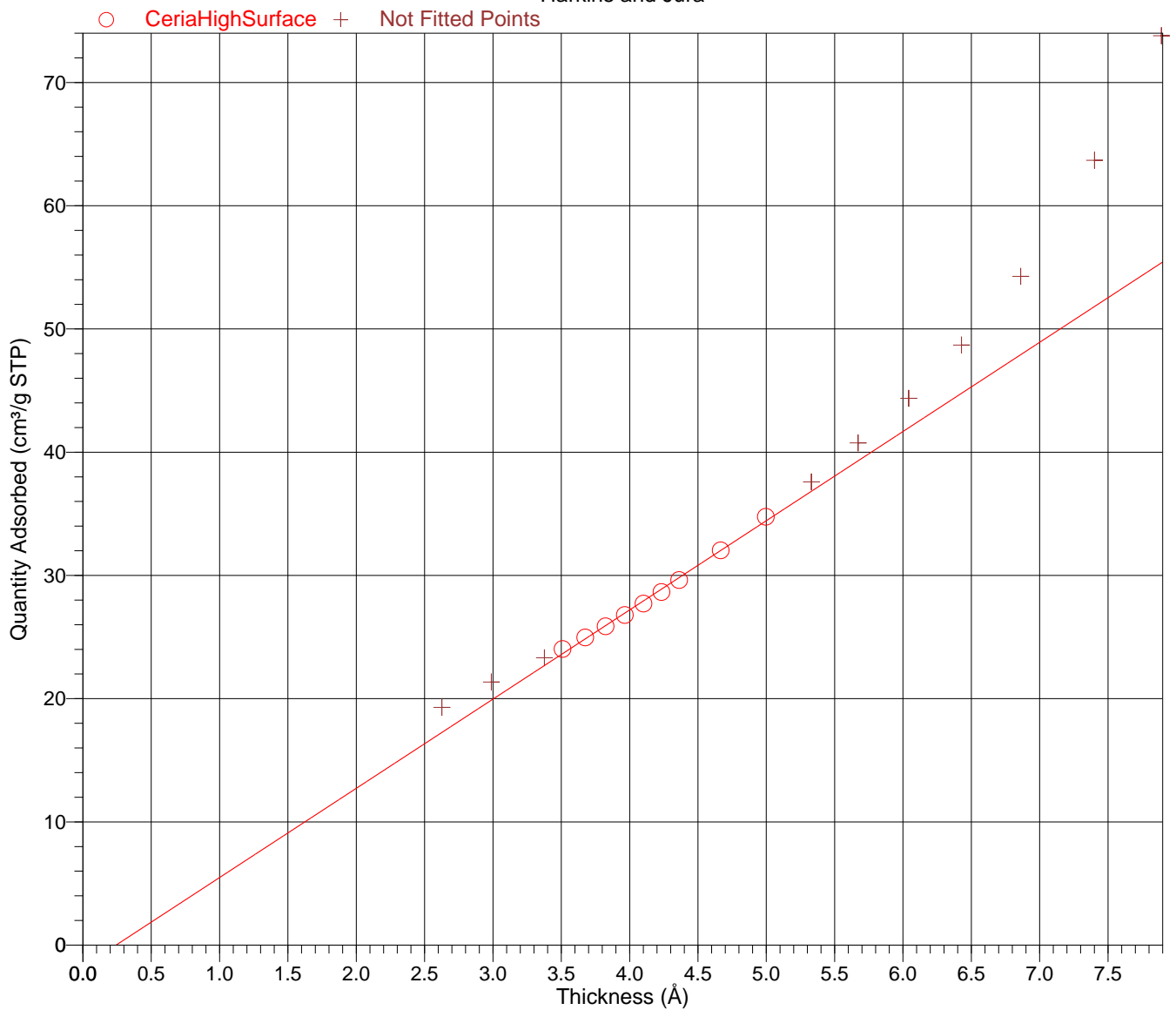
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t-Plot

Harkins and Jura



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Equilibration Interval: 5 s	Low Pressure Dose: None
Sample Density: 1.000 g/cm ³	Automatic Degas: No

BJH Adsorption Pore Distribution Report

Faas Correction
 Broekhoff-De Boer
 $\log(P/P_0) = -16.11 / t^2 + 0.1682 \exp\{-0.1137 t\}$
 Diameter Range: 17.000 Å to 3000.000 Å
 Adsorbate Property Factor: 9.53000 Å
 Density Conversion Factor: 0.0015468
 Fraction of Pores Open at Both Ends: 0.00

Pore Diameter Range (Å)	Average Diameter (Å)	Incremental Pore Volume (cm ³ /g)	Cumulative Pore Volume (cm ³ /g)	Incremental Pore Area (m ² /g)	Cumulative Pore Area (m ² /g)
3914.1 - 1851.7	2220.2	0.000616	0.000616	0.011	0.011
1851.7 - 998.6	1188.0	0.000516	0.001132	0.017	0.028
998.6 - 767.1	852.7	0.000241	0.001373	0.011	0.040
767.1 - 396.7	472.5	0.000728	0.002102	0.062	0.101
396.7 - 269.3	308.4	0.000558	0.002659	0.072	0.174
269.3 - 206.1	229.0	0.000469	0.003128	0.082	0.256
206.1 - 193.0	199.1	0.000121	0.003249	0.024	0.280
193.0 - 156.6	170.8	0.000473	0.003722	0.111	0.391
156.6 - 127.9	139.2	0.000544	0.004266	0.156	0.547
127.9 - 110.6	117.9	0.000737	0.005003	0.250	0.797
110.6 - 85.8	94.9	0.003936	0.008939	1.659	2.457
85.8 - 68.0	74.7	0.021160	0.030099	11.329	13.786
68.0 - 56.6	61.2	0.037258	0.067358	24.360	38.146
56.6 - 49.6	52.6	0.024063	0.091421	18.291	56.437
49.6 - 42.7	45.6	0.021430	0.112851	18.814	75.252
42.7 - 37.5	39.7	0.011154	0.124006	11.228	86.479
37.5 - 33.3	35.2	0.007747	0.131753	8.814	95.293
33.3 - 29.6	31.2	0.005559	0.137311	7.127	102.421
29.6 - 26.3	27.7	0.004304	0.141615	6.208	108.628
26.3 - 23.4	24.6	0.003124	0.144740	5.072	113.700
23.4 - 20.6	21.8	0.002540	0.147279	4.664	118.365
20.6 - 18.2	19.2	0.001770	0.149049	3.680	122.045
18.2 - 17.2	17.7	0.000431	0.149480	0.975	123.020

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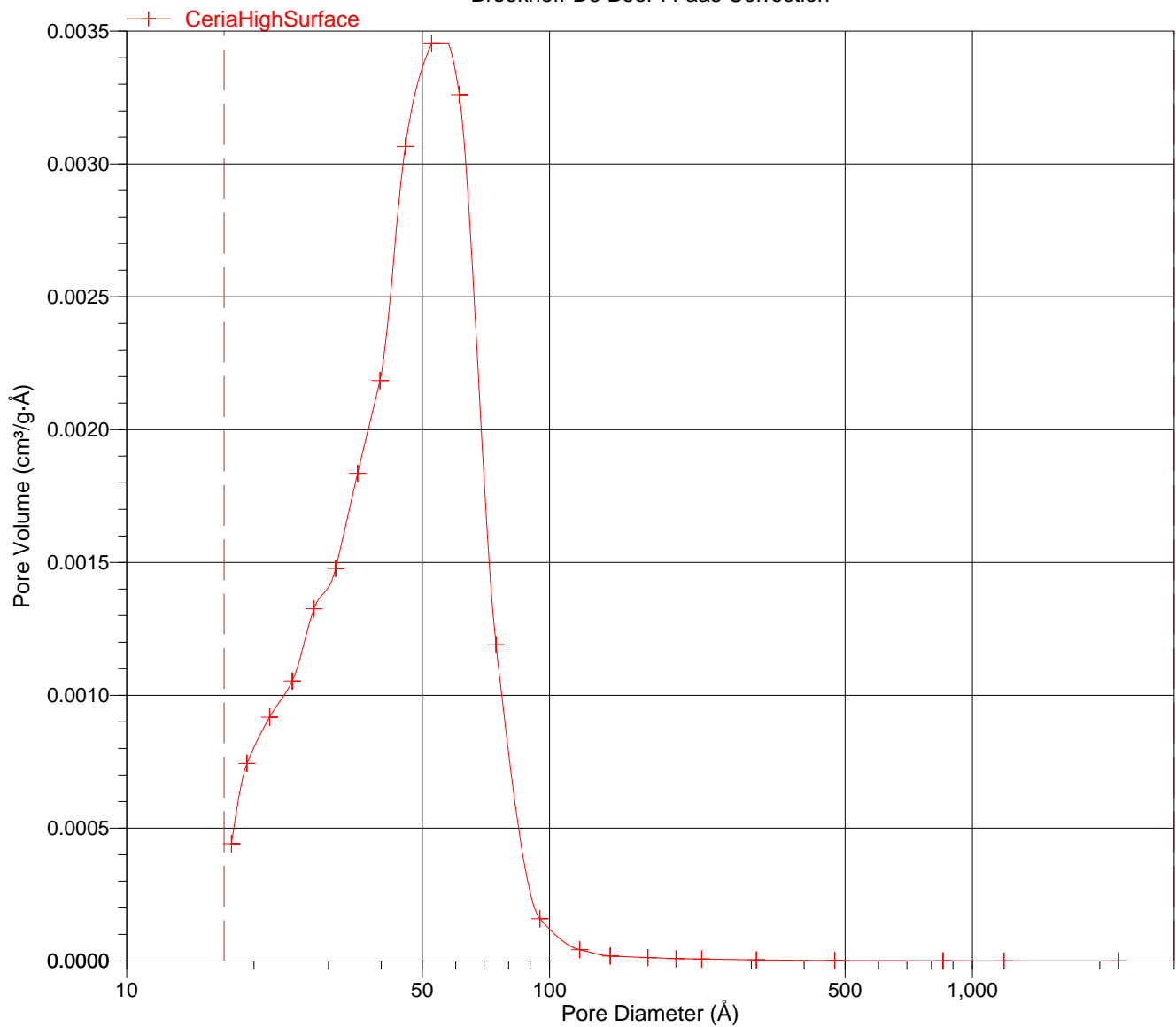
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BJH Adsorption dV/dD Pore Volume

Broekhoff-De Boer : Faas Correction



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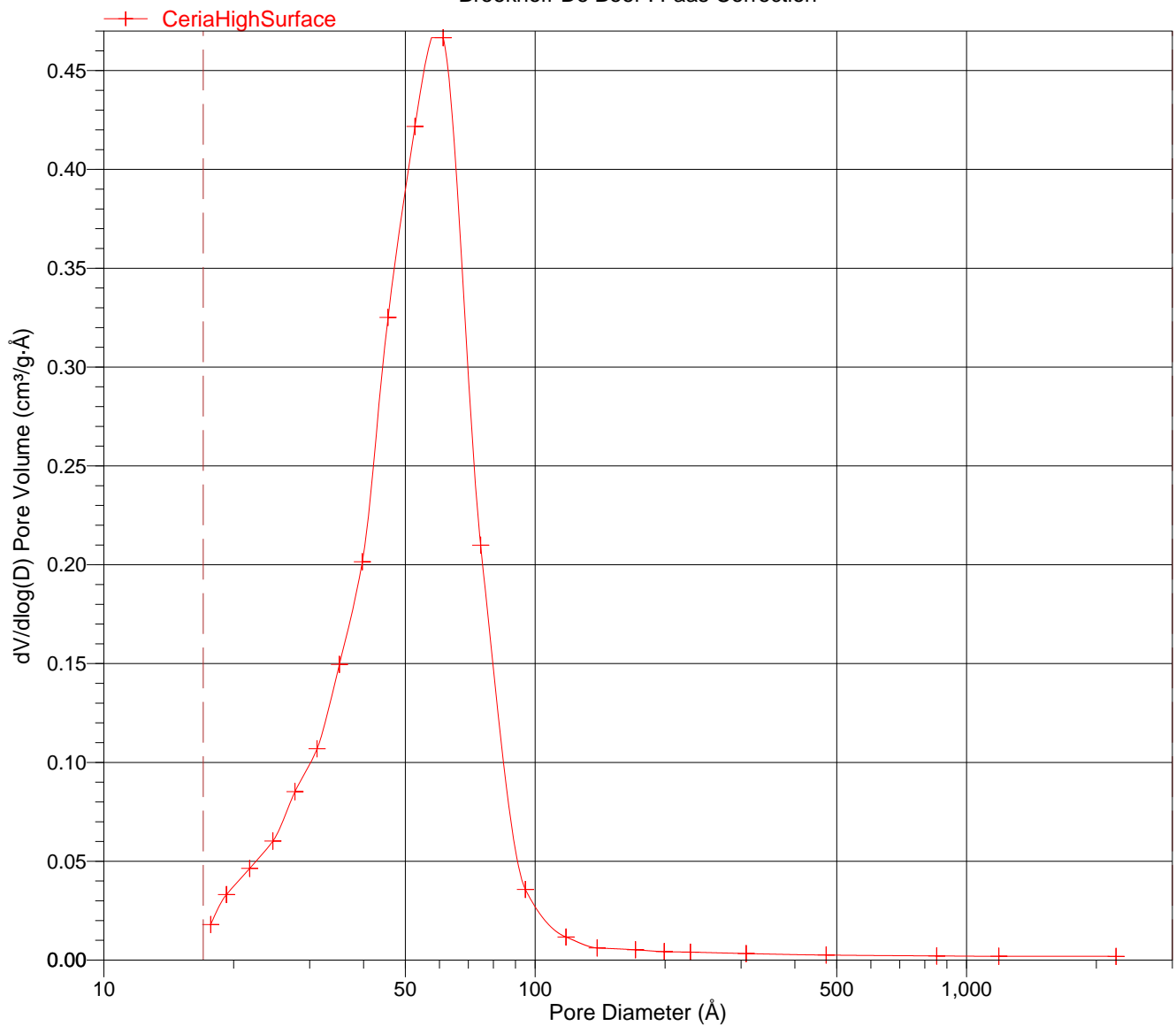
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Low Pressure Dose: None
Automatic Degas: No

BJH Adsorption dV/dlog(D) Pore Volume

Broekhoff-De Boer : Faas Correction



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BJH Desorption Pore Distribution Report

Faas Correction
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Pore Diameter Range (Å)	Average Diameter (Å)	Incremental Pore Volume (cm ³ /g)	Cumulative Pore Volume (cm ³ /g)	Incremental Pore Area (m ² /g)	Cumulative Pore Area (m ² /g)
3914.2 - 753.2	861.0	0.001007	0.001007	0.047	0.047
753.2 - 312.1	373.5	0.001099	0.002106	0.118	0.164
312.1 - 223.5	252.8	0.000589	0.002694	0.093	0.258
223.5 - 176.1	193.9	0.000491	0.003185	0.101	0.359
176.1 - 166.5	171.0	0.000146	0.003331	0.034	0.393
166.5 - 139.5	150.4	0.000404	0.003735	0.107	0.500
139.5 - 119.7	128.0	0.000449	0.004184	0.140	0.641
119.7 - 104.3	110.9	0.000428	0.004612	0.154	0.795
104.3 - 83.4	91.3	0.000872	0.005483	0.382	1.177
83.4 - 68.8	74.6	0.001580	0.007064	0.848	2.024
68.8 - 58.5	62.7	0.004501	0.011565	2.870	4.895
58.5 - 49.7	53.3	0.035159	0.046724	26.383	31.278
49.7 - 42.9	45.7	0.057246	0.103971	50.088	81.365
42.9 - 38.0	40.1	0.022380	0.126351	22.325	103.691
38.0 - 33.2	35.2	0.014200	0.140550	16.114	119.805
33.2 - 28.9	30.7	0.008645	0.149195	11.263	131.067
28.9 - 26.7	27.7	0.001998	0.151193	2.886	133.953
26.7 - 23.8	25.0	0.002260	0.153453	3.608	137.561
23.8 - 20.9	22.1	0.001589	0.155042	2.870	140.431
20.9 - 18.4	19.5	0.000833	0.155874	1.709	142.140

Full Report Set

TriStar II 3020 V1.03 (V1.03)

Unit 1 Port 1

Serial #: 731

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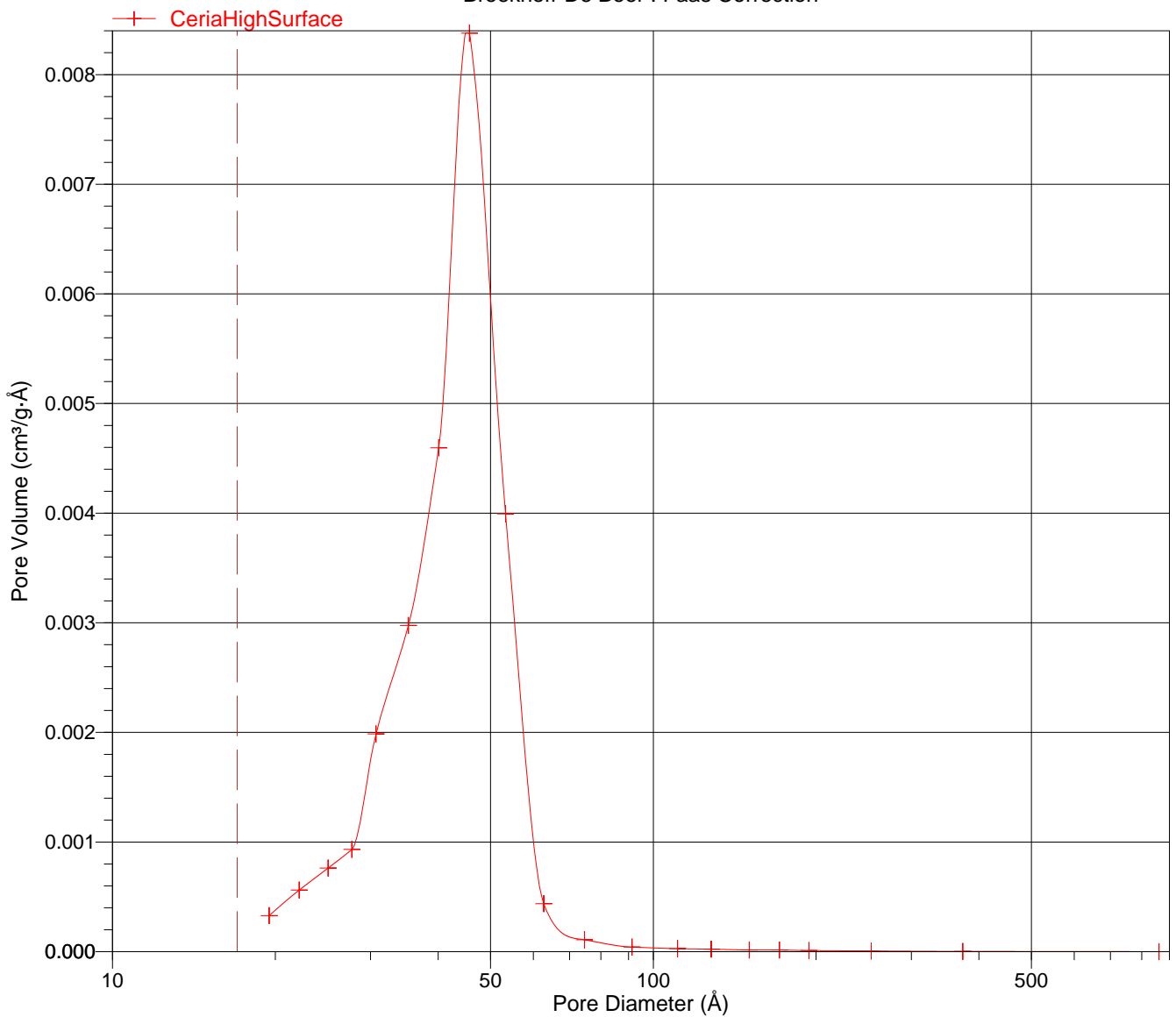
Sample: CeriaHighSurface
Operator: Karl Magnus
Submitter:
File: C:\...\AKARLM-1\CERIAH.SMP

Started: 04.10.2013 12:00:18
Completed: 04.10.2013 15:14:07
Report Time: 04.10.2013 21:02:58
Warm Free Space: 11.5271 cm³ Measured
Equilibration Interval: 5 s
Sample Density: 1.000 g/cm³

Analysis Adsorptive: N₂
Analysis Bath Temp.: -195.850 °C
Sample Mass: 0.1207 g
Cold Free Space: 33.3766 cm³ Measured
Low Pressure Dose: None
Automatic Degas: No

BJH Desorption dV/dD Pore Volume

Broekhoff-De Boer : Faas Correction



Full Report Set

TriStar II 3020 V1.03 (V1.03)

Unit 1 Port 1

Serial #: 731

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Sample: CeriaHighSurface
Operator: Karl Magnus
Submitter:
File: C:\...\AKARLM-1\CERIAH.SMP

Started: 04.10.2013 12:00:18
Completed: 04.10.2013 15:14:07
Report Time: 04.10.2013 21:02:58
Warm Free Space: 11.5271 cm³ Measured
Equilibration Interval: 5 s
Sample Density: 1.000 g/cm³
Analysis Adsorptive: N2
Analysis Bath Temp.: -195.850 °C
Sample Mass: 0.1207 g
Cold Free Space: 33.3766 cm³ Measured
Low Pressure Dose: None
Automatic Degas: No

Options Report

Sample Tube

Warm free space: 3.7700 cm³
Cold free space: 3.7700 cm³
Non-ideality factor: 0.0000620
Use Isothermal Jacket: Yes
Use Filler Rod: No
Vacuum seal type: None

Analysis Conditions

Preparation

Fast evacuation: No
Evacuation rate: 5.0 mmHg/s
Unrestricted evacuation from: 5.0 mmHg
Evacuation time: 0.10 h
Leak test: Yes
Leak test duration: 120 s
Use TranSeal: No

Free Space

Free-space type: Measured
Lower dewar for evacuation: Yes
Evacuation time: 0.20 h
Outgas test: No

Po and Temperature

Po and T type: Measure Po in the Po tube for each isotherm point. Enter the Analysis Bath Temperature below.
Temperature: -195.850 °C

Dosing

Use first pressure fixed dose: No
Use maximum volume increment: No
Target tolerance: 5.0% or 5.000 mmHg

Equilibration

Equilibration interval: 5 s
Minimum equilibration delay at P/Po >= 0.995: 600 s

Sample Backfill

Backfill at start of analysis: Yes
Backfill at end of analysis: Yes
Backfill gas: N2

Adsorptive Properties

Adsorptive: Nitrogen
Maximum manifold pressure: 1050.00 mmHg
Non-ideality factor: 0.0000620
Density conversion factor: 0.0015468
Molecular cross-sectional area: 0.162 nm²

Full Report Set

TriStar II 3020 V1.03 (V1.03)

Unit 1 Port 1

Serial #: 731

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Sample: CeriaHighSurface
Operator: Karl Magnus
Submitter:
File: C:\...\AKARLM~1\CERIAH.SMP

Started: 04.10.2013 12:00:18
Completed: 04.10.2013 15:14:07
Report Time: 04.10.2013 21:02:59
Warm Free Space: 11.5271 cm³ Measured
Equilibration Interval: 5 s
Sample Density: 1.000 g/cm³

Analysis Adsorptive: N2
Analysis Bath Temp.: -195.850 °C
Sample Mass: 0.1207 g
Cold Free Space: 33.3766 cm³ Measured
Low Pressure Dose: None
Automatic Degas: No

Validation Report

Isotherm Reports

Free Space: Low free space values may be observed when using liquid argon or ice baths.

Po: Passed

Pressure/Volume Adsorbed: Passed

Desorption: Not within limits. Increase the sample mass, increase the equilibration interval, or check the free space.