# CARBIDES ANALYSIS IN NICKEL-BASED ALLOY

Sample Description

Three nickel-based samples (labeled as sample #2, #3 and #6) showing gamma prime particles and some primary carbides were submitted for analysis.

Purpose of Analysis

Demonstrate the ability of Clemex Vision image analysis system can distinguish the gamma prime particles, the primary carbides and perform size, shape, alignment and distribution measurements on them.
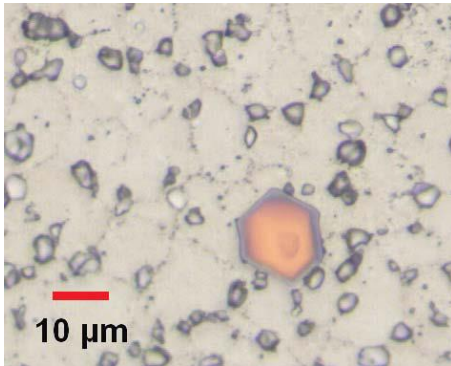
Figure 1: *Part of the original image showing the largest particle found in sample 6.*
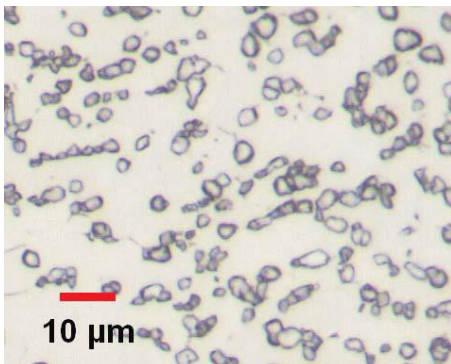
Figure 2: *Longest stringer found in sample 3.*

Procedure[1]

Primary carbides (orange) were isolated from gamma prime particles using their color as criterion. The influence zone of each particle was then identified together with the denuded areas. Aligned gamma prime particles were identified and isolated.

Equipment

Image Analysis System:	Clemex Vision PE
Microscope:	Leica DMI 5000M
Camera:	Clemex L 2.0 C
Magnification:	500X
Stage:	Marzhauser EK32IM 75x50mm

Results[2]

All particles and inter particle zone were measured for their circular diameter. The mean free path of the gamma prime particles was also evaluated. The denuded zones were measured for their respective area and also for their overall area percentage.

Automated statistics and graphs were generated. Final results can be printed directly from Clemex Vision. Raw data are linked to their respective objects for validation purpose. Raw data can also be exported in Excel format.


Minimum:	0.19 microns
Maximum:	10.36 microns
Mean:	1.88 microns
Std Dev.:	1.05 microns
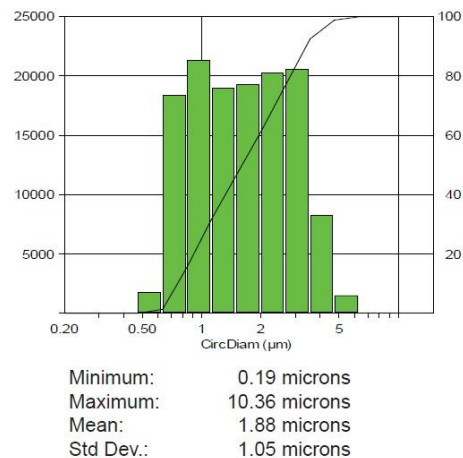
Figure 3: *Circular diameter distribution of gamma prime particles and corresponding statistics.*

1.Images taken during the procedure are available in appendix A
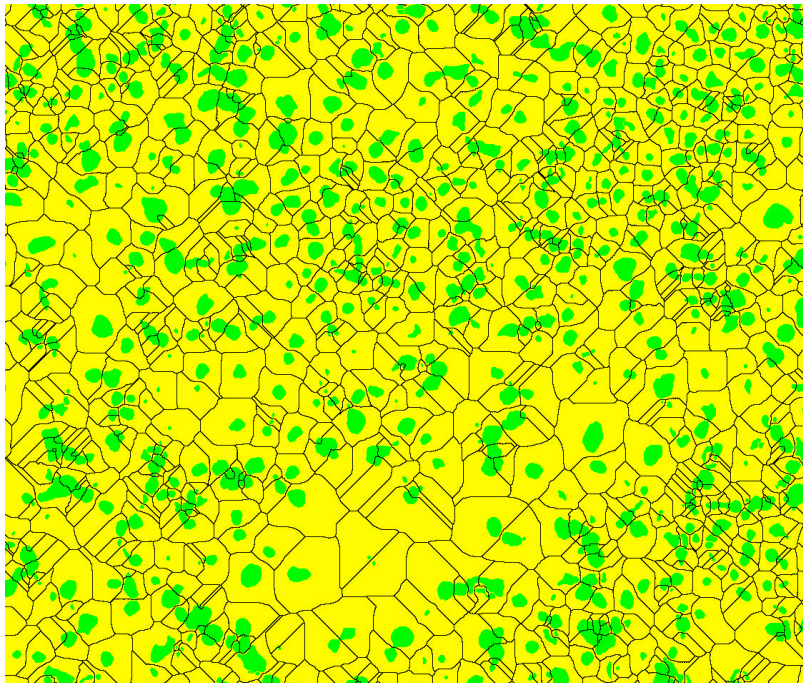*2. Complete results are available in appendix B*
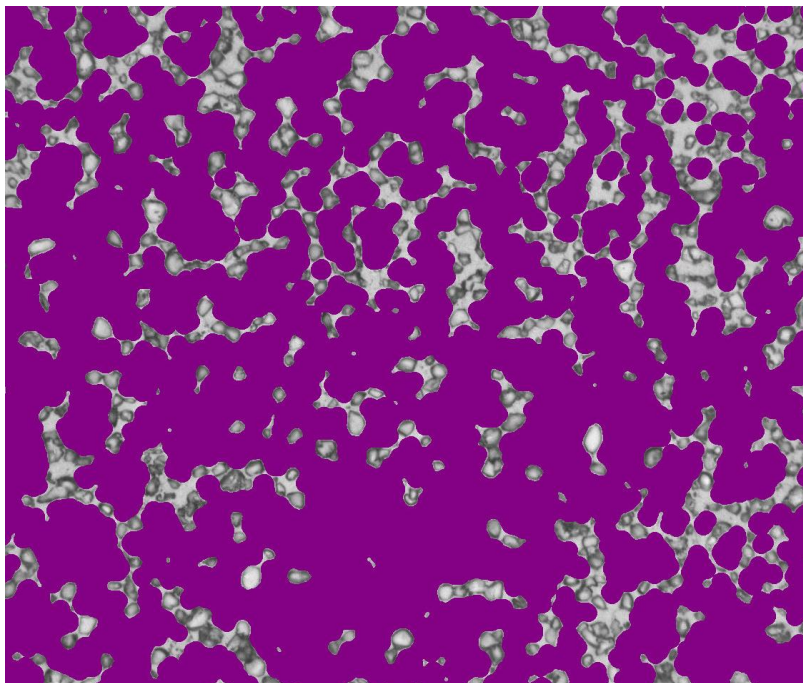
Appendix A: Image Analysis Steps
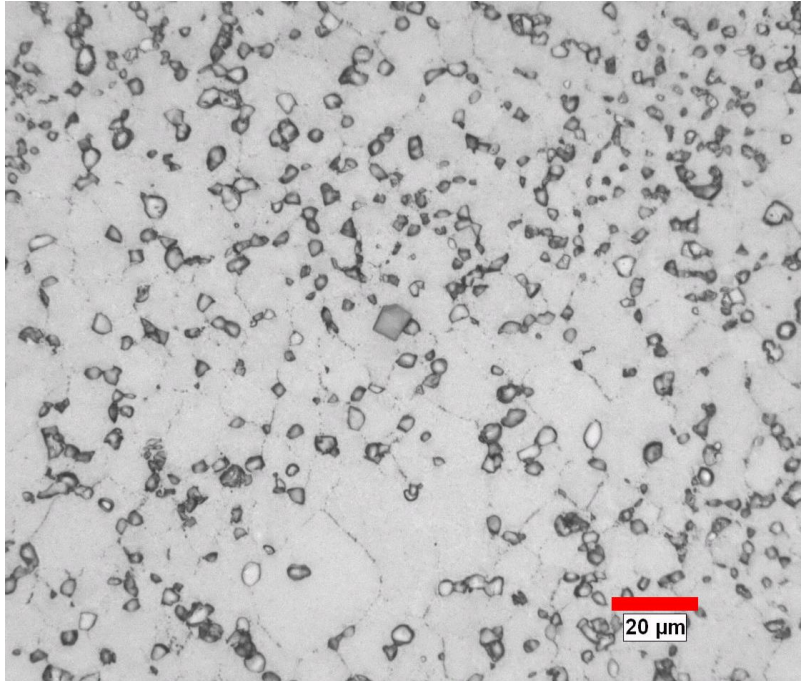
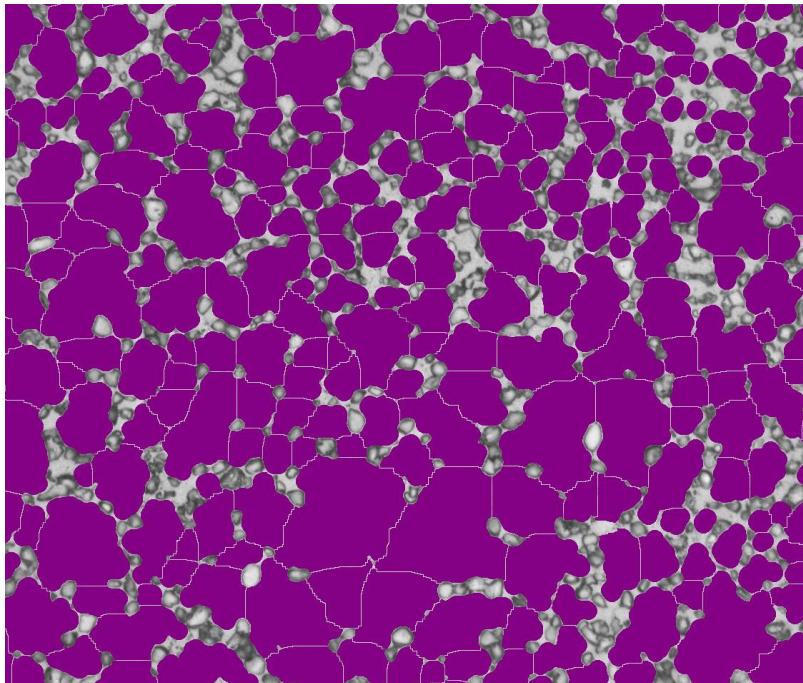*Image 1: Original image captured at 500X (0.165 microns/pixel)*
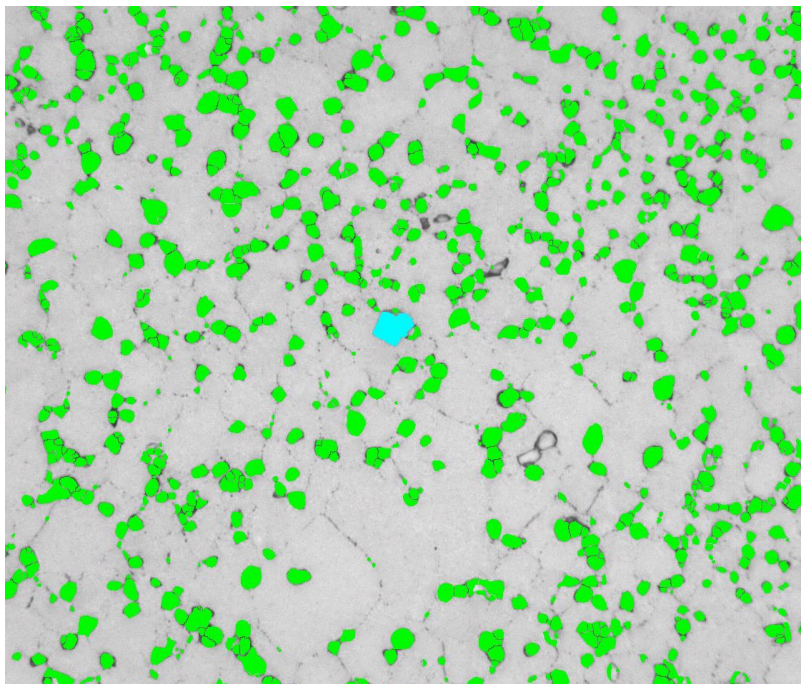
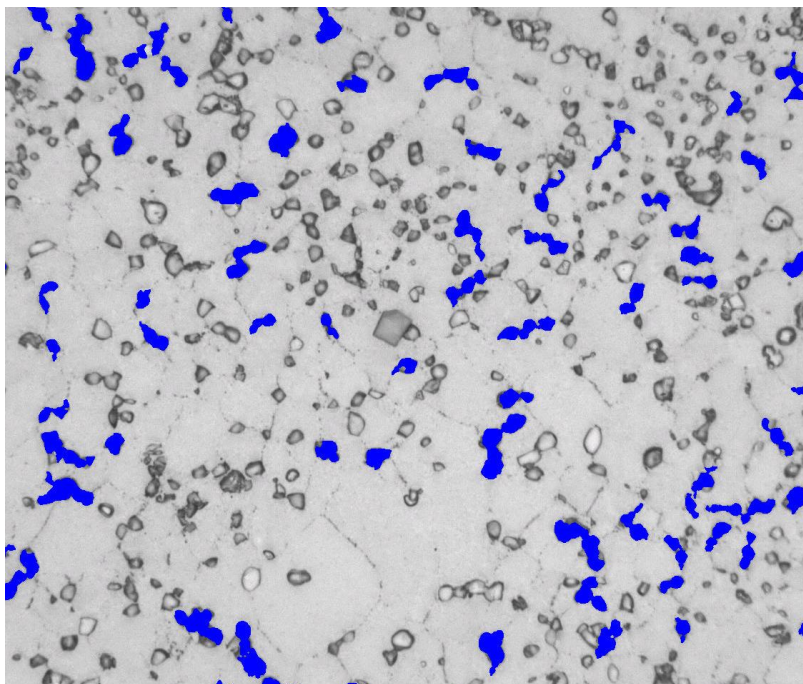*Image 2: Gamma prime particles are binarized into the green bitplane and measured.*

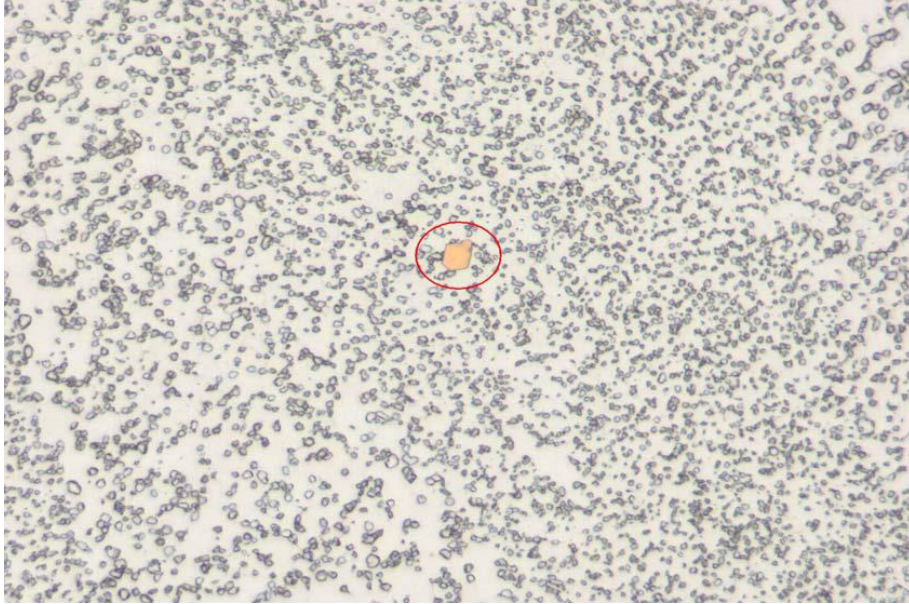*Image 3: The influence zone is determined for each particle and measured as "inter particle distance"*

Image 4: Area percentage covered by the denuded zones is measured.

Image 5: Denuded zones are separated to evaluate their sizes.

Image 6: Groups of connected and aligned particles are identified and measured.
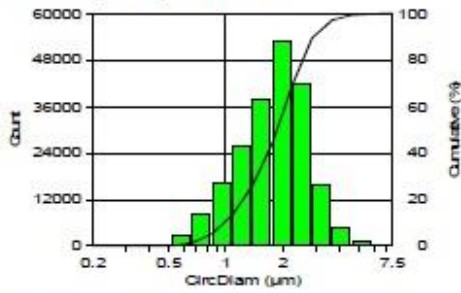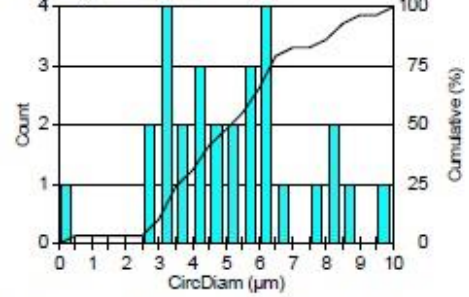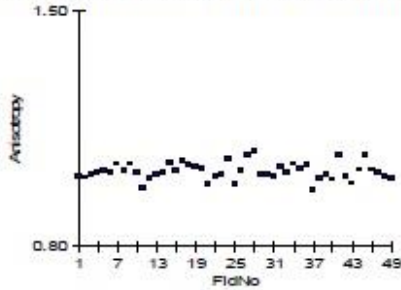
Appendix B: Results

Sample #3

(a)

(b)

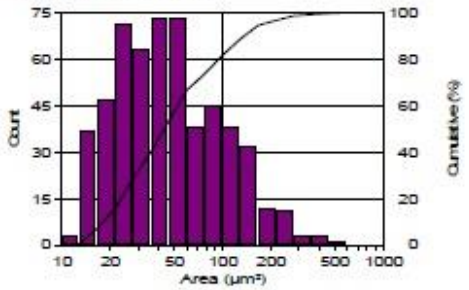*Image 1: (a) Largest particle; (b) largest stringer.*

Gamma prime particle size

Min:	0.19	Mean:	1.93
Max:	7.34	Std Dev.:	0.76
Count:	208106		

Primary carbides

Min:	0.19	Mean:	5.24
Max:	9.91	Std Dev.:	2.14
Count:	29		

Anisotropy index of aligned group of particles

Min:	0.97	Mean:	1.02
Max:	1.09	Std Dev.:	0.03

Denuded zone size

Min:	11.49	Mean:	45.00
Max:	492.84	Std Dev.:	39.83

Aligned group of particles size
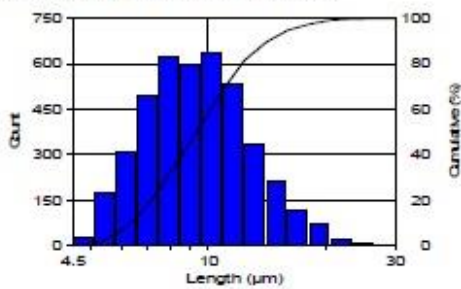
Min:	4.46	Mean:	9.90
Max:	27.26	Std Dev.:	3.23
Count:	4168		

Inter particle distance
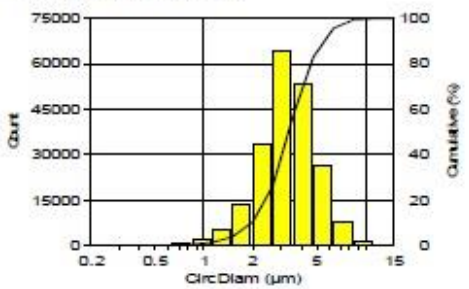
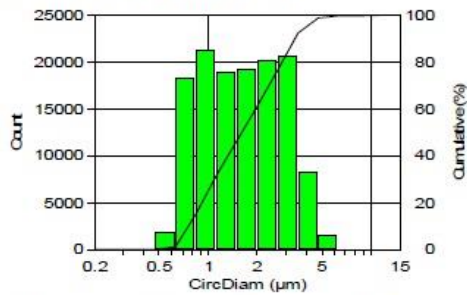|			
Min:	0.19	Mean:	3.55
Max:	13.98	Std Dev.:	1.39

Sample #6
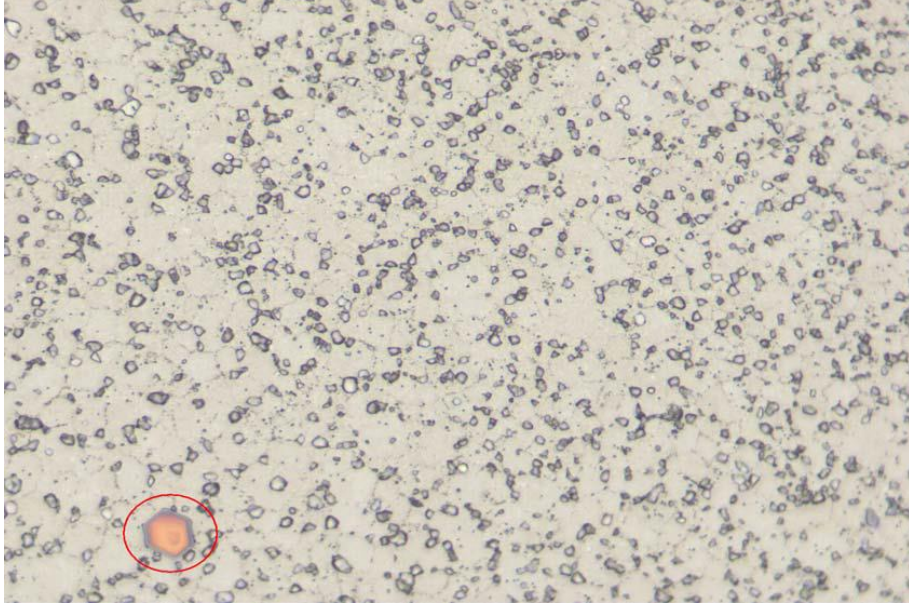
(a)
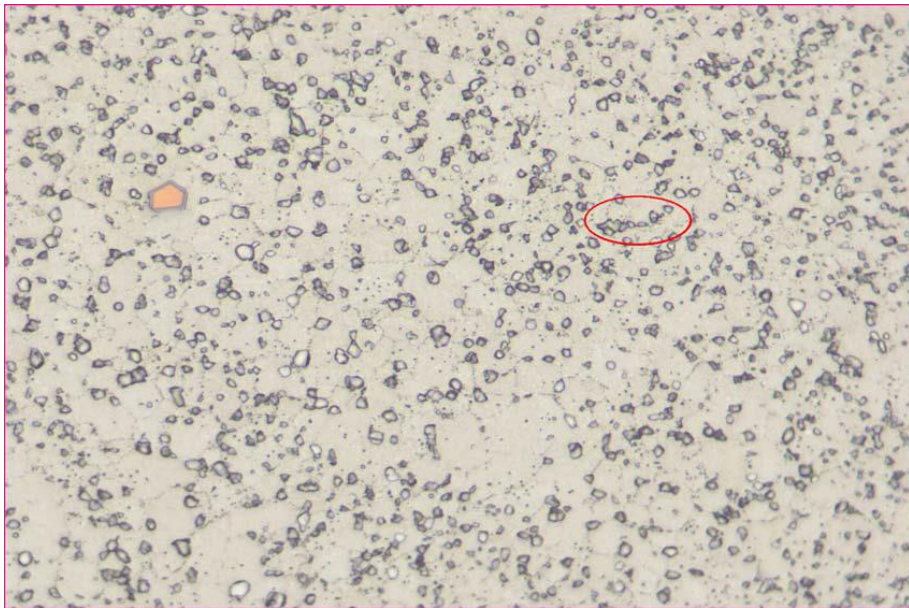
(b)

Image 2: (a) Largest particle; (b) largest stringer.

Gamma prime particle size

Min:	0.19	Mean:	1.88
Max:	10.36	Std Dev.:	1.05
Count:	130378		

Primary carbides
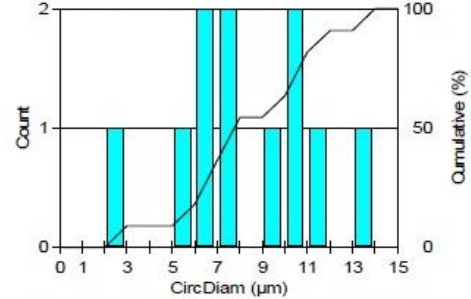
Min:	2.20	Mean:	8.32
Max:	13.84	Std Dev.:	3.32
Count:	11		

Anisotropy index of aligned group of particles
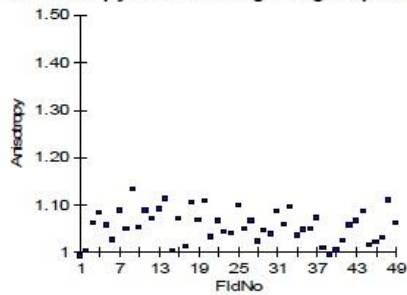
Min:	0.99	Mean:	1.06
Max:	1.13	Std Dev.:	0.03

Denuded zone size
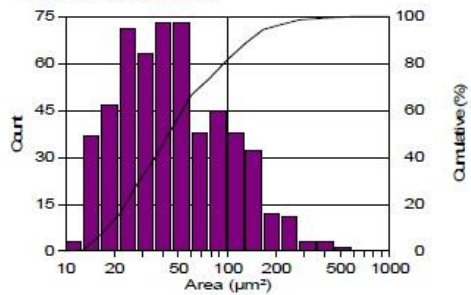
Min:	11.55	Mean:	58.54
Max:	688.14	Std Dev.:	47.32

Aligned group of particles size
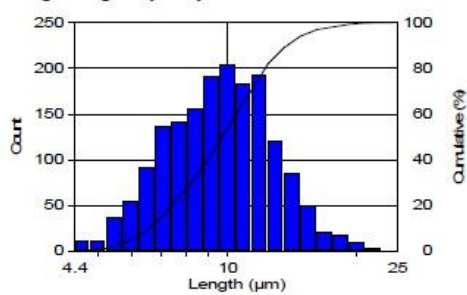
Min:	4.42	Mean:	10.05
Max:	23.44	Std Dev.:	2.94
Count:	1714		

Inter particle distance
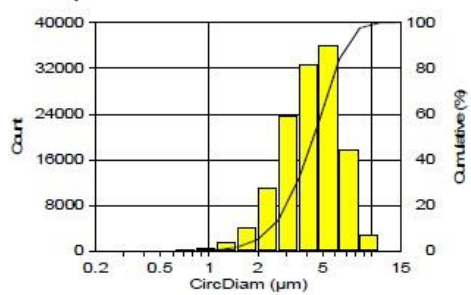
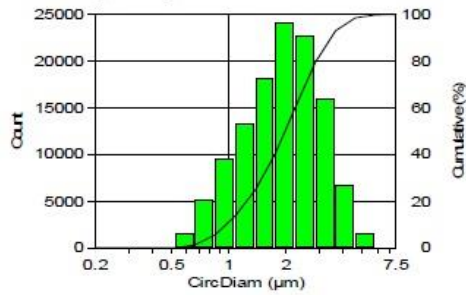| Min:	0.19	Mean:	4.56
Max:	14.77	Std Dev.:	1.75

Sample #2

(a)

(b)

Image 3: (a) Largest particle; (b) largest stringer.

Gamma prime particle size

Min:	0.19	Mean:	2.11
Max:	7.43	Std Dev.:	0.94
Count:	118855		

Primary carbides
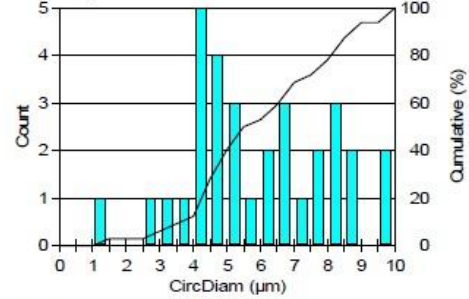
Min:	1.48	Mean:	5.93
Max:	9.84	Std Dev.:	2.04
Count:	32		

Anisotropy index of aligned group of particles
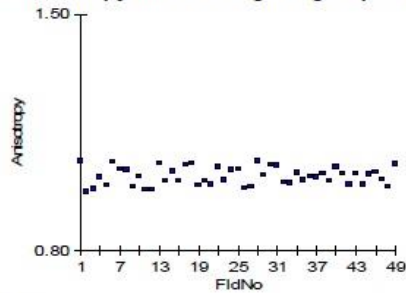
Min:	0.98	Mean:	1.02
Max:	1.07	Std Dev.:	0.03

Denuded zone size
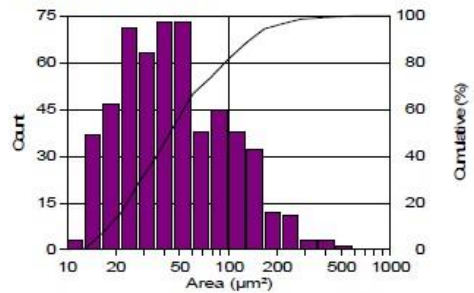
Min:	11.35	Mean:	68.16
Max:	987.25	Std Dev.:	65.29

Aligned group of particles size
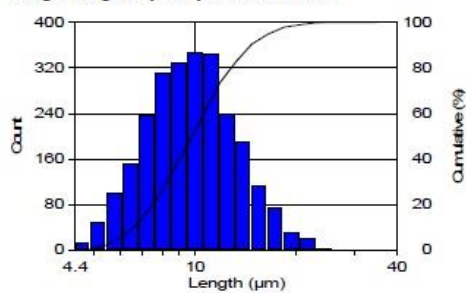
Min:	4.44	Mean:	10.31
Max:	35.10	Std Dev.:	3.35
Count:	2563		

Inter particle distance
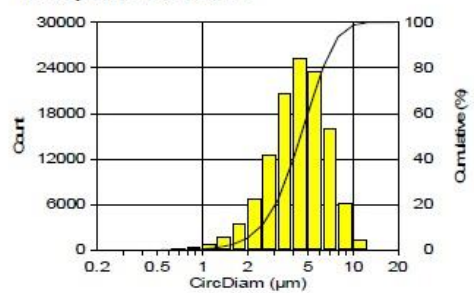
Min:	0.19	Mean:	4.73
Max:	16.90	Std Dev.:	1.95