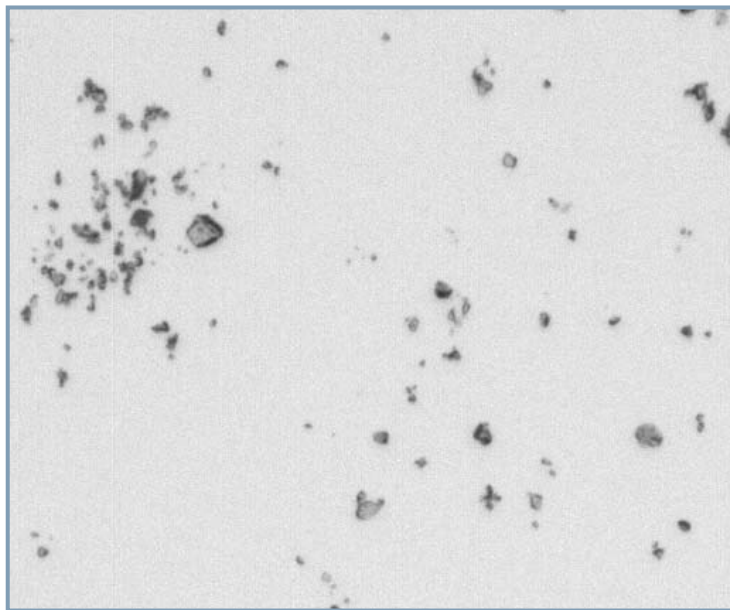


CLEMEX
intelligent microscopy

746

Particle Size Analysis



Prepared by Myriam Savard Eng.
Clemex Technologies Inc.
For Cambridge Testing

Sample Description

One sample of mono ammonium phosphate powder was submitted for analysis.

Purpose of Analysis

To demonstrate that the Clemex Vision image analysis system can discriminate the particles and perform size measurements on them.

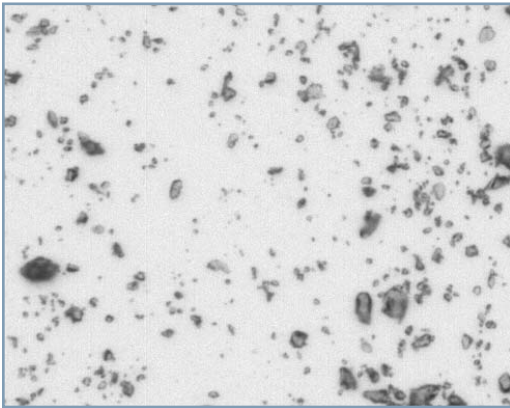


Figure 1: Part of the original image (0.6173 microns/pixel).

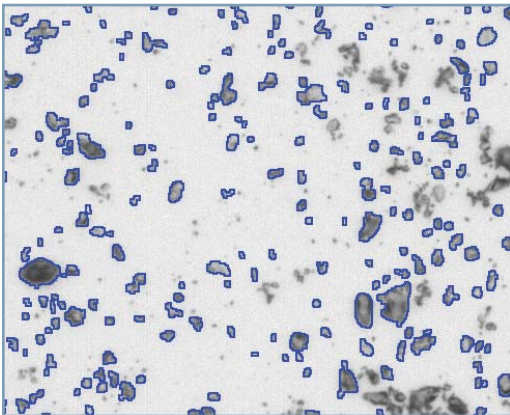


Figure 2: Outline of particles as measured in blue bitplane.

Procedure¹

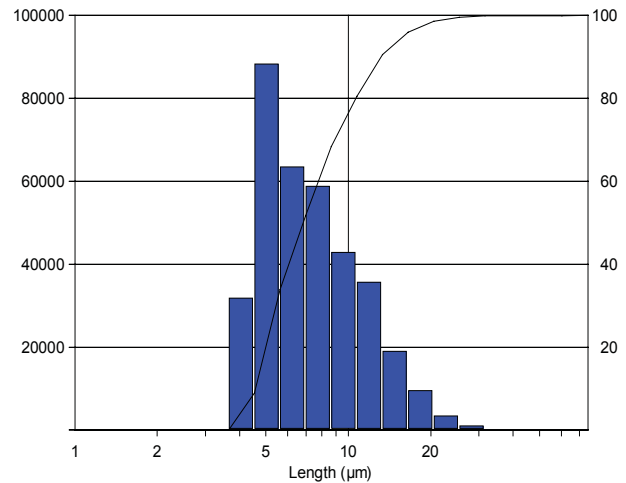
A small part of the sample was dispersed on a slide. The camera exposure time was automatically set for a perfect and constant lightening. A Guard Frame was used to avoid measuring features sectioned by the field of view.

A few intermediate gray levels were eliminated at features / background transition to facilitate their detection. Particles were binarized in blue using Contrast Thresholding.

Holes were filled in and a small cleaning was done. Connected particles were eliminated prior to measurements.

Results²

Length, Width, Circular Diameter, and Ellipsoidal Volume measurements were performed on each feature. Automated statistics and graphs were generated and cumulated. Final results were printed directly from Clemex Vision and saved for further use. A customized report was built using the Report Generator module. Raw data is linked to their respective objects for validation purposes. Raw data could also be exported in Excel format.



Minimum: 3.7 microns
Maximum: 64.7 microns
Mean: 8.02 microns
Std Dev.: 3.93 microns

Figure 3: Particles' Length distribution and corresponding statistics.

Equipment

Image Analysis System: Clemex Vision PE V5.0
Stereoscope: Leica Z6 APOA
Objective/Magnification: 7.2x / 72x
Illumination: Transmitted Light
Calibration: 0.6172839506 microns/pixel
Camera: Clemex L2.1M (1608 x 1212)
Motorized Stage: Marzhauser EK32IM 75x50mm

Discussion

This analysis was straightforward and present no particular problem.

A separate could have been applied on agglomerations to increase the quantity of measured particles. Remaining connected ones could still be eliminated. However, since the quantity of isolated particles was sufficient, no additional steps were executed keeping the analysis time to the minimum.

¹ Images taken during the procedure are available in appendix A

² Complete results are available in appendix B.



Appendix A: Image Analysis Steps

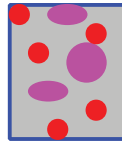


Image Analysis Steps

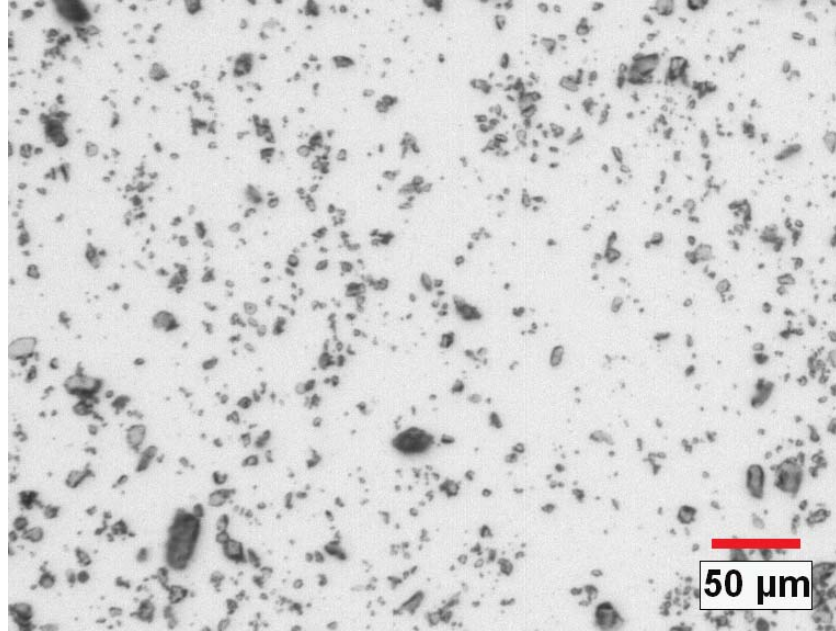


Image 1: Part of the original image at 72x magnification (0.6173 mic./pixel).

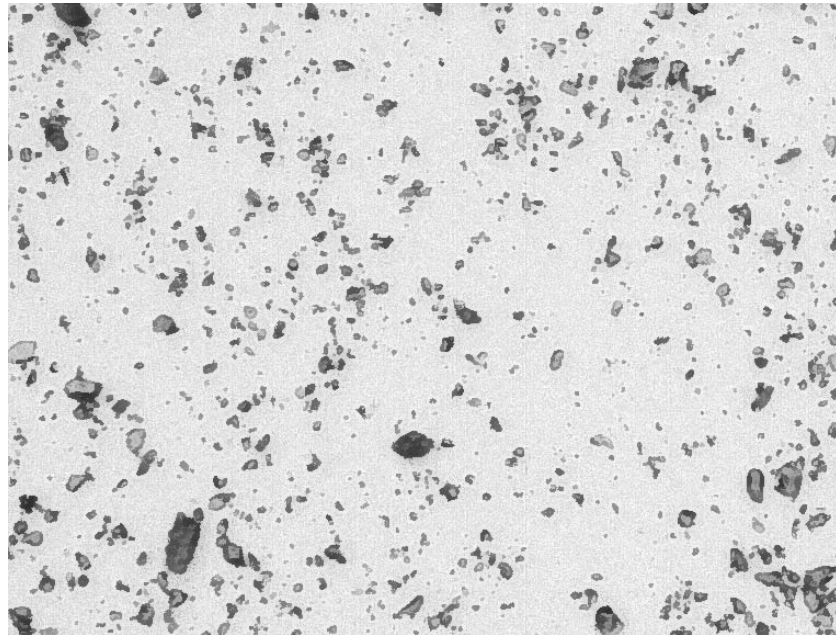


Image 2: Gray image enhanced by a delineate.

Image Analysis Steps

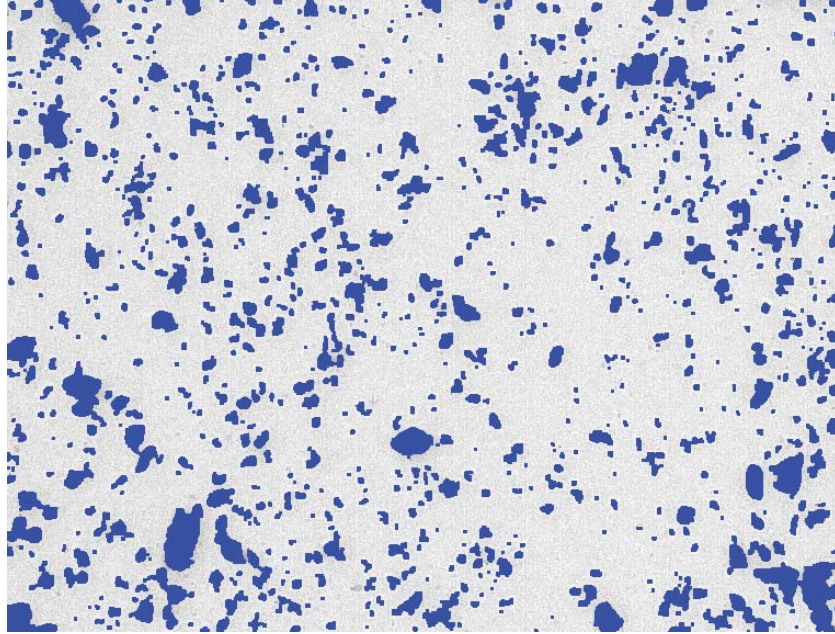


Image 3: Particles as binarized in blue using contrast thresholding.

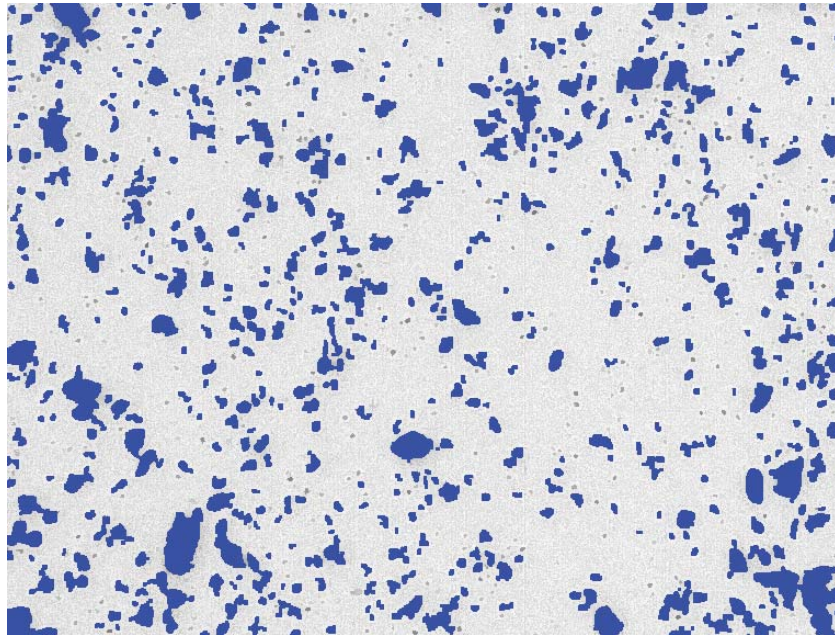


Image 4: Same view after filling holes and eliminating small artifacts.

Image Analysis Steps

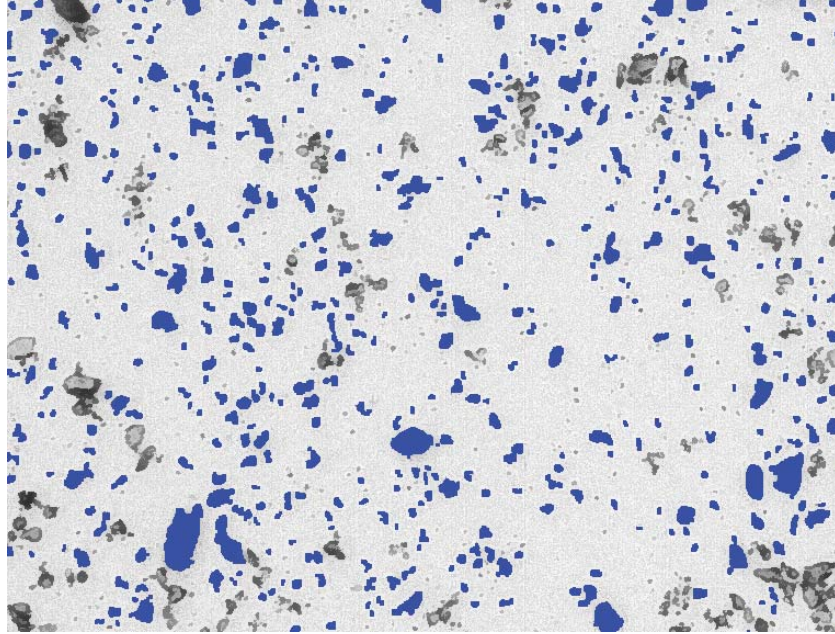


Image 5: Clusters were eliminated based on their roughness.

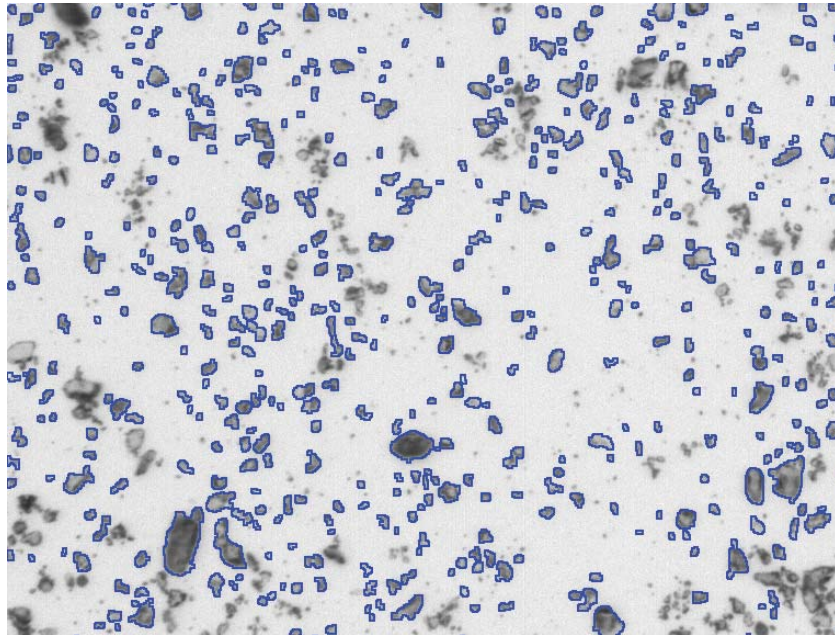
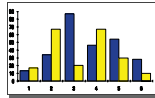


Image 6: Outline view of the particles as measured, on top of the original image.



Appendix B: Results



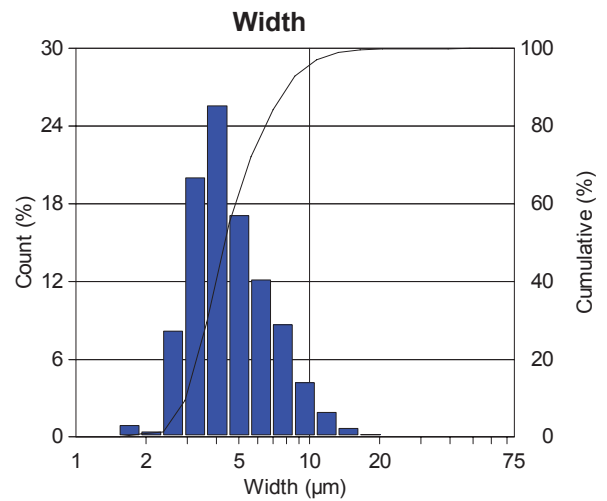
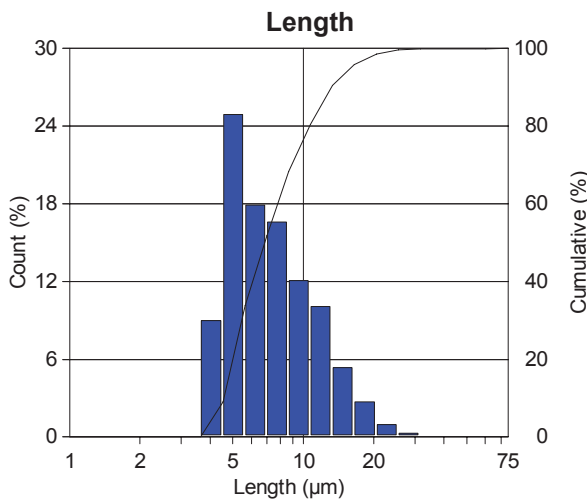
**One Page Report produced
using the Report Generator tool**

Particle Sizing

Date: 2007-Oct-01, 3:57:39 PM -04'00'
Company: Clemex
Department: Laboratory
User Name: clemex (signed on 200...)
Sample ID: Sample 1

Magnification: 72x
Calibration: 0.6173 $\mu\text{m}/\text{pixel}$
Units: microns
Fields: 630
Particle Count: 354413

Figure 1: Field of view showing the longest particle found.



Min:	3.70	microns	1.85	microns
Max.:	64.74	microns	42.05	microns
Mean:	8.02	microns	5.00	microns
Std. Dev.:	3.93	microns	2.36	microns
D10:	4.49	microns	3.01	microns
D50:	6.78	microns	4.29	microns
D90:	13.20	microns	7.98	microns

**Results printed directly
from Clemex Vision**

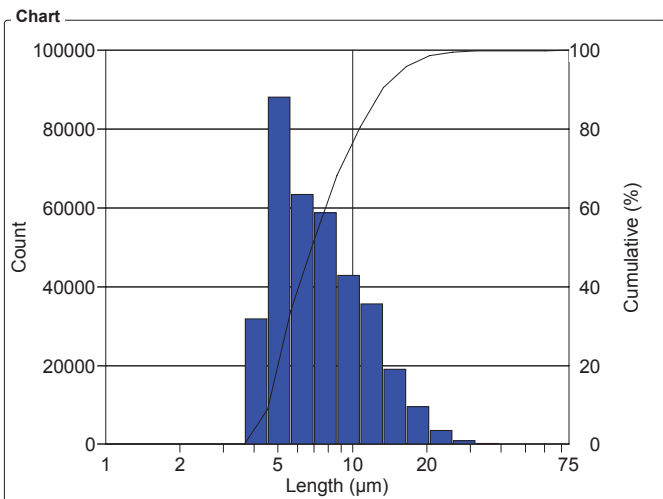
Particle Sizing

Organization: **Clemex**
 Department: **Laboratory**
 User: **clemex (signed on 2007-Sep-29 18:02:31 -04'00')**

Date & Time: **02/10/2007 14:03:59 PM**
 Sample: **Sample 1**

OBJM1 Count - Length

Magn.: 72x Calib.: 0.6173 µm/pixel Bitplane: Bitplane 1

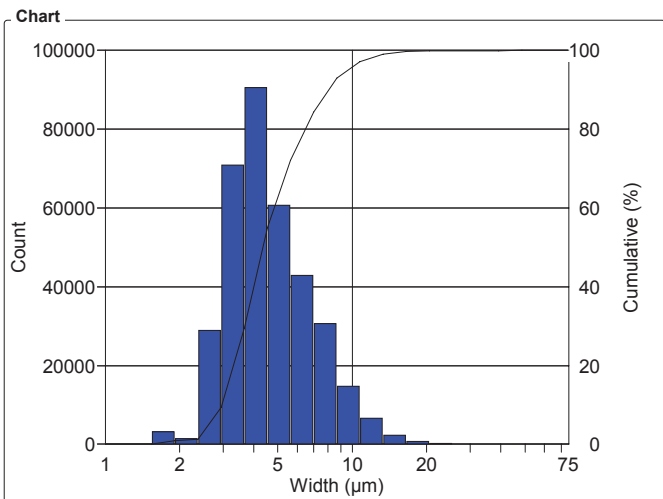


Length Intervals (µm)	Count	%	Cumul%
1 - 1.2	0	0	0
1.2 - 1.5	0	0	0
1.5 - 1.9	0	0	0
1.9 - 2.4	0	0	0
2.4 - 2.9	0	0	0
2.9 - 3.7	0	0	0
3.7 - 4.5	31804	8.97	8.97
4.5 - 5.6	88255	24.90	33.88
5.6 - 7	63464	17.91	51.78
7 - 8.7	58845	16.60	68.39
8.7 - 10.7	42907	12.11	80.49
10.7 - 13.3	35690	10.07	90.56
13.3 - 16.5	19056	5.38	95.94
16.5 - 20.5	9588	2.71	98.64
20.5 - 25.5	3468	0.98	99.62
25.5 - 31.6	990	0.28	99.90
31.6 - 39.2	274	0.08	99.98
39.2 - 49	60	0.02	100.00
49 - 60	8	2.26e-03	100.00
60 - 75	4	1.13e-03	100

Statistics	
Minimum:	3.7 µm
Maximum:	64.7 µm
Mean:	8.02 µm
Std Dev.:	3.93 µm
Sum:	2841926.5 µm
Count:	354413
Under:	0
Over:	0
Accepted:	100 %
Field Count:	310
Field Area:	727331.2 µm ²
Total Area:	225.5e+06 µm ²
D10:	4.5 µm
D50:	6.8 µm
D90:	13.2 µm

OBJM1 Count - Width

Magn.: 72x Calib.: 0.6173 µm/pixel Bitplane: Bitplane 1



Width Intervals (µm)	Count	%	Cumul%
1 - 1.2	0	0	0
1.2 - 1.5	0	0	0
1.5 - 1.9	3153	0.89	0.89
1.9 - 2.4	1426	0.40	1.29
2.4 - 2.9	28991	8.18	9.47
2.9 - 3.7	70904	20.01	29.48
3.7 - 4.5	90620	25.57	55.05
4.5 - 5.6	60645	17.11	72.16
5.6 - 7	42998	12.13	84.29
7 - 8.7	30714	8.67	92.96
8.7 - 10.7	14816	4.18	97.14
10.7 - 13.3	6690	1.89	99.02
13.3 - 16.5	2355	0.66	99.69
16.5 - 20.5	786	0.22	99.91
20.5 - 25.5	239	0.07	99.98
25.5 - 31.6	65	0.02	100.00
31.6 - 39.2	10	2.83e-03	100.00
39.2 - 49	1	280.14e-06	100
49 - 60	0	0	100
60 - 75	0	0	100

Statistics	
Minimum:	1.9 µm
Maximum:	42.1 µm
Mean:	5.00 µm
Std Dev.:	2.36 µm
Sum:	1770392.1 µm
Count:	354413
Under:	0
Over:	0
Accepted:	100 %
Field Count:	310
Field Area:	727331.2 µm ²
Total Area:	225.5e+06 µm ²
D10:	3.0 µm
D50:	4.3 µm
D90:	8.0 µm

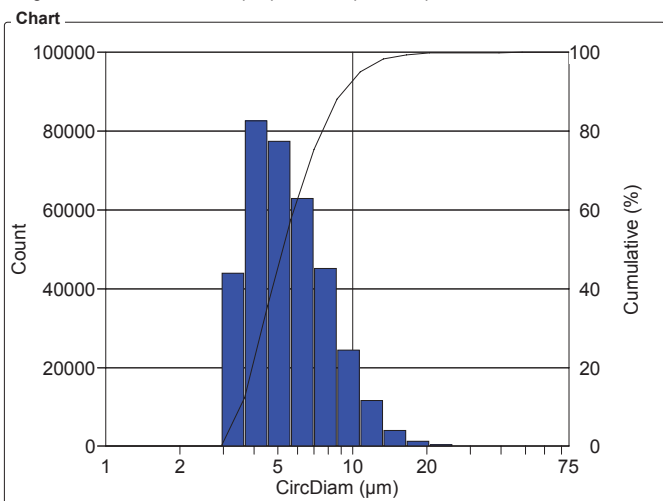
Particle Sizing

Organization: **Clemex**
 Department: **Laboratory**
 User: **clemex (signed on 2007-Sep-29 18:02:31 -04'00')**

Date & Time: **02/10/2007 14:03:59 PM**
 Sample: **Sample 1**

OBJM1 Count - CircDiam

Magn.: 72x Calib.: 0.6173 µm/pixel Bitplane: Bitplane 1

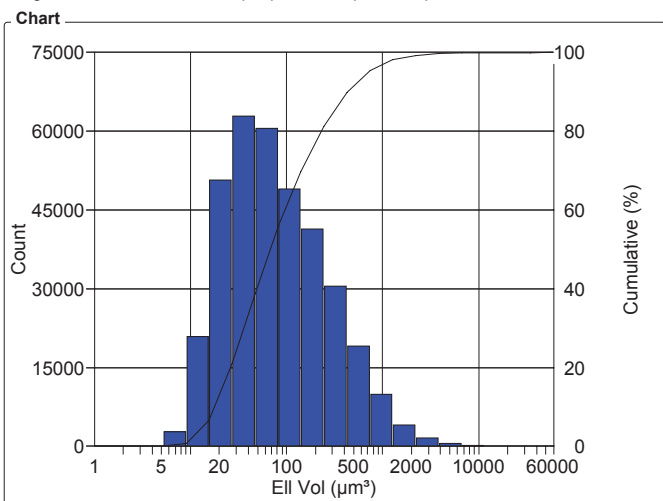


Values			
CircDiam Intervals (µm)	Count	%	Cumul%
1 - 1.2	0	0	0
1.2 - 1.5	0	0	0
1.5 - 1.9	0	0	0
1.9 - 2.4	0	0	0
2.4 - 2.9	6	1.69e-03	1.69e-03
2.9 - 3.7	43926	12.39	12.40
3.7 - 4.5	82585	23.30	35.70
4.5 - 5.6	77509	21.87	57.57
5.6 - 7	62989	17.77	75.34
7 - 8.7	45199	12.75	88.09
8.7 - 10.7	24457	6.90	94.99
10.7 - 13.3	11706	3.30	98.30
13.3 - 16.5	4106	1.16	99.46
16.5 - 20.5	1348	0.38	99.84
20.5 - 25.5	429	0.12	99.96
25.5 - 31.6	127	0.04	99.99
31.6 - 39.2	22	6.21e-03	100.00
39.2 - 49	4	1.13e-03	100
49 - 60	0	0	100
60 - 75	0	0	100

Statistics	
Minimum:	2.4 µm
Maximum:	46.6 µm
Mean:	5.88 µm
Std Dev.:	2.53 µm
Sum:	2084275.5 µm
Count:	354413
Under:	0
Over:	0
Accepted:	100 %
Field Count:	310
Field Area:	727331.2 µm ²
Total Area:	225.5e+06 µm ²
D10:	3.6 µm
D50:	5.1 µm
D90:	9.1 µm

OBJM1 Count - Ell Vol

Magn.: 72x Calib.: 0.6173 µm/pixel Bitplane: Bitplane 1



Values			
Ell Vol Intervals (µm ²)	Count	%	Cumul%
1 - 1.7	0	0	0
1.7 - 3	0	0	0
3 - 5.2	0	0	0
5.2 - 9	2834	0.80	0.80
9 - 16	20981	5.92	6.72
16 - 27	50684	14.30	21.02
27 - 47	62853	17.73	38.75
47 - 82	60512	17.07	55.83
82 - 141	49076	13.85	69.68
141 - 245	41342	11.66	81.34
245 - 425	30492	8.60	89.94
425 - 736	19157	5.41	95.35
736 - 1276	9879	2.79	98.14
1276 - 2212	4103	1.16	99.29
2212 - 3834	1611	0.45	99.75
3834 - 6645	590	0.17	99.92
6645 - 11519	213	0.06	99.98
11519 - 19968	67	0.02	99.99
19968 - 34613	16	4.51e-03	100.00
34613 - 60000	3	846.39e-06	100

Statistics	
Minimum:	6.7 µm ²
Maximum:	58442.6 µm ²
Mean:	191.1 µm ²
Std Dev.:	514.8 µm ²
Sum:	67.7e+06 µm ²
Count:	354413
Under:	0
Over:	0
Accepted:	100 %
Field Count:	310
Field Area:	727331.2 µm ²
Total Area:	225.5e+06 µm ²
D10:	20.7 µm ²
D50:	66.9 µm ²
D90:	426.9 µm ²

Particle Sizing

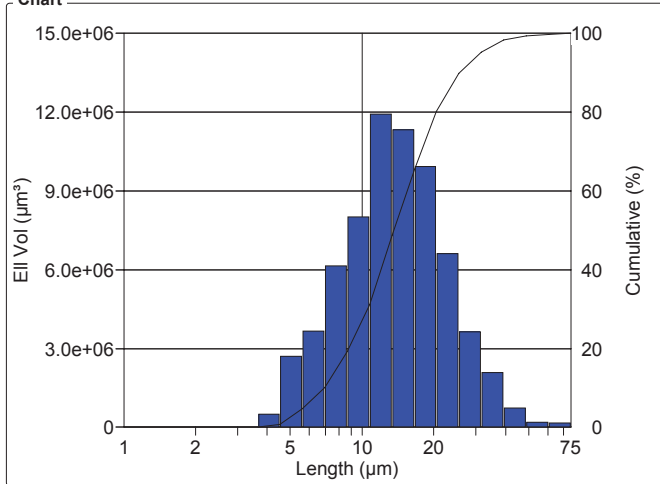
Organization: **Clemex**
 Department: **Laboratory**
 User: **clemex (signed on 2007-Sep-29 18:02:31 -04'00')**

Date & Time: **02/10/2007 14:03:59 PM**
 Sample: **Sample 1**

OBJM1 EII Vol - Length

Magn.: 72x Calib.: 0.6173 $\mu\text{m}/\text{pixel}$ Bitplane: Bitplane 1

Chart



Values

Length Intervals (µm)	EII Vol (µm³)	%	Cumul%
1 - 1.2	0	0	0
1.2 - 1.5	0	0	0
1.5 - 1.9	0	0	0
1.9 - 2.4	0	0	0
2.4 - 2.9	0	0	0
2.9 - 3.7	0	0	0
3.7 - 4.5	517374.4	0.76	0.76
4.5 - 5.6	2712060	4.01	4.77
5.6 - 7	3667514	5.42	10.19
7 - 8.7	6156431.5	9.09	19.28
8.7 - 10.7	8017631	11.84	31.12
10.7 - 13.3	11.9e+06	17.62	48.74
13.3 - 16.5	11.3e+06	16.74	65.48
16.5 - 20.5	9940544	14.68	80.16
20.5 - 25.5	6607099.5	9.76	89.92
25.5 - 31.6	3643118.3	5.38	95.30
31.6 - 39.2	2075493.5	3.07	98.36
39.2 - 49	744346.6	1.10	99.46
49 - 60	200417.8	0.30	99.76
60 - 75	165003.5	0.24	100

Statistics

Minimum:	3.7	µm
Maximum:	64.7	µm
Mean:	15.3	µm
Std Dev.:	8.12	µm
Sum:	1.0e+09	µm
Count:	354413	
Under:	0	
Over:	0	
Accepted:	100	%
Field Count:	310	
Field Area:	727331.2	µm²
Total Area:	225.5e+06	µm²
D10:	6.9	µm
D50:	13.6	µm
D90:	25.5	µm

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