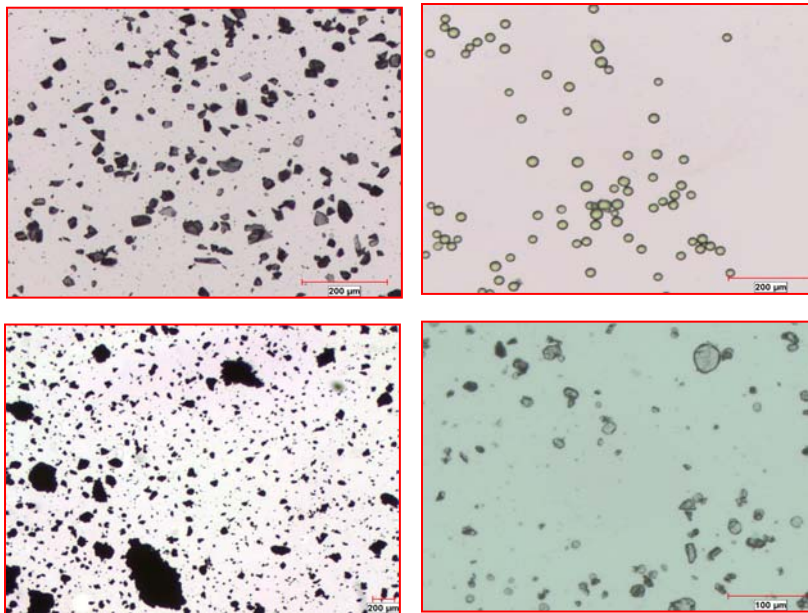


CLEMEX

Image Analysis Report

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Particle Size Analysis

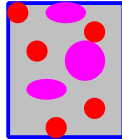


Clemex Technologies Inc.

CLEMEX

Image Analysis Report

Images Processing



Main Steps of Image Processing

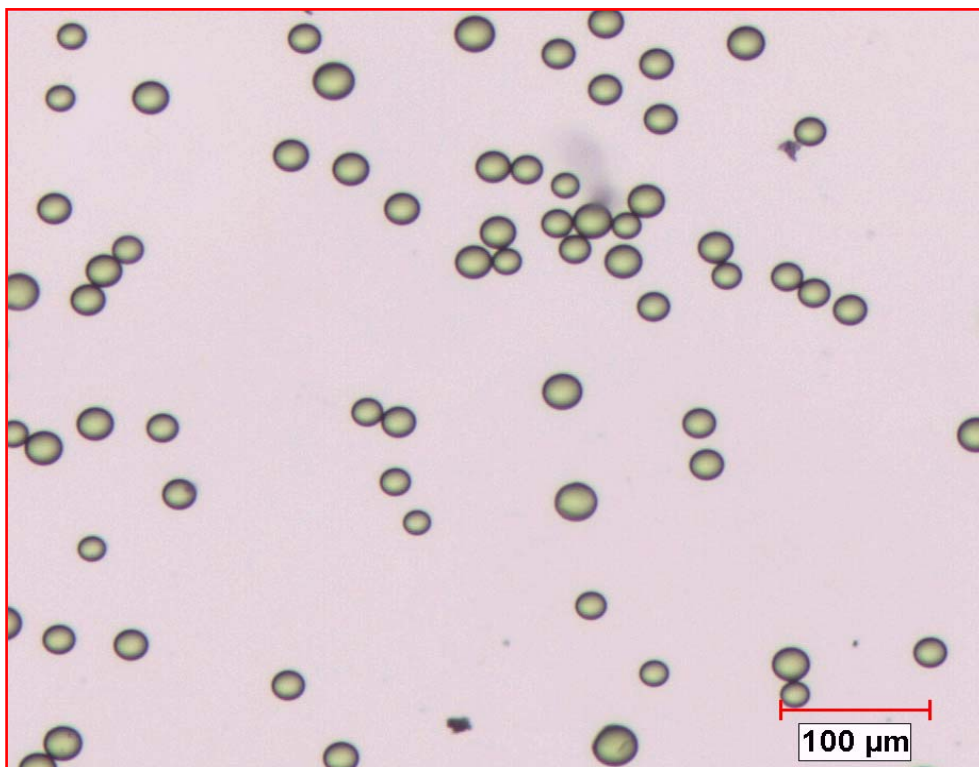


Figure 1: Part of the original image at 100x (0.7308 microns / pixel)

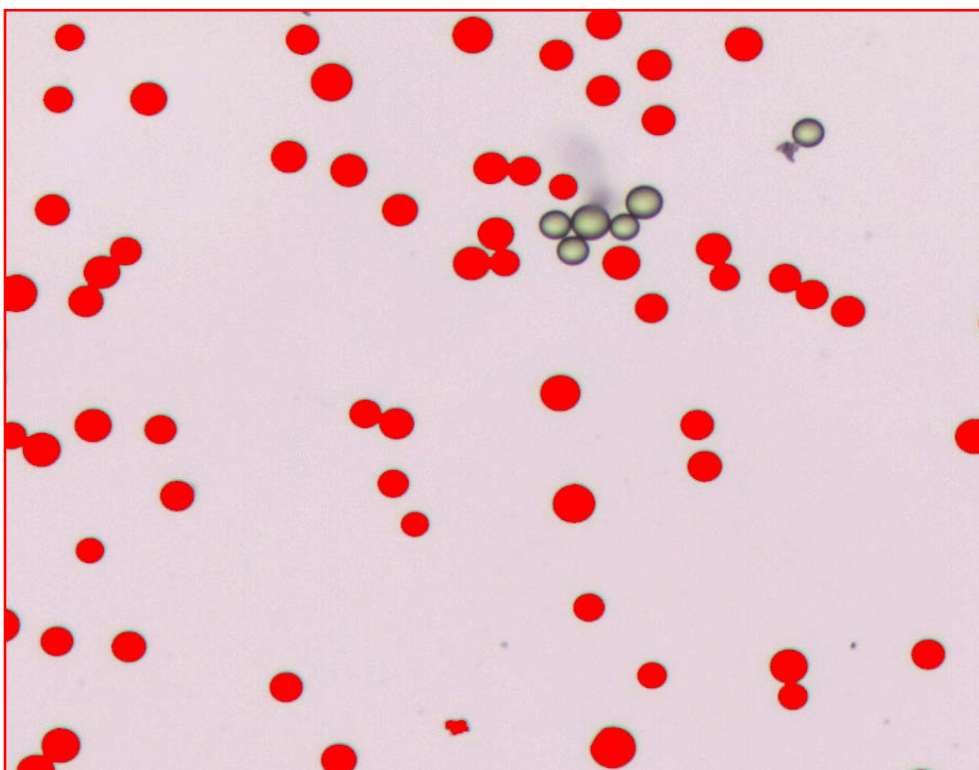


Figure 2: Particles as binarized.

Main Steps of Image Processing

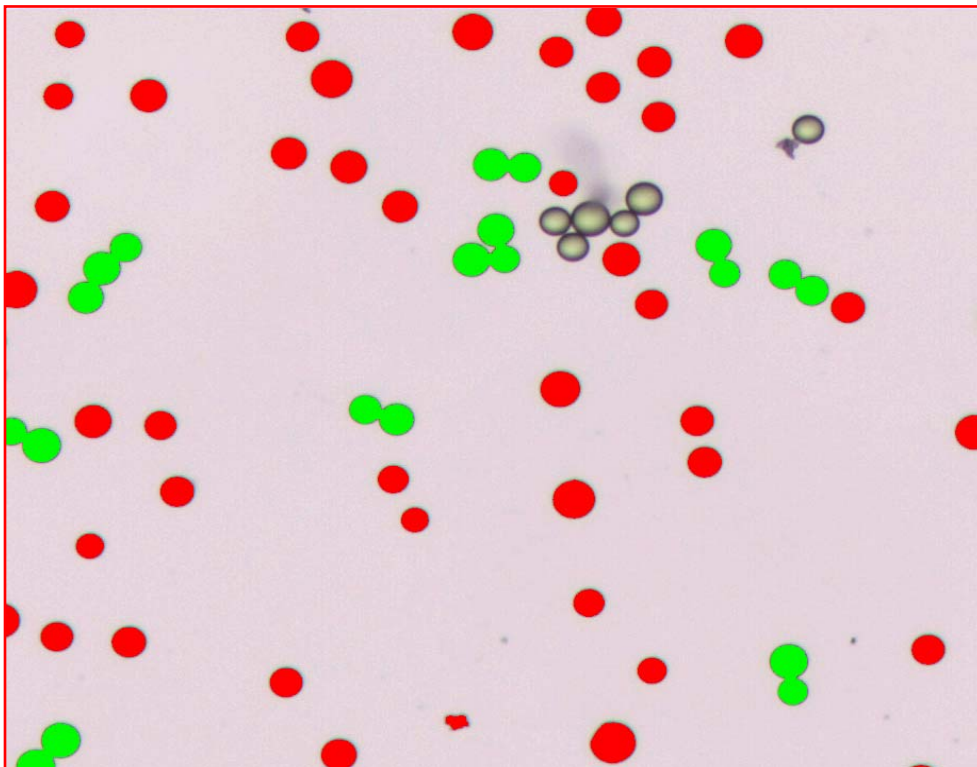


Figure 3: Connected particles are isolated into green bitplane for further processing.

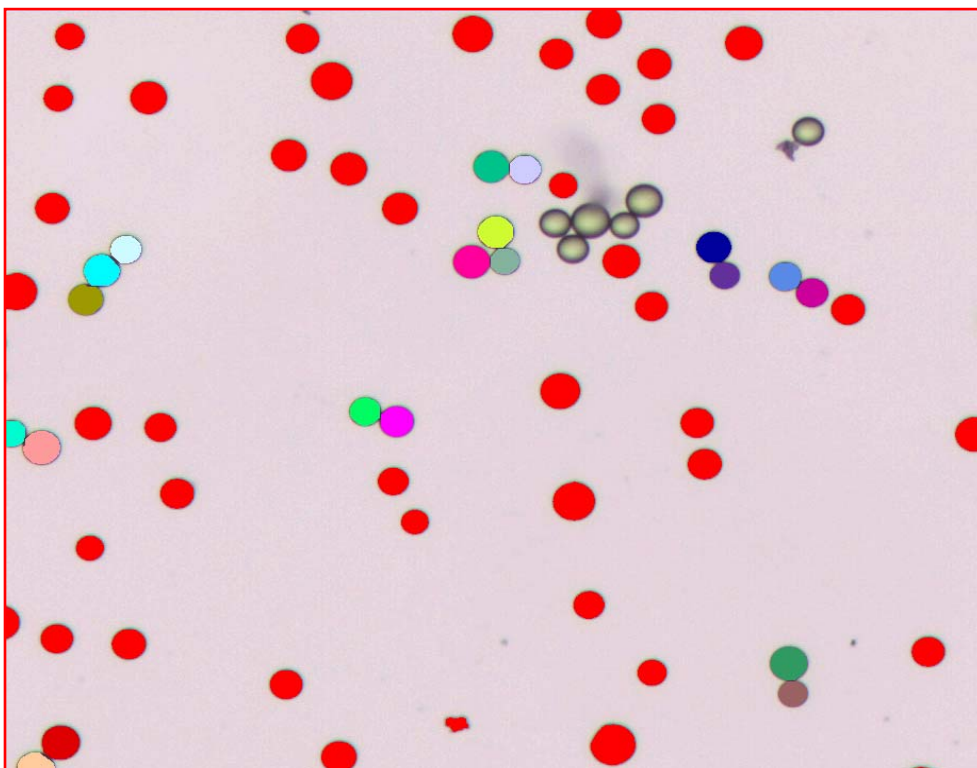


Figure 4: Separated features are shown in labelling view (different color for each particle).

Main Steps of Image Processing

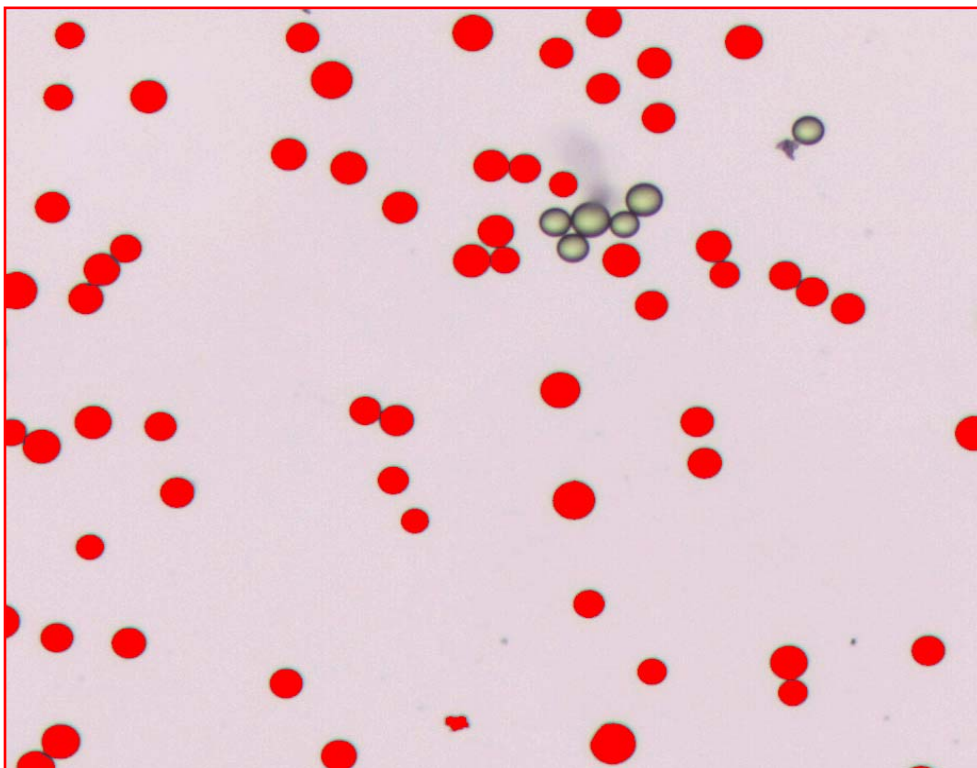


Figure 5: Separated particles are added back to the original isolated ones.

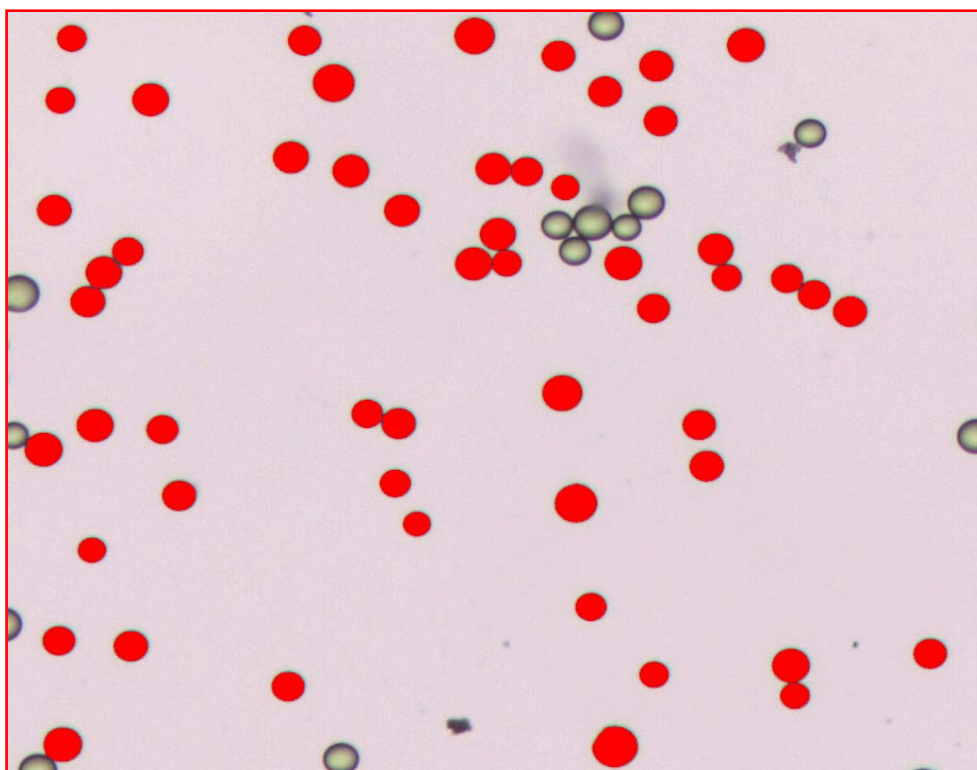


Figure 4: Artifacts are eliminated prior to measurements (features that are sectioned, too small or connected).

Main Steps of Image Processing

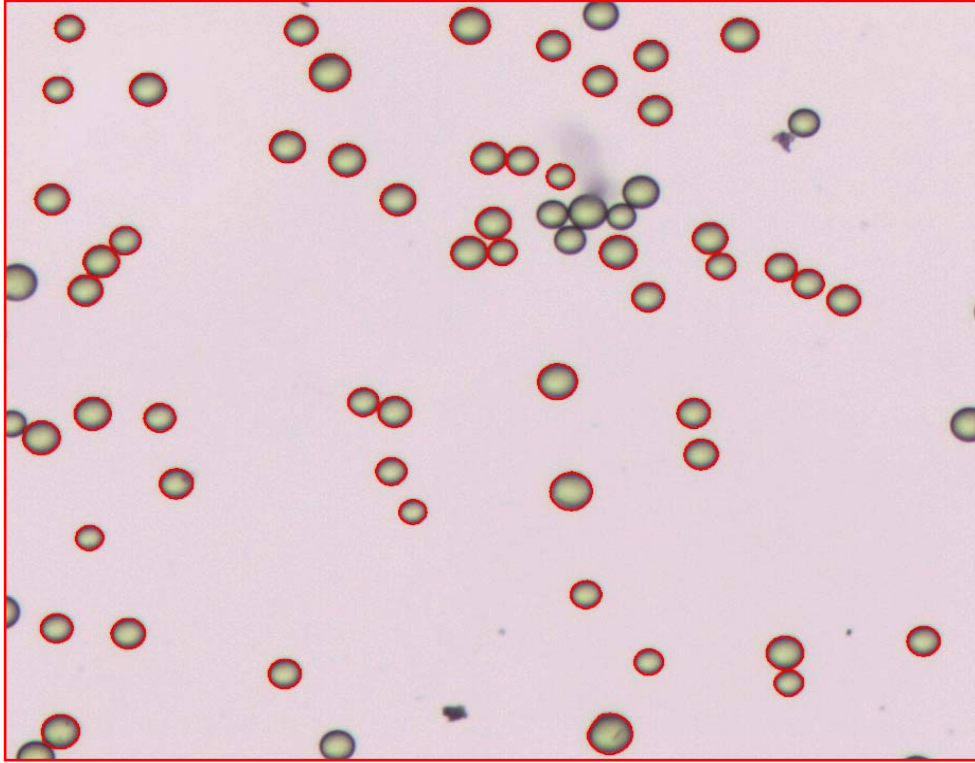
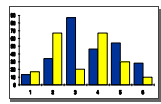


Figure 5: Same image as previous but in outline view mode.

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Image Analysis Report

Results



Sample A

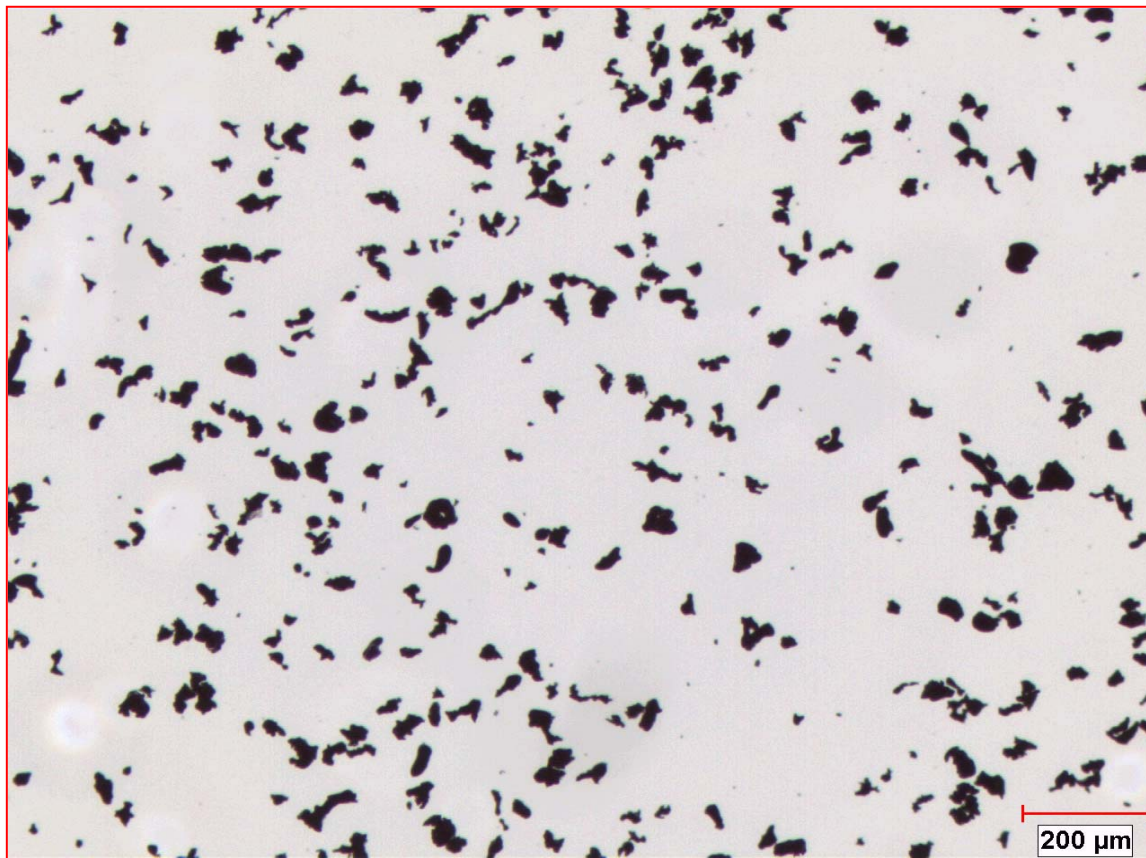
Stainless Steel

Particle Sizing Analysis

Compagny: Clemex
Date: 2006-Mar-31, 2:47:55 PM -05'00'
User: Myriam Savard
Sample ID: A

Magnification: 50x
Calibration: 1.4559 $\mu\text{m}/\text{pixel}$
Units: microns
Fields: 286
Count: 51989

Figure 1: Typical field of view.

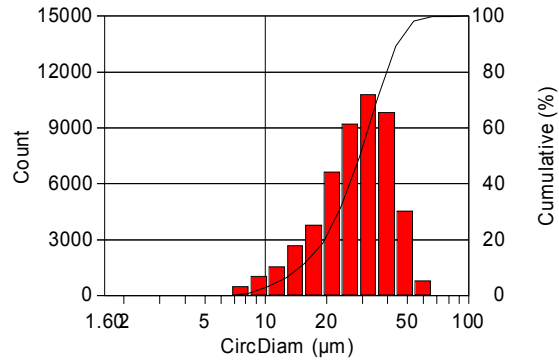


Comments:

This analysis was performed at 50x. The sample was spread on the slide to avoid agglomerates as much as possible. Features that were connected by a small link were separated. Remaining connected ones were eliminated. Particles having a width smaller than twice the optical resolution limit were eliminated from the analysis. At 50x, this means 2×3.15 microns. Many measurements were performed. Their chart and statistics appear in the following pages. Many other measurements are available and we can always create custom ones if needed.

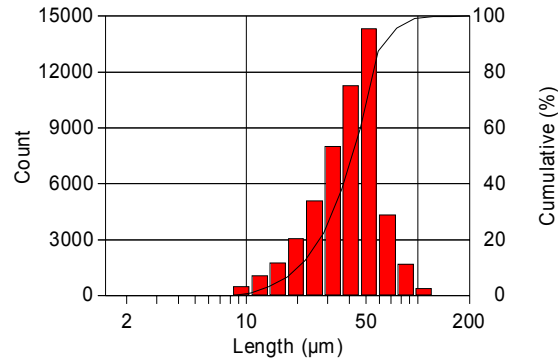
Particle Sizing Analysis

Diameter - Count



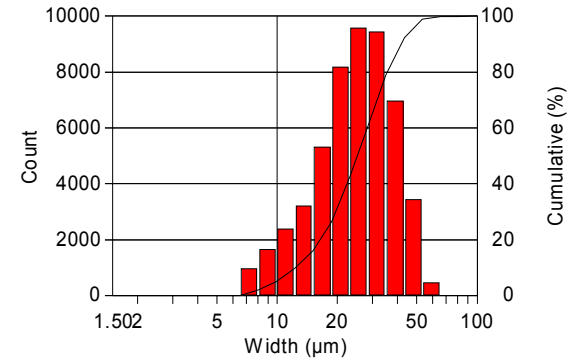
Minimum:	1.64	microns
Maximum:	94.83	microns
Mean:	29.54	microns
Std Dev.:	11.27	microns
D10:	14.70	microns
D50:	29.02	microns
D90:	44.36	microns

Length - Count



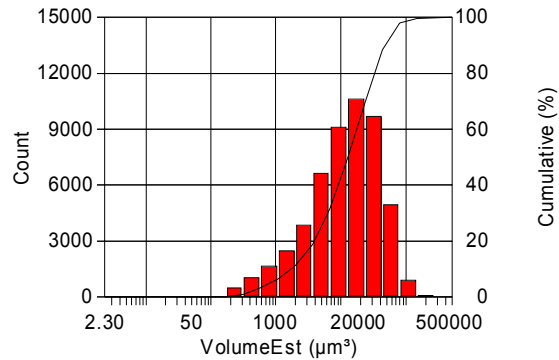
Minimum:	1.46	microns
Maximum:	171.43	microns
Mean:	42.14	microns
Std Dev.:	17.49	microns
D10:	20.13	microns
D50:	41.26	microns
D90:	60.76	microns

Width - Count



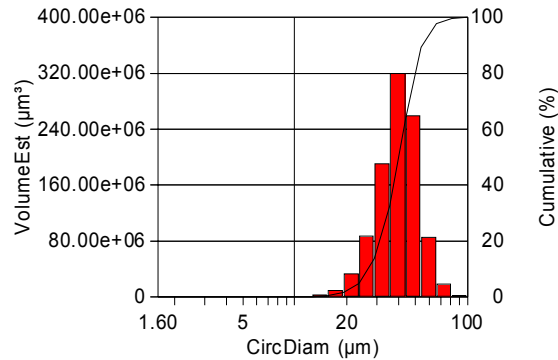
Minimum:	1.46	microns
Maximum:	96.82	microns
Mean:	26.24	microns
Std Dev.:	10.96	microns
D10:	12.22	microns
D50:	25.10	microns
D90:	41.14	microns

Volume - Count



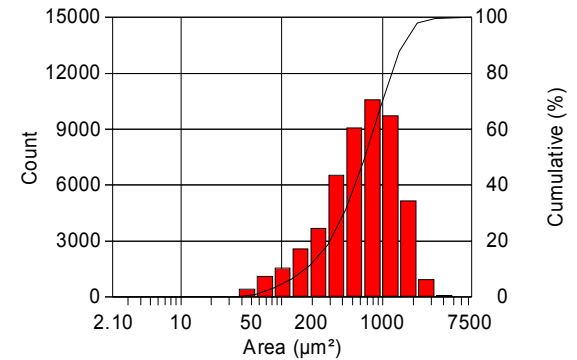
Minimum:	2.32	microns	³
Maximum:	446494.25	microns	³
Mean:	19628.84	microns	³
Std Dev.:	21731.45	microns	³
D10:	1663.62	microns	³
D50:	12792.20	microns	³
D90:	45716.93	microns	³

Diameter - Volume



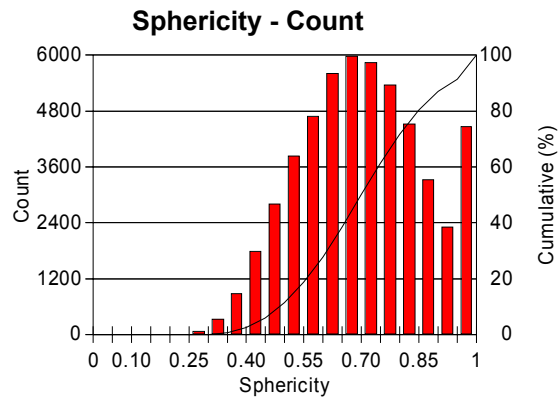
Minimum:	1.64	microns
Maximum:	94.83	microns
Mean:	40.75	microns
Std Dev.:	0.00	microns
D10:	26.91	microns
D50:	40.41	microns
D90:	54.59	microns

Area - Count

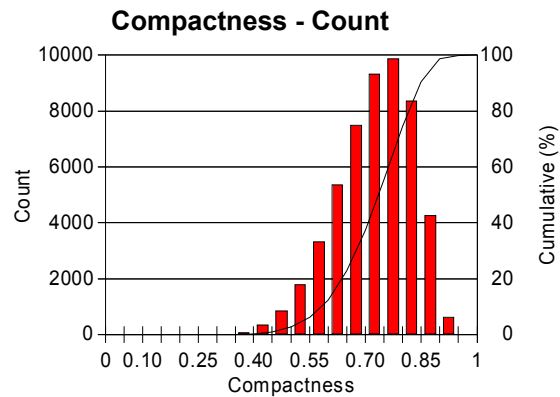


Minimum:	2.12	microns	²
Maximum:	7062.66	microns	²
Mean:	785.08	microns	²
Std Dev.:	570.95	microns	²
D10:	169.74	microns	²
D50:	661.28	microns	²
D90:	1545.76	microns	²

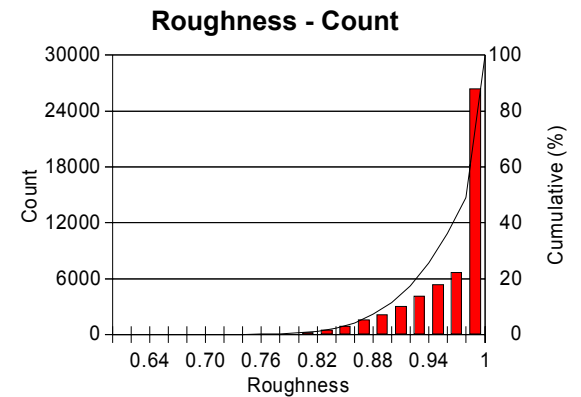
Particle Sizing Analysis



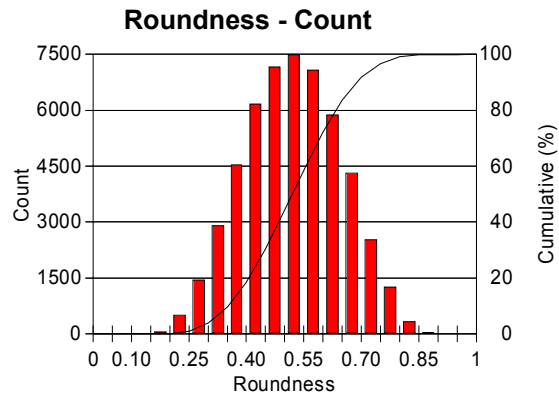
Minimum: 0.21
Maximum: 1.00
Mean: 0.70
Std Dev.: 0.16
D10: 0.49
D50: 0.70
D90: 0.93



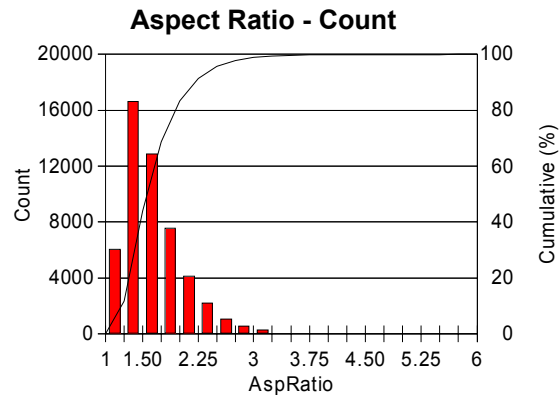
0.25
 1.00
 0.72
 0.10
 0.58
 0.74
 0.85



0.66
 1.00
 0.96
 0.05
 0.89
 0.98
 1.00



Minimum: 0.12
Maximum: 1.00
Mean: 0.52
Std Dev.: 0.13
D10: 0.35
D50: 0.52
D90: 0.69



1.00
 5.66
 1.65
 0.41
 1.24
 1.55
 2.20

Sample B

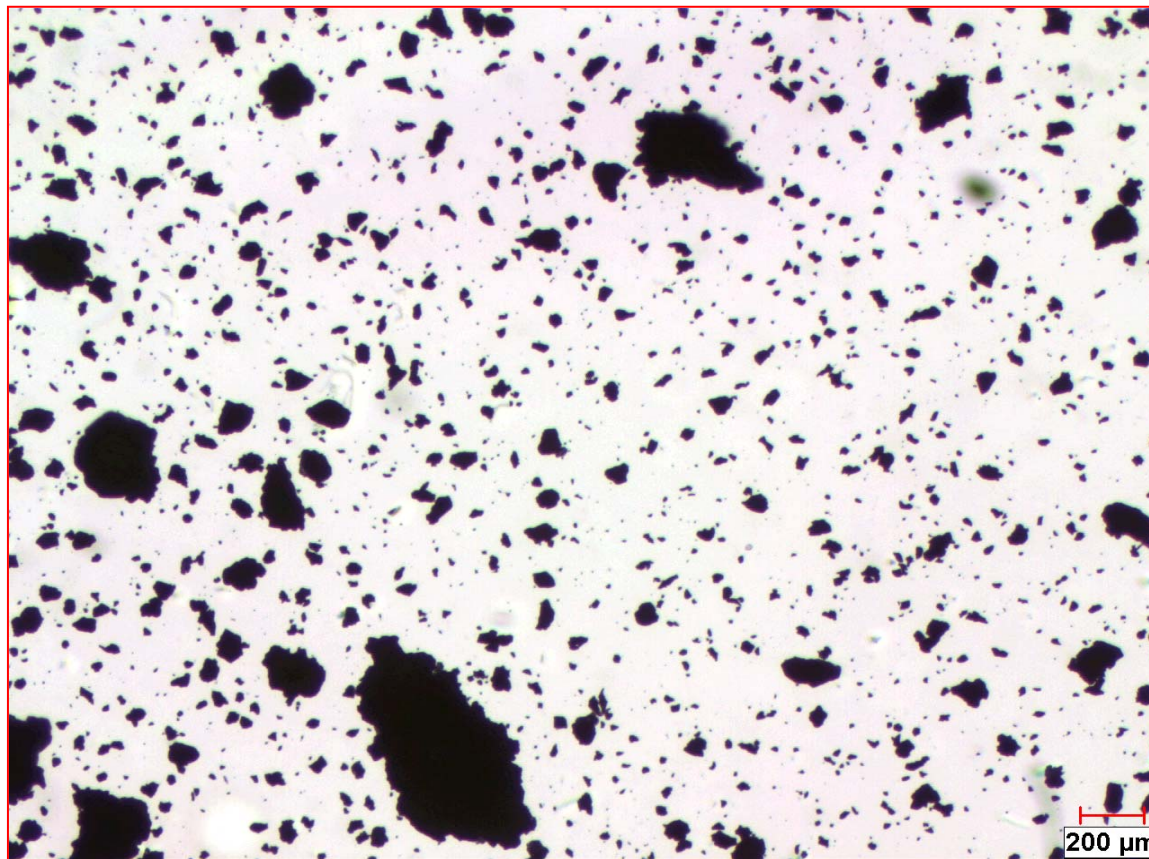
Aluminum

Particle Sizing Analysis

Compagny: Clemex
Date: 2006-Apr-03, 10:23:35 AM -04'00'
User: Myriam Savard
Sample ID: B

Magnification: 25x
Calibration: 2.9349 $\mu\text{m}/\text{pixel}$
Units: microns
Fields: 143
Count: 65351

Figure 1: Typical field of view.

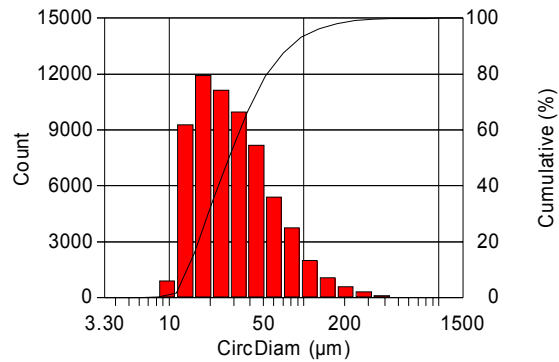


Comments:

This analysis was performed at 25x. The sample was analyzed directly in the plastic holder. Features that were connected by a small link were separated. Remaining connected ones were eliminated. Particles having a width smaller than twice the optical resolution limit were eliminated from the analysis. At 25x, this means 2×4.5 microns. Many measurements were performed. Their chart and statistics appear in the following pages. Many other measurements are available and we can always create custom ones if needed.

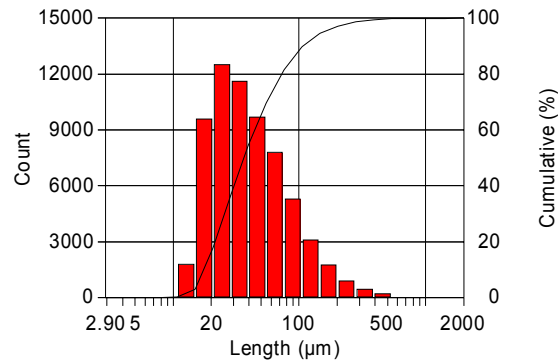
Particle Sizing Analysis

Diameter - Count



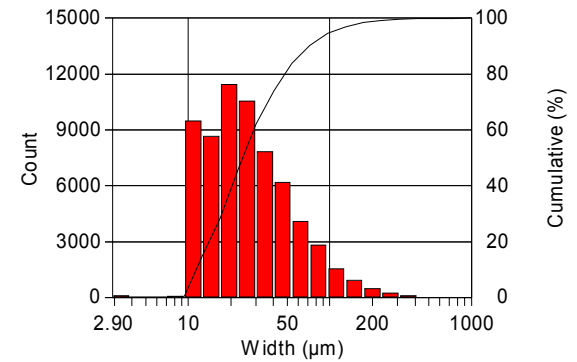
Minimum:	3.31	microns
Maximum:	1048.53	microns
Mean:	41.16	microns
Std Dev.:	46.14	microns
D10:	13.54	microns
D50:	27.28	microns
D90:	79.13	microns

Length - Count



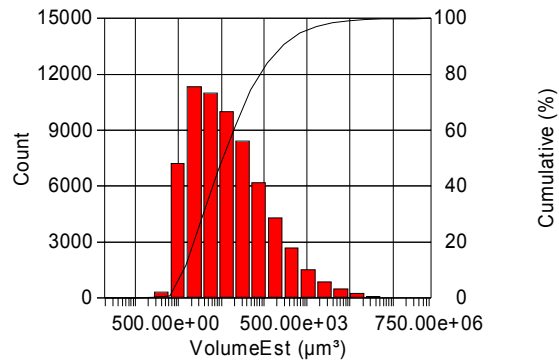
Minimum:	2.93	microns
Maximum:	1515.88	microns
Mean:	55.25	microns
Std Dev.:	61.61	microns
D10:	17.25	microns
D50:	36.28	microns
D90:	106.95	microns

Width - Count



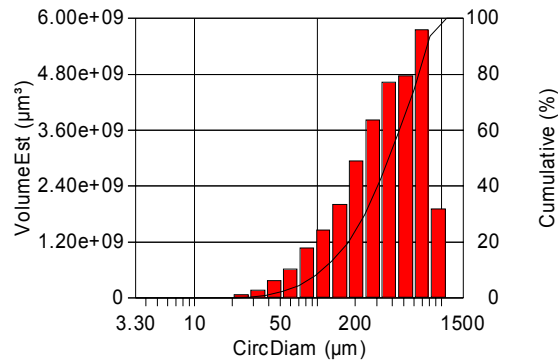
Minimum:	2.93	microns
Maximum:	916.79	microns
Mean:	36.83	microns
Std Dev.:	43.33	microns
D10:	11.51	microns
D50:	23.33	microns
D90:	71.71	microns

Volume - Count



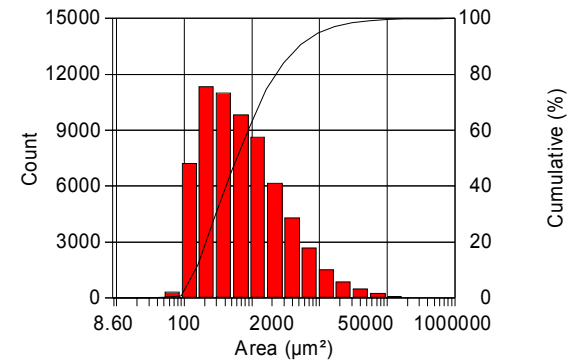
Minimum:	19.02	microns	³
Maximum:	603584256.00	microns	³
Mean:	456277.76	microns	³
Std Dev.:	5922976.75	microns	³
D10:	1281.46	microns	³
D50:	35286.51	microns	³
D90:	689069.00	microns	³

Diameter - Volume



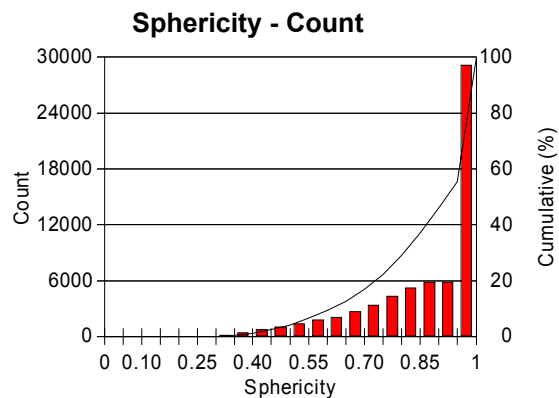
Minimum:	3.31	microns
Maximum:	1048.53	microns
Mean:	409.81	microns
Std Dev.:	0.00	microns
D10:	109.39	microns
D50:	376.56	microns
D90:	724.87	microns

Area - Count

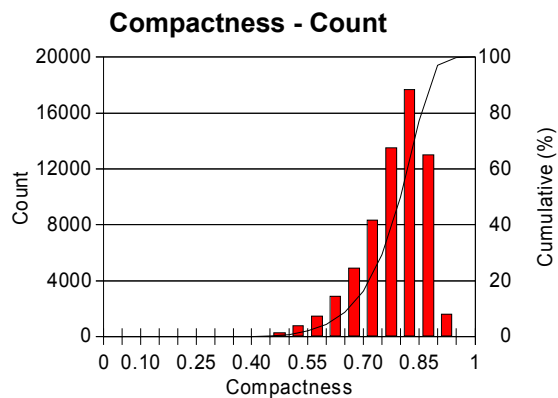


Minimum:	8.61	microns	²
Maximum:	863474.19	microns	²
Mean:	3002.21	microns	²
Std Dev.:	14535.40	microns	²
D10:	144.10	microns	²
D50:	584.68	microns	²
D90:	4918.30	microns	²

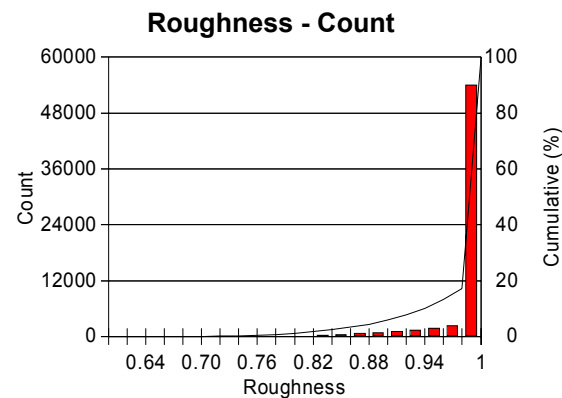
Particle Sizing Analysis



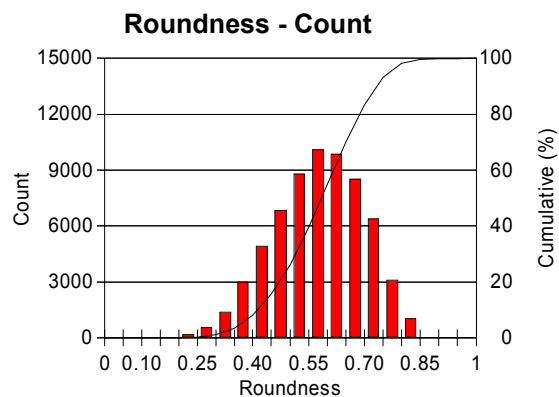
Minimum: 0.18
Maximum: 1.00
Mean: 0.86
Std Dev.: 0.16
D10: 0.61
D50: 0.92
D90: 1.00



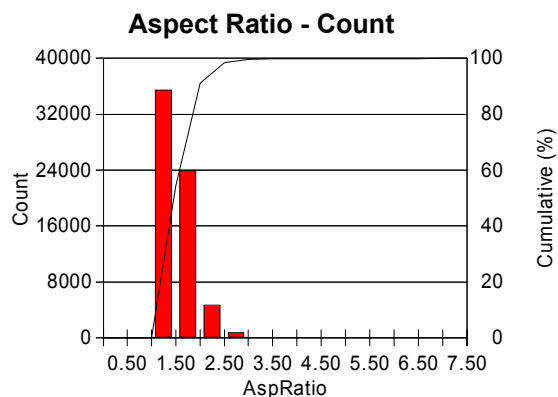
Minimum: 0.27
Maximum: 1.00
Mean: 0.78
Std Dev.: 0.09
D10: 0.66
D50: 0.80
D90: 0.88



Minimum: 0.63
Maximum: 1.00
Mean: 0.98
Std Dev.: 0.04
D10: 0.94
D50: 1.00
D90: 1.00



Minimum: 0.13
Maximum: 1.00
Mean: 0.58
Std Dev.: 0.12
D10: 0.42
D50: 0.58
D90: 0.73



Minimum: 1.00
Maximum: 7.00
Mean: 1.55
Std Dev.: 0.33
D10: 1.21
D50: 1.48
D90: 1.98

Sample C

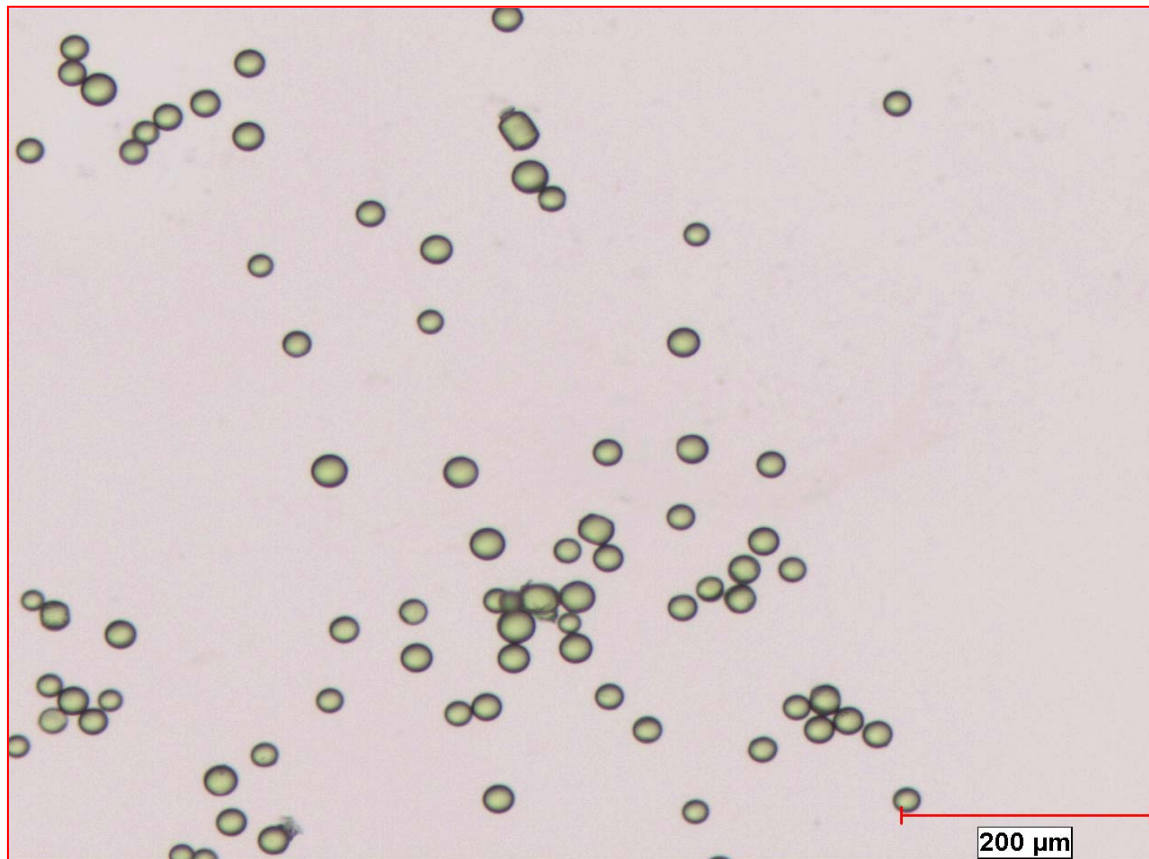
Polystyrene Latex

Particle Sizing Analysis

Compagny: Clemex
Date: 2006-Apr-04, 12:46:20 PM -04'00'
User: Myriam Savard
Sample ID: C

Magnification: 100x
Calibration: 0.7308 $\mu\text{m}/\text{pixel}$
Units: microns
Fields: 945
Count: 9332

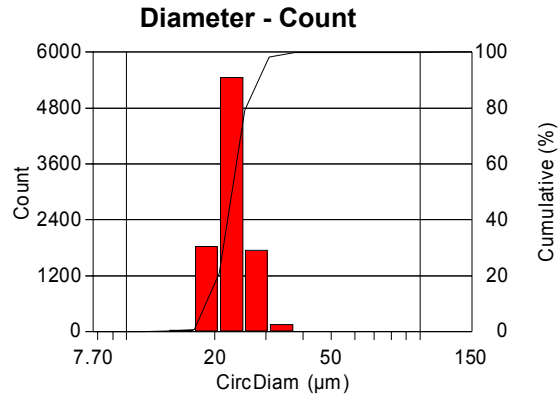
Figure 1: Typical field of view.



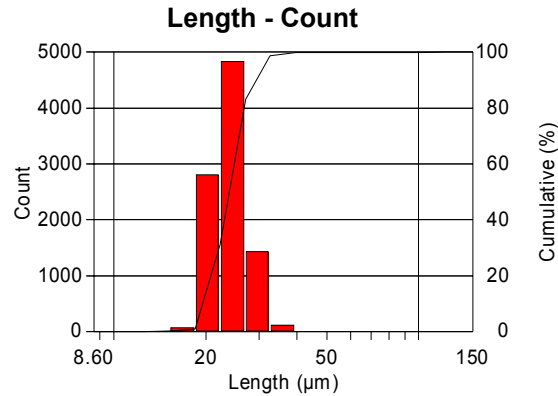
Comments:

This analysis was performed at 100 x. The sample was spread on a slide avoiding particle connection as much as possible. Since the original shape of particles was definitively smooth, all connected features were separated. Remaining clusters were eliminated. Particles having a width smaller than twice the optical resolution limit were eliminated from the analysis. At 100 x, this means 2×1.25 microns. Many measurements were performed. Their chart and statistics appear in the following pages. Many other measurements are available and we can always create custom ones if needed.

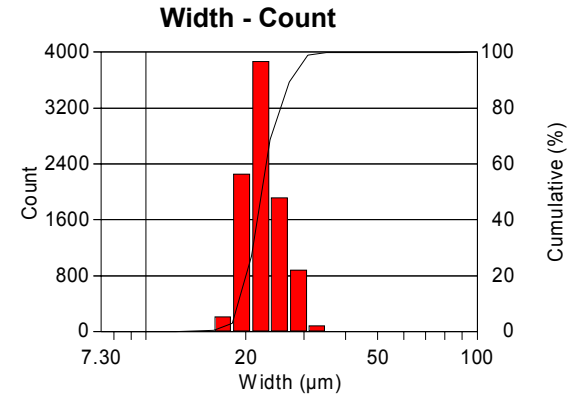
Particle Sizing Analysis



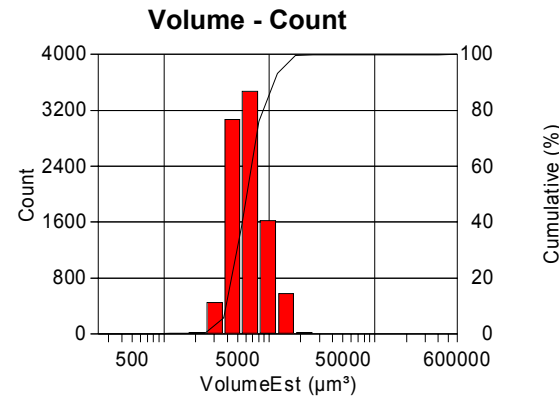
Minimum:	7.69	microns
Maximum:	101.64	microns
Mean:	23.08	microns
Std Dev.:	3.15	microns
D10:	19.80	microns
D50:	22.57	microns
D90:	27.31	microns



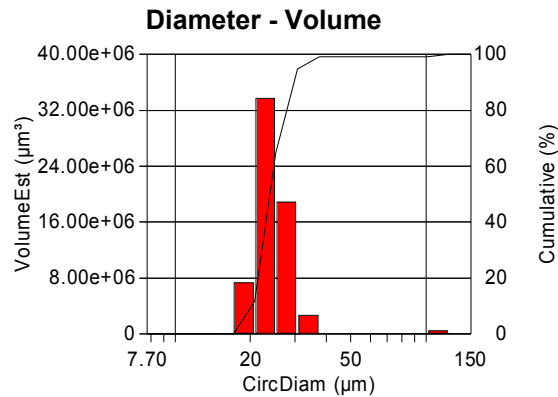
Minimum:	8.59	microns
Maximum:	123.23	microns
Mean:	24.11	microns
Std Dev.:	3.30	microns
D10:	20.74	microns
D50:	23.55	microns
D90:	28.44	microns



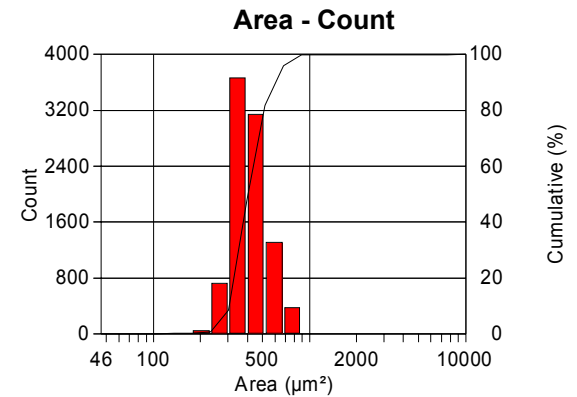
Minimum:	7.31	microns
Maximum:	99.30	microns
Mean:	22.66	microns
Std Dev.:	3.15	microns
D10:	19.32	microns
D50:	22.01	microns
D90:	26.97	microns



Minimum:	238.25	microns ³
Maximum:	549771.00	microns ³
Mean:	6830.79	microns ³
Std Dev.:	6296.09	microns ³
D10:	4066.97	microns ³
D50:	6020.51	microns ³
D90:	10660.98	microns ³



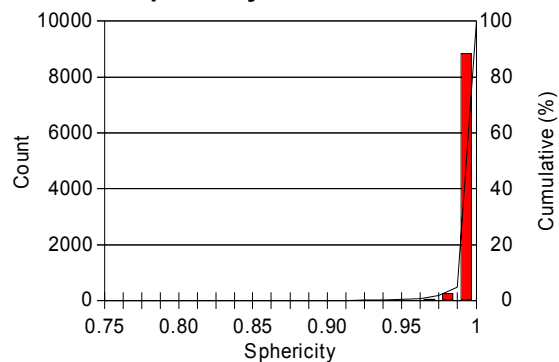
Minimum:	7.69	microns
Maximum:	101.64	microns
Mean:	24.99	microns
Std Dev.:	0.00	microns
D10:	20.47	microns
D50:	23.80	microns
D90:	29.39	microns



Minimum:	46.46	microns ²
Maximum:	8113.57	microns ²
Mean:	426.10	microns ²
Std Dev.:	139.74	microns ²
D10:	308.04	microns ²
D50:	400.11	microns ²
D90:	585.63	microns ²

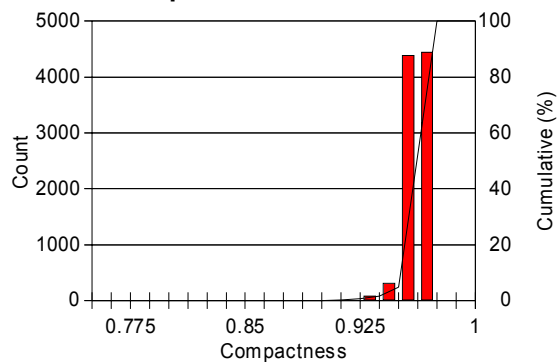
Particle Sizing Analysis

Sphericity - Count



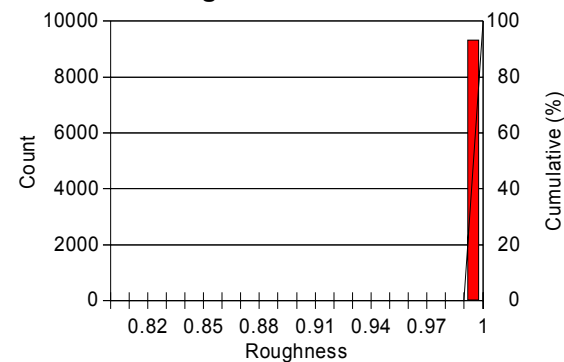
Minimum: 0.76
Maximum: 1.00
Mean: 1.00
Std Dev.: 0.01
D10: 1.00
D50: 1.00
D90: 1.00

Compactness - Count



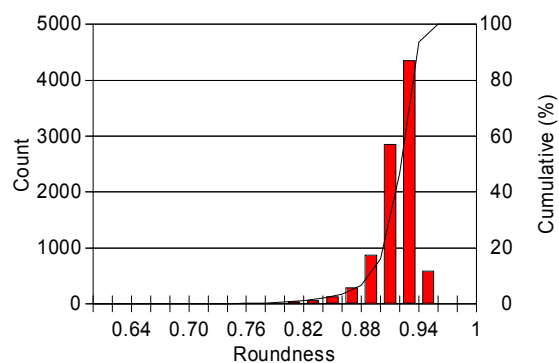
Minimum: 0.76
Maximum: 0.97
Mean: 0.96
Std Dev.: 0.01
D10: 0.95
D50: 0.96
D90: 0.97

Roughness - Count



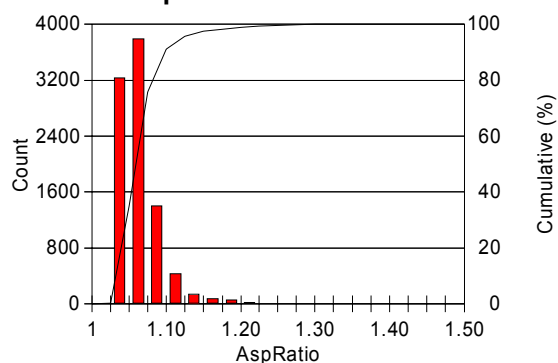
Minimum: 0.96
Maximum: 1.00
Mean: 1.00
Std Dev.: 0.00
D10: 1.00
D50: 1.00
D90: 1.00

Roundness - Count



Minimum: 0.61
Maximum: 0.96
Mean: 0.92
Std Dev.: 0.03
D10: 0.89
D50: 0.92
D90: 0.94

Aspect Ratio - Count



Minimum: 1.02
Maximum: 1.30
Mean: 1.07
Std Dev.: 0.03
D10: 1.04
D50: 1.06
D90: 1.10

Sample D

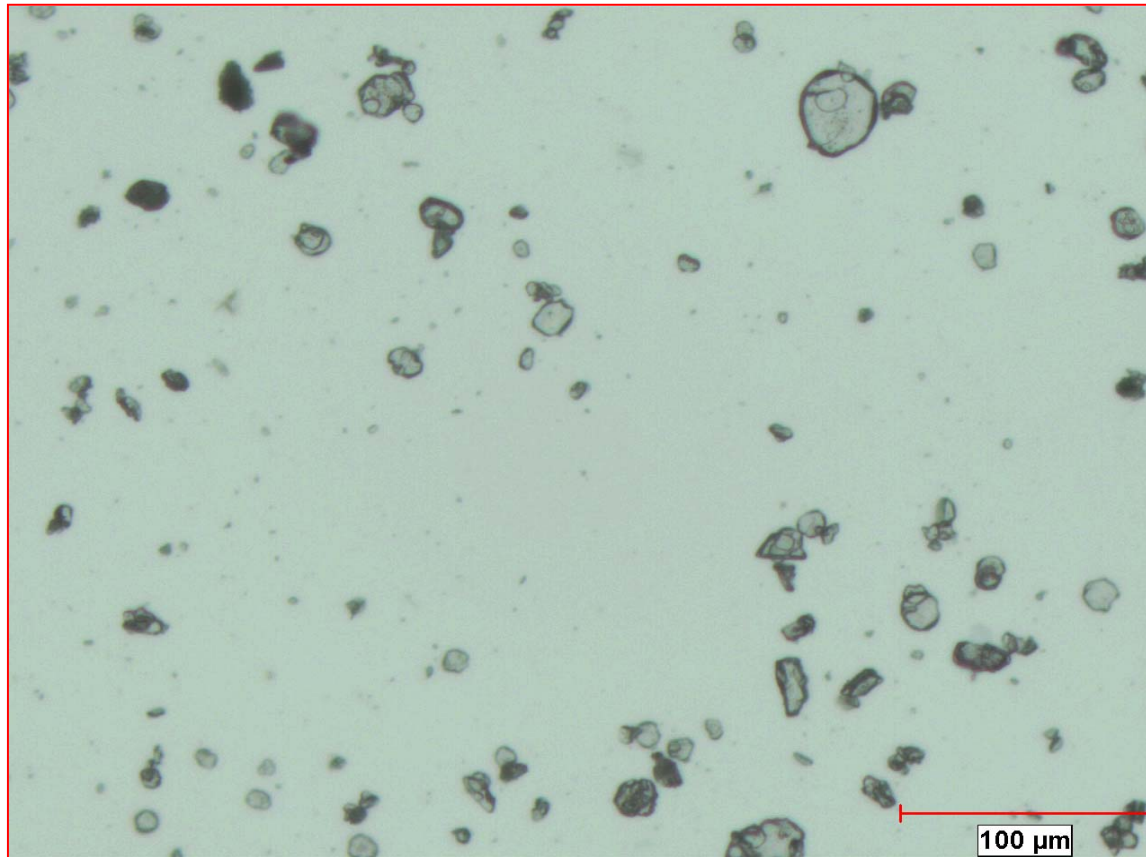
Alumina

Particle Sizing Analysis

Compagny: Clemex
Date: 2006-Apr-07, 10:57:33 AM -04'00'
User: Myriam Savard
Sample ID: D

Magnification: 200x
Calibration: 0.3633 $\mu\text{m}/\text{pixel}$
Units: microns
Fields: 600
Count: 39425

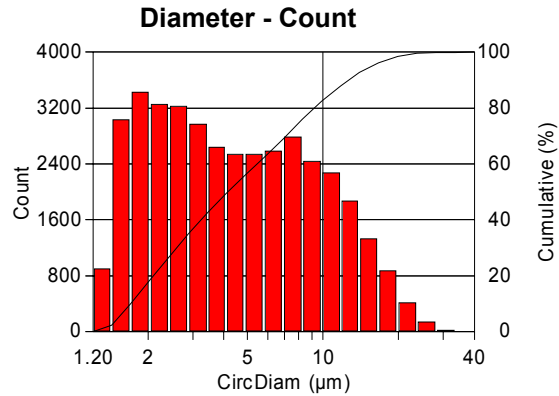
Figure 1: Typical field of view.



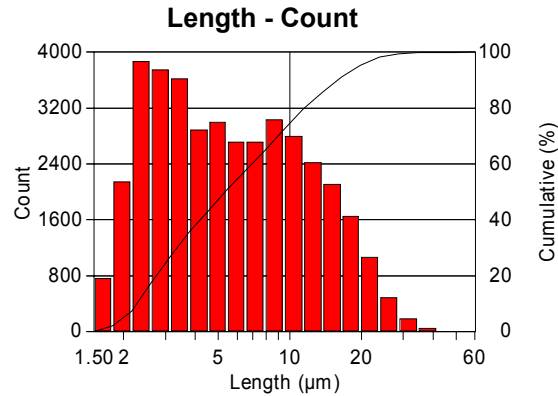
Comments:

This analysis was performed at 200x. The sample was spread on the slide to avoid agglomerates as much as possible. Connected features were separated when possible and remaining agglomerates were eliminated. Particles having a width smaller than twice the optical resolution limit were eliminated from the analysis. At 200x, this means 2×0.625 microns. Many measurements were performed. Their chart and statistics appear in the following pages. Many other measurements are available and we can always create custom ones if needed. Since the distribution presented two peaks, a stronger elimination of small particles was performed using 10 times the optical resolution limit as rejection factor. All measurements can be presented according to this second criterion, all in the same run. The last chart of page 3 illustrates the Diameter distribution of remaining measured features.

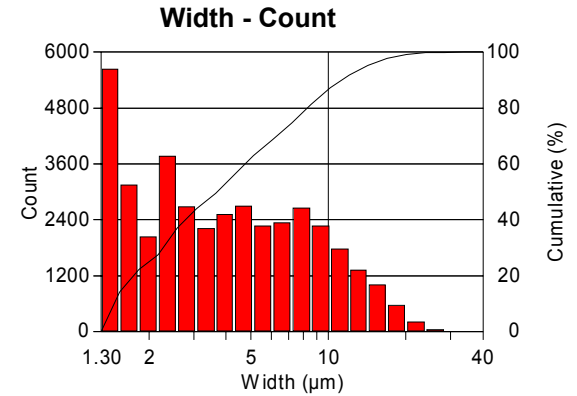
Particle Sizing Analysis



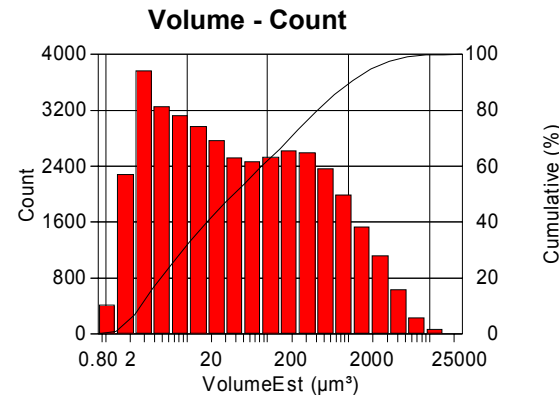
Minimum:	1.16	microns
Maximum:	35.11	microns
Mean:	5.86	microns
Std Dev.:	4.66	microns
D10:	1.81	microns
D50:	3.69	microns
D90:	9.70	microns



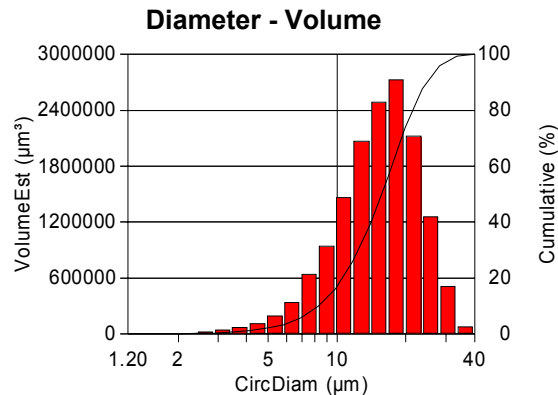
1.50	microns
50.04	microns
7.45	microns
5.84	microns
2.13	microns
5.33	microns
15.79	microns



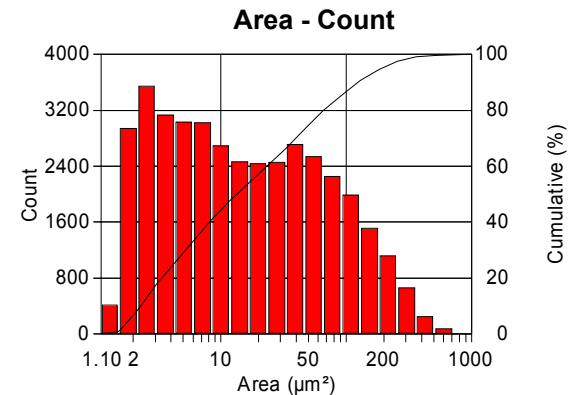
1.27	microns
32.47	microns
5.22	microns
4.27	microns
1.43	microns
3.60	microns
11.24	microns



Minimum:	0.82	microns	³
Maximum:	22664.65	microns	³
Mean:	386.28	microns	³
Std Dev.:	1042.98	microns	³
D10:	2.53	microns	³
D50:	37.02	microns	³
D90:	1033.43	microns	³

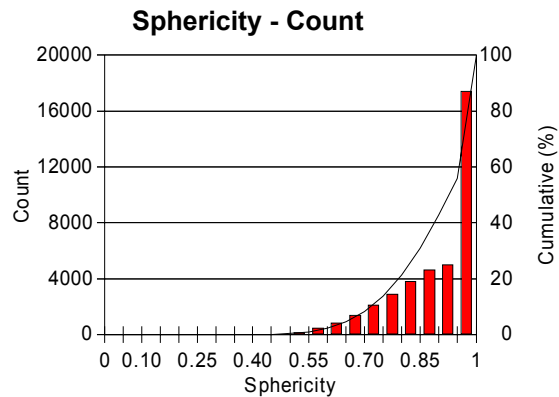


1.16	microns
35.11	microns
16.09	microns
0.00	microns
8.33	microns
15.72	microns
24.47	microns

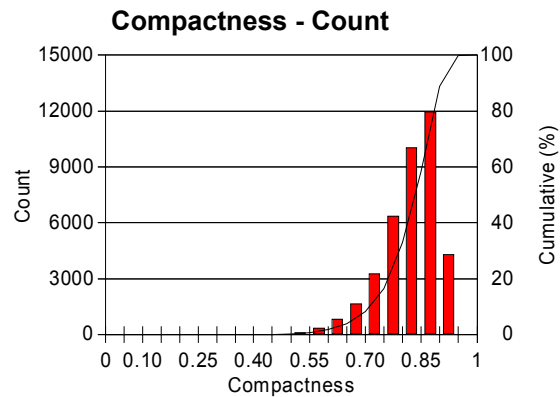


1.06	microns	²
968.26	microns	²
43.99	microns	²
73.39	microns	²
2.24	microns	²
13.43	microns	²
123.58	microns	²

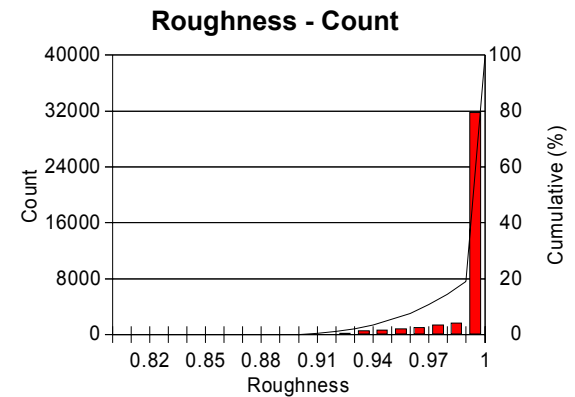
Particle Sizing Analysis



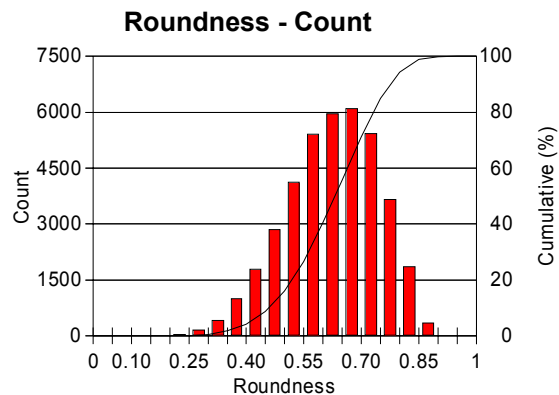
Minimum: 0.18
 Maximum: 1.00
 Mean: 0.89
 Std Dev.: 0.12
 D10: 0.72
 D50: 0.93
 D90: 1.00



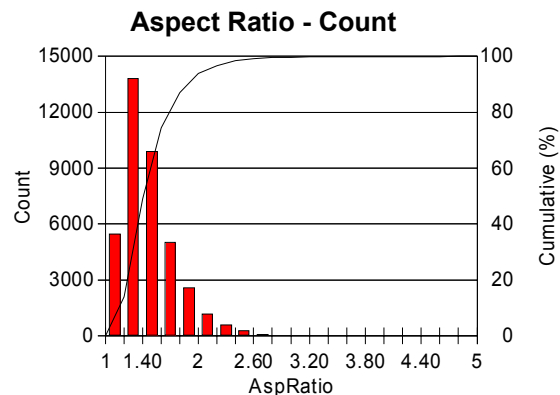
0.16
 0.96
 0.82
 0.08
 0.71
 0.84
 0.90



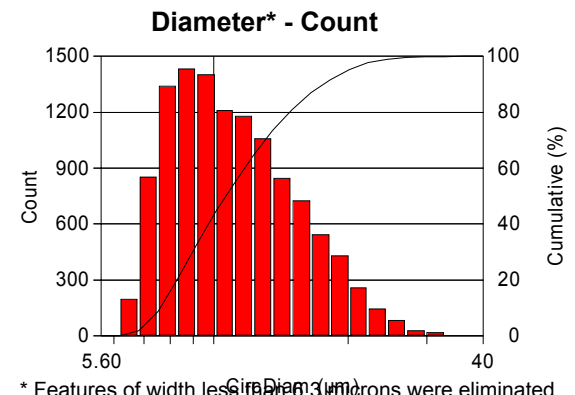
0.90
 1.00
 0.99
 0.02
 0.97
 1.00
 1.00



Minimum: 0.08
 Maximum: 0.93
 Mean: 0.62
 Std Dev.: 0.12
 D10: 0.46
 D50: 0.63
 D90: 0.77



1.03
 4.68
 1.48
 0.31
 1.18
 1.41
 1.87



* Features of width less than 0.3 microns were eliminated

Count: 5.58 microns
 11801 35.11 microns
 11.74 microns
 4.12 microns
 7.58 microns
 10.62 microns
 17.50 microns

Sample E

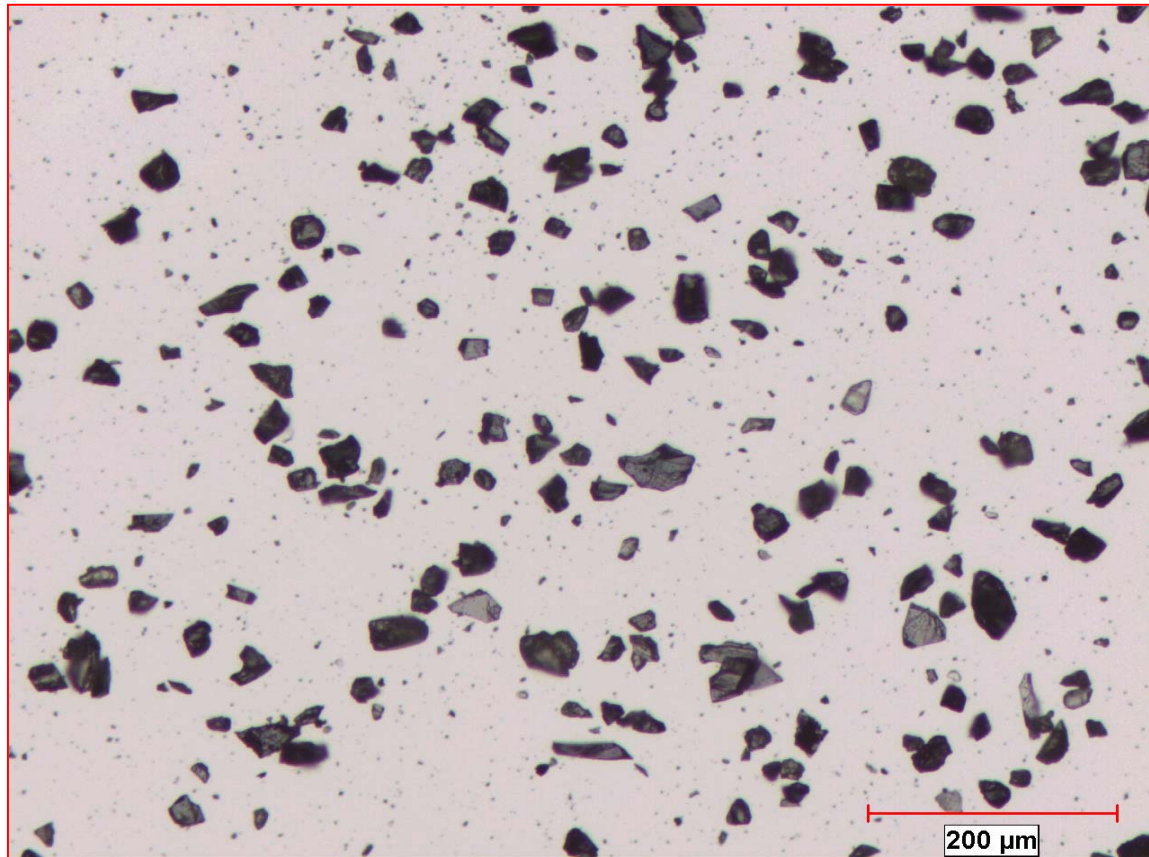
Silicon Carbide

Particle Sizing Analysis

Compagny: Clemex
Date: 2006-Apr-05, 3:54:39 PM -04'00'
User: Myriam Savard
Sample ID: E

Magnification: 100x
Calibration: 0.7308 $\mu\text{m}/\text{pixel}$
Units: microns
Fields: 660
Count: 84954

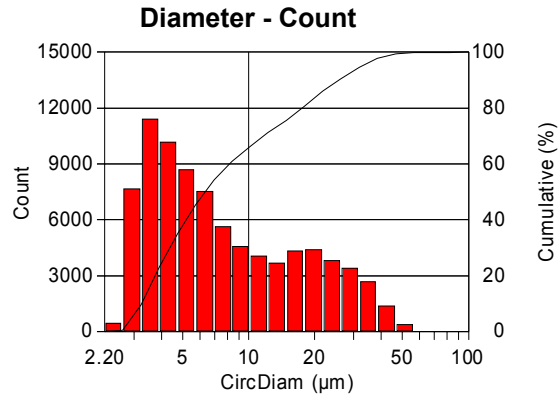
Figure 1: Typical field of view.



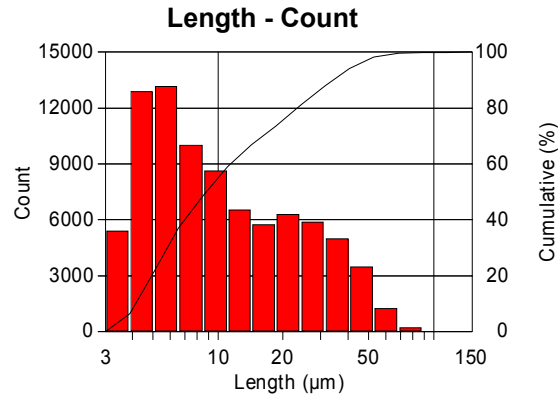
Comments:

This analysis was performed at 100x. The sample was spread on the slide to avoid agglomerates as much as possible. Connected features were separated when possible and remaining agglomerates were eliminated. Particles having a width smaller than twice the optical resolution limit were eliminated from the analysis. At 100x, this means 2×1.25 microns. Many measurements were performed. Their chart and statistics appear in the following pages. Many other measurements are available and we can always create custom ones if needed. Since the distribution presented two peaks, a stronger elimination of small particles was performed using 10 times the optical resolution limit as rejection factor. All measurements can be presented according to this second criterion, all in the same run. The last chart of page 3 illustrates the Diameter distribution of remaining measured features.

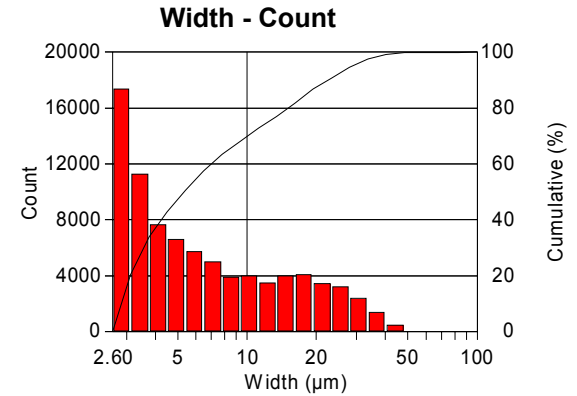
Particle Sizing Analysis



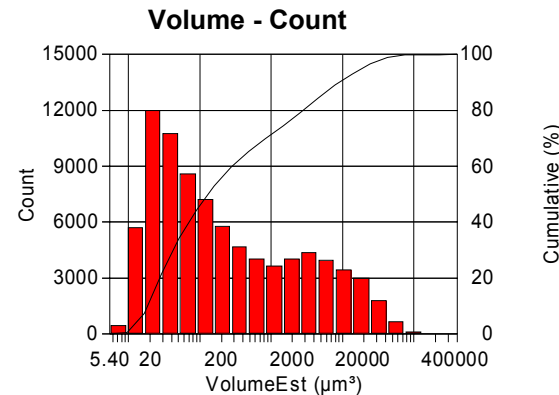
Minimum:	2.18	microns
Maximum:	85.74	microns
Mean:	10.76	microns
Std Dev.:	9.85	microns
D10:	3.19	microns
D50:	6.54	microns
D90:	29.67	microns



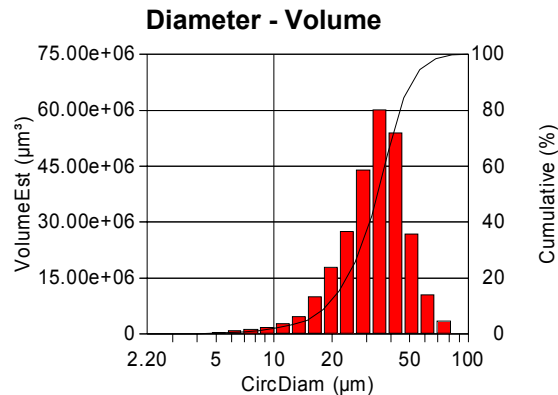
	3.01	microns
	133.28	microns
	14.47	microns
	13.15	microns
	3.93	microns
	8.61	microns
	34.05	microns



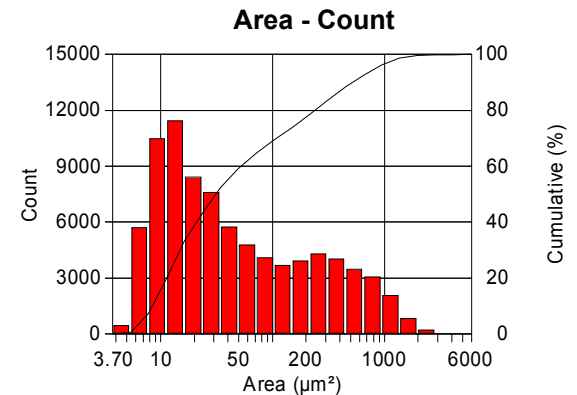
	2.56	microns
	89.34	microns
	9.32	microns
	8.71	microns
	2.84	microns
	5.26	microns
	22.32	microns



Minimum:	5.44	microns ³
Maximum:	330033.63	microns ³
Mean:	3173.79	microns ³
Std Dev.:	9427.86	microns ³
D10:	17.37	microns ³
D50:	126.33	microns ³
D90:	8898.26	microns ³

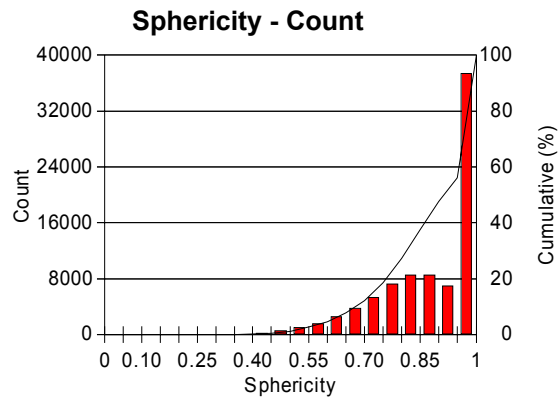


	2.18	microns
	85.74	microns
	34.61	microns
	0.00	microns
	18.79	microns
	34.14	microns
	50.52	microns

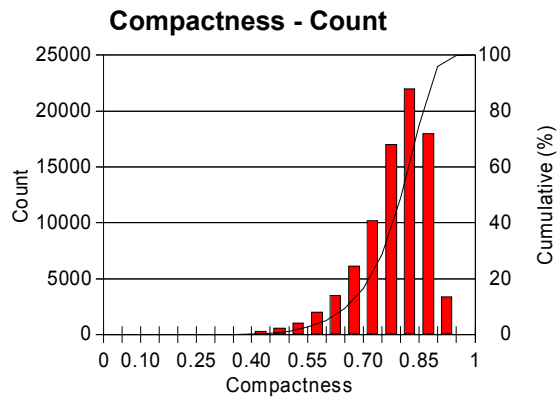


	3.74	microns ²
	5773.82	microns ²
	167.10	microns ²
	318.57	microns ²
	8.11	microns ²
	30.44	microns ²
	519.15	microns ²

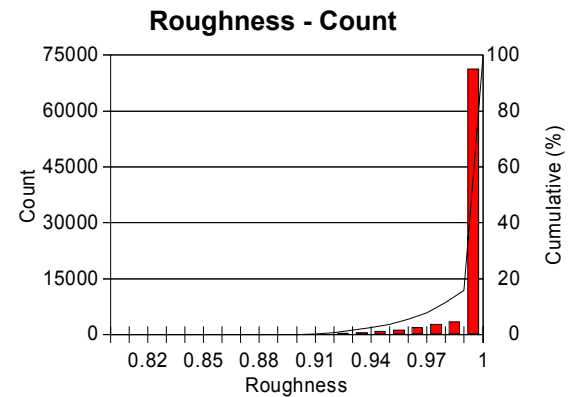
Particle Sizing Analysis



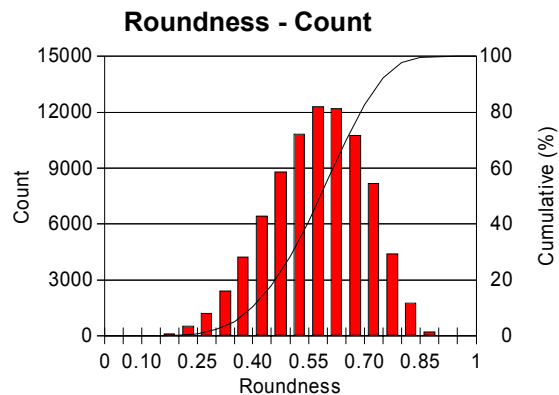
Minimum: 0.17
Maximum: 1.00
Mean: 0.88
Std Dev.: 0.14
D10: 0.68
D50: 0.91
D90: 1.00



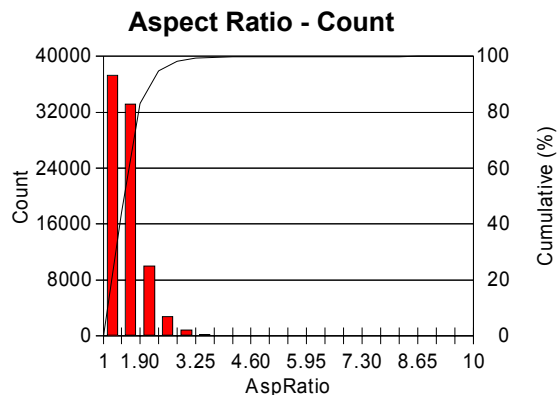
Minimum: 0.18
Maximum: 0.96
Mean: 0.78
Std Dev.: 0.09
D10: 0.66
D50: 0.80
D90: 0.88



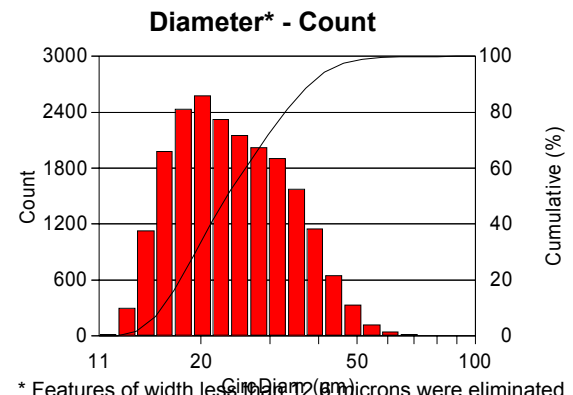
Minimum: 0.90
Maximum: 1.00
Mean: 0.99
Std Dev.: 0.02
D10: 0.98
D50: 1.00
D90: 1.00



Minimum: 0.08
Maximum: 0.93
Mean: 0.57
Std Dev.: 0.13
D10: 0.40
D50: 0.58
D90: 0.74



Minimum: 1.02
Maximum: 8.39
Mean: 1.60
Std Dev.: 0.41
D10: 1.21
D50: 1.50
D90: 2.10



* Features of width less than 12 microns were eliminated

Count: 11.12 microns
20829 85.74 microns
 25.47 microns
 8.94 microns
 15.94 microns
 23.31 microns
 37.92 microns

Particle Sizing Analysis

Description of each measurement performed:

Length:	Longest feret
Width:	Shortest feret
Volume:	$(\text{Diameter}^3) \times \text{PI} / 6$
Diameter:	$2 \times (\text{Area} / \text{PI})^{1/2}$
Area:	Calibrated detected pixels (see calibration in page 1)
Sphericity:	$4 \times \text{PI} \times \text{Area} / (\text{Perimeter}^2)$
Compactness:	$4 \times \text{PI} \times \text{Area} / (\text{Convex Perimeter}^2)$
Roughness:	Convex Perimeter / Perimeter
Roundness:	$4 \times \text{Area} / (\text{PI} \times \text{Length}^2)$
Aspect Ratio:	Length / Width

* Perimeter accuracy decreases when measuring very small particles because of pixel shape

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