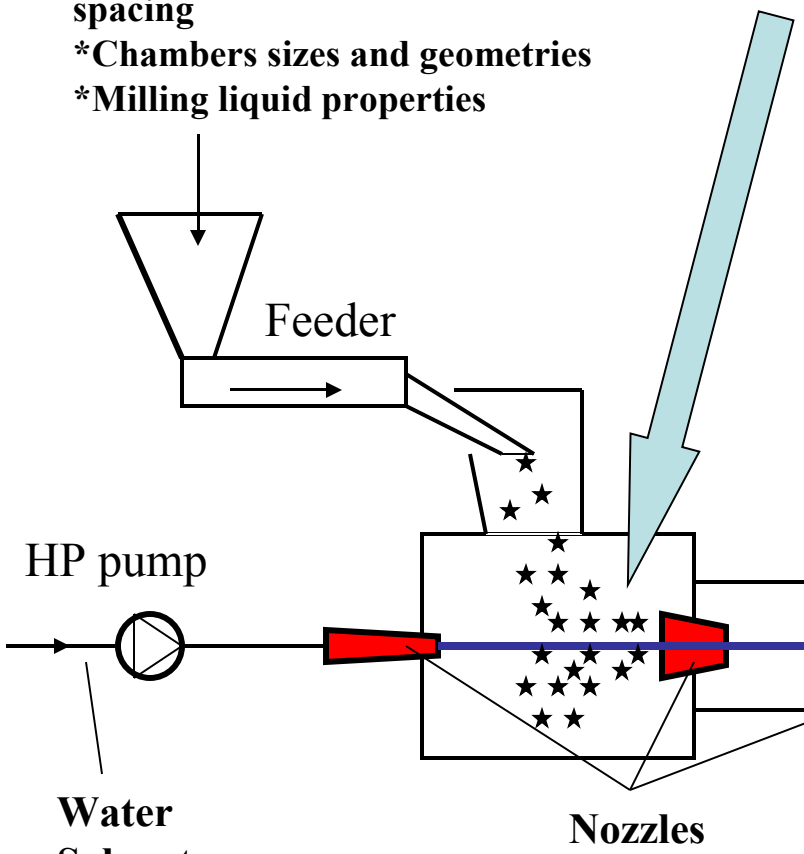
Aktywacja surowców farmaceutycznych i kosmetycznych w mikro i nanoskali procesów mechanochemicznych

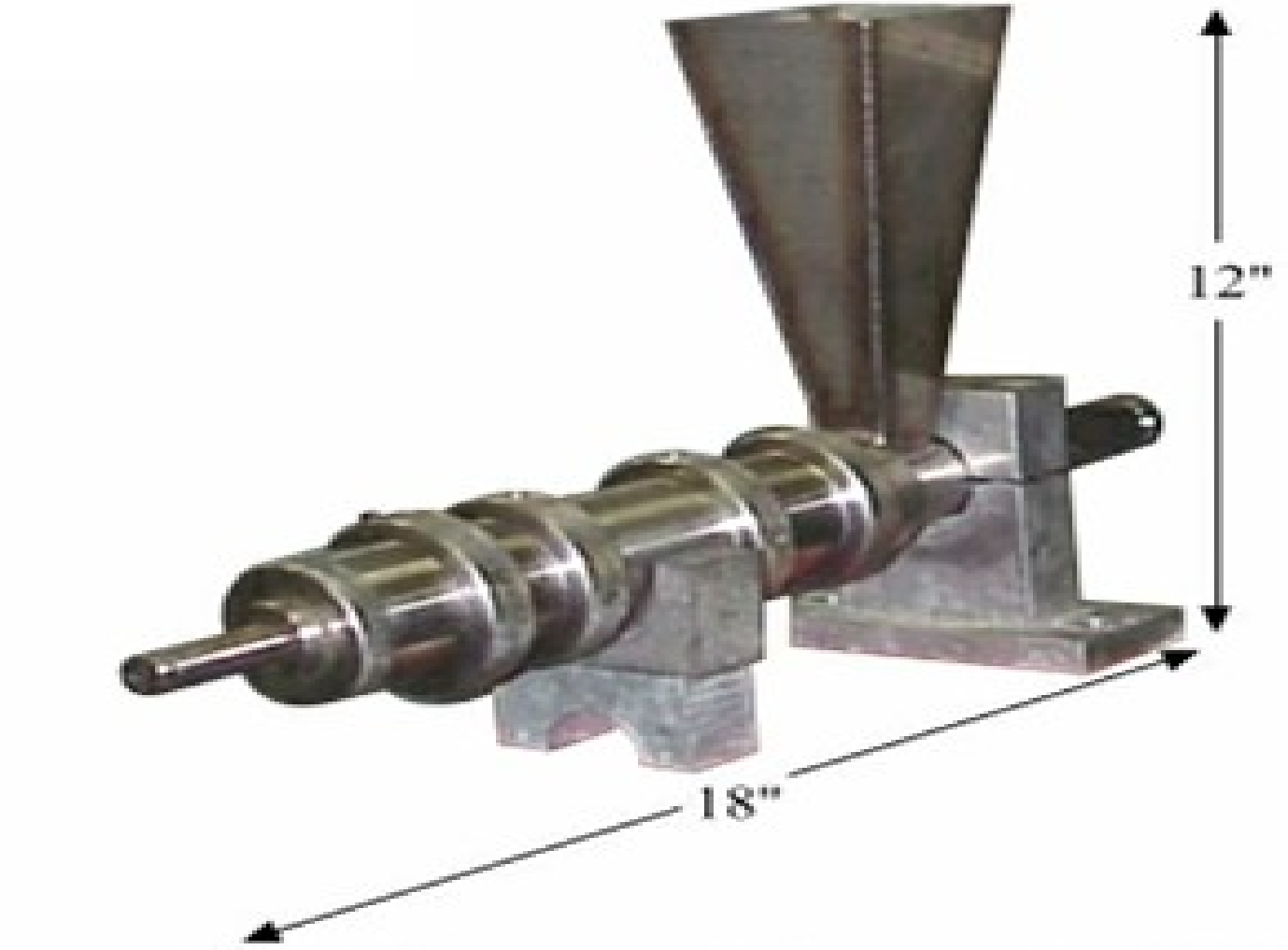
Process Parameters:

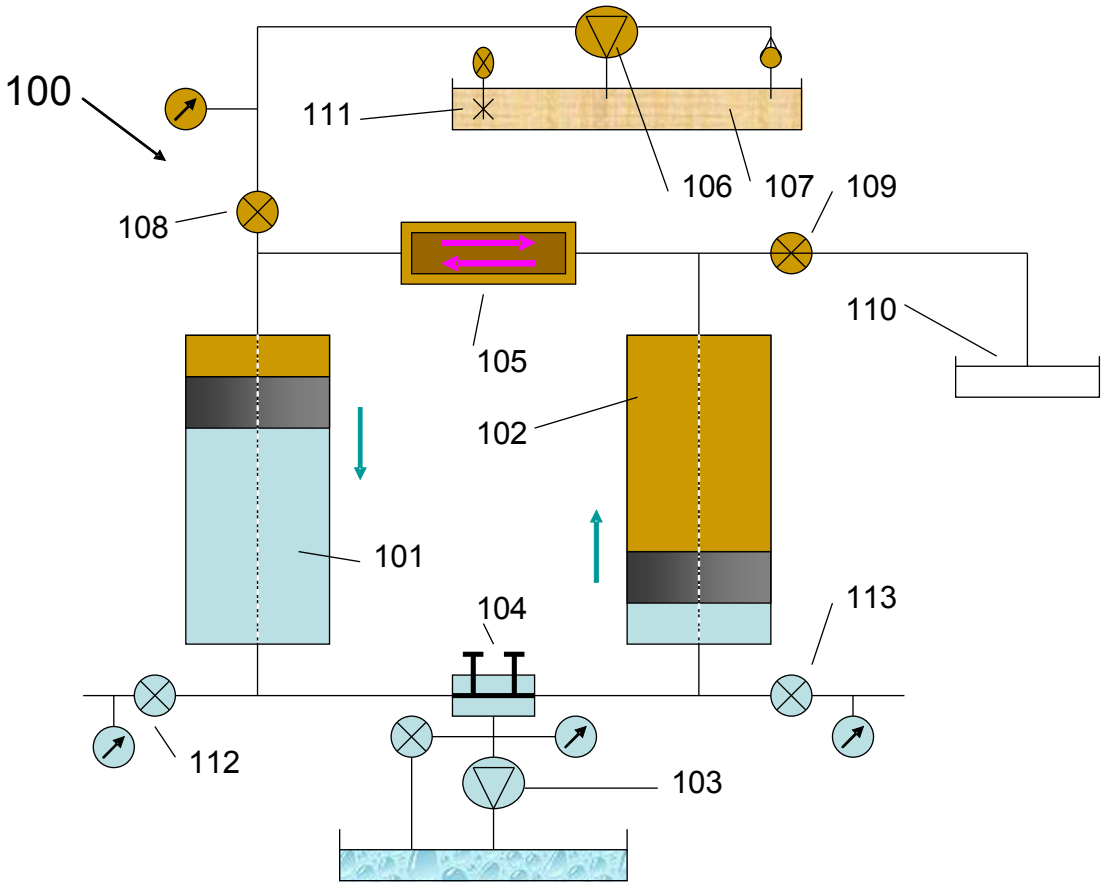
*Jet power (pressure and volume)
*Feed rate
*Nozzles geometry, size and spacing
*Chambers sizes and geometries
*Milling liquid properties



Process Physics:

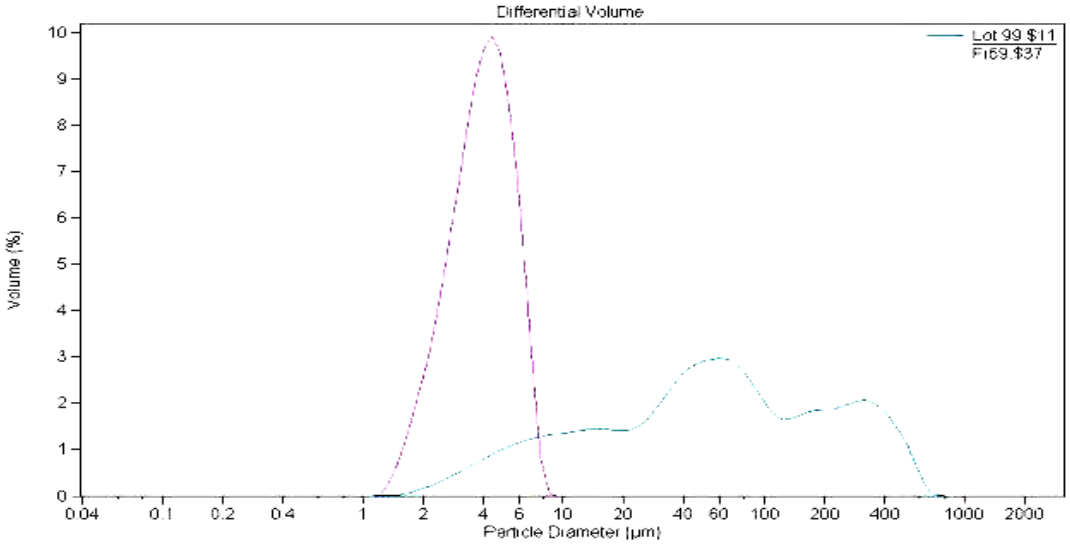
*Tremendous energy concentration and stress application where there are particles *High turbulence and intensive abrasion *Ultra-high frequency pressure pulsation *High speed collisions between jet and particles (800–1300 m/s) and between particles *High shearing energy *Aggressive cavitation *Water-hammer and shock wave effects *Hydro-wedging *Jet's nature: the jet, upon impact of the target generates intense differential stagnation pressure which forces the liquid into cracks and creates a hydro-mechanical action in these cracks, to form an increasingly dense network of a new cracks. Induced cracks propagating with the speed of sound in particular material.


12"
18"

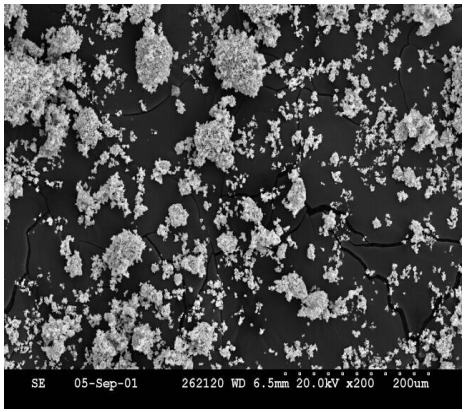


The modified milling system

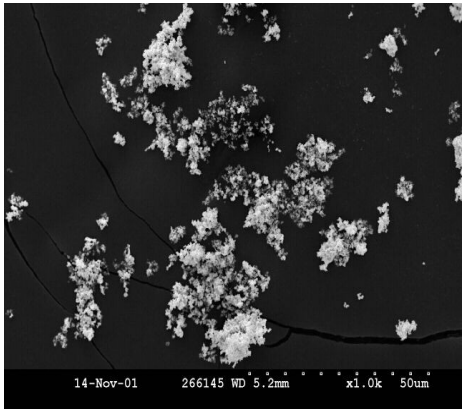
100 – recirculation system, 101 i 102 high pressure cylinders, 103 – high pressure water pump, 104 – flow control valve , 105 –flow through mill, 106 – slurry supply pump, 107 – slurry tank, 108 i 109 – cut-off valves, 110 – product tank, 111 – mixer, 112 i 113 - water supply cut-off valves



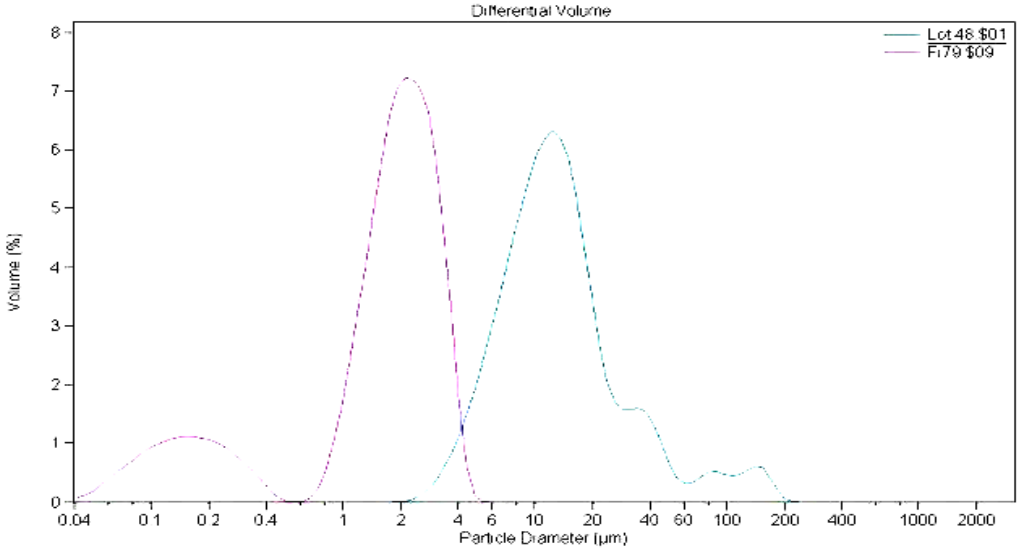
Single Pass Densification of Silver



Raw Silver 200x

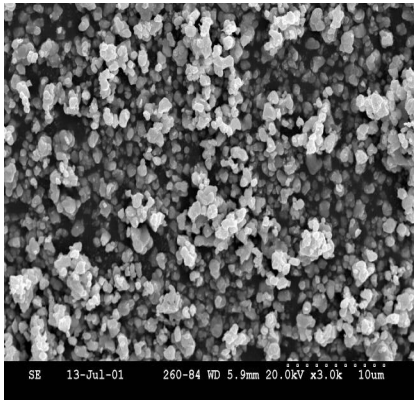


Milled Silver 1k

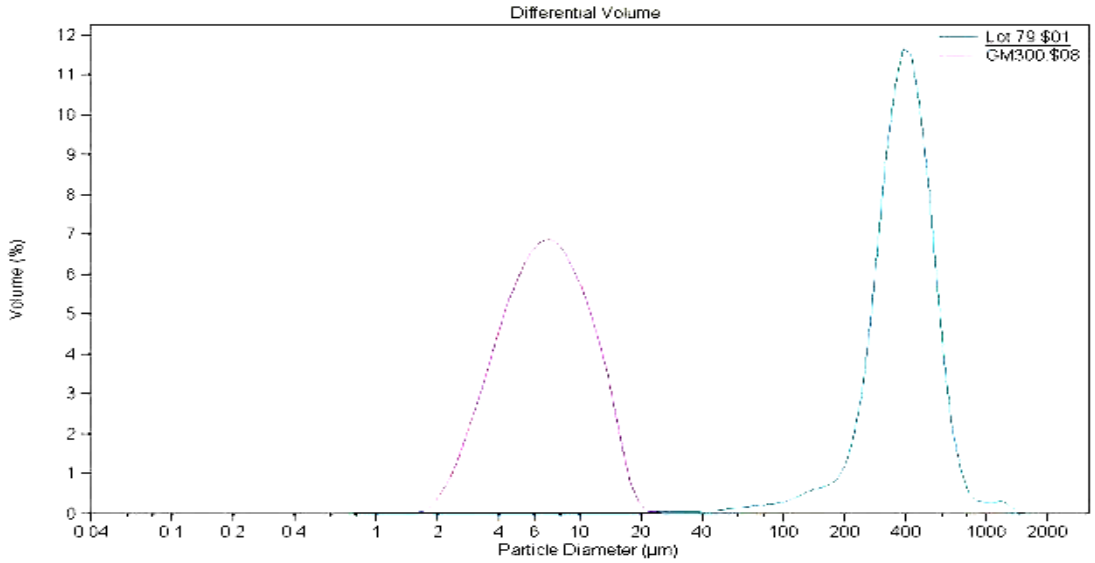


Single Pass Barium Titanate

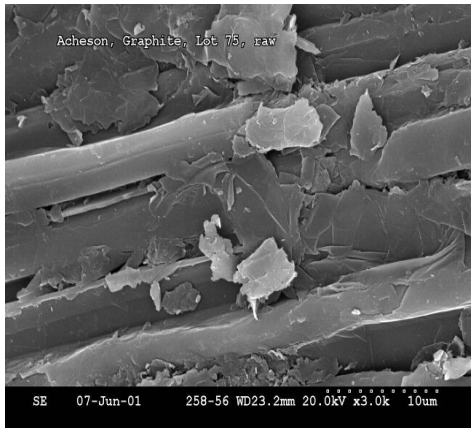
Raw Barium Titanate 5k



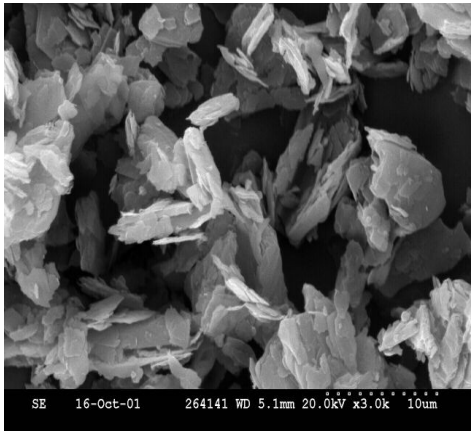
Milled Barium Titanate 3k



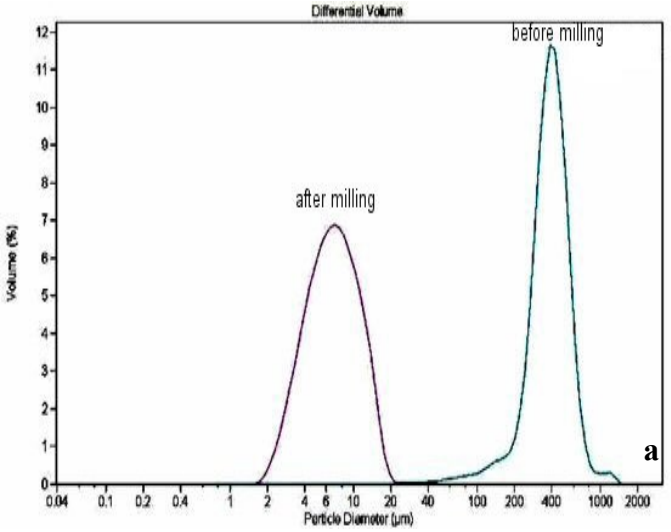
Multi Pass Crystalline Graphite



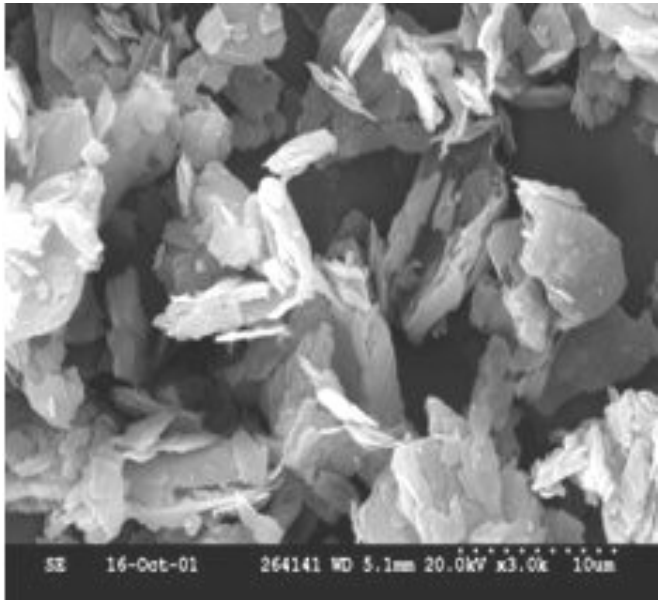
Raw Graphite 3k



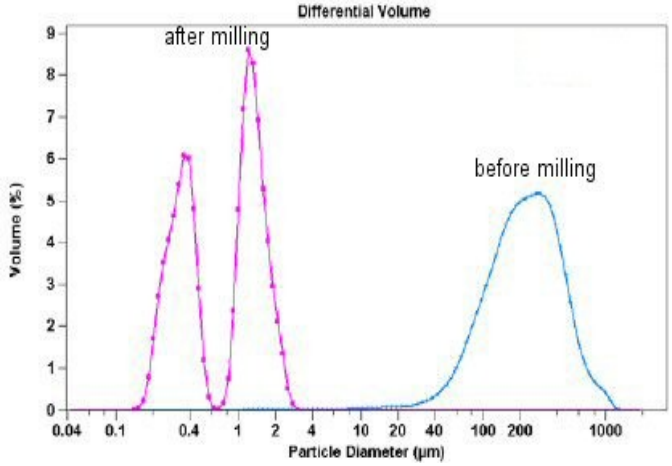
Multi Pass Graphite 3k

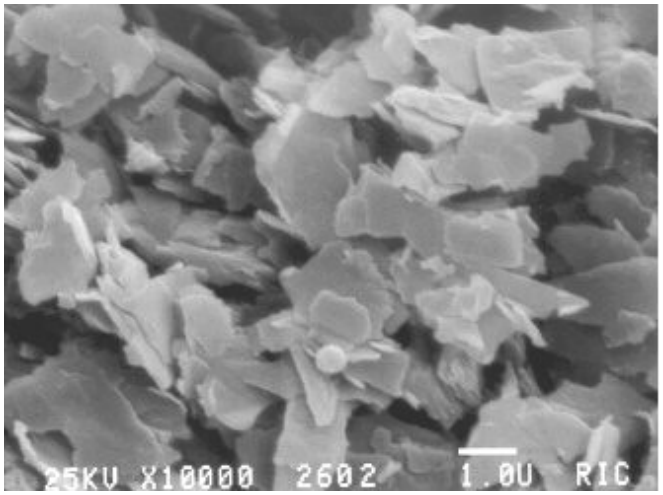


a



c

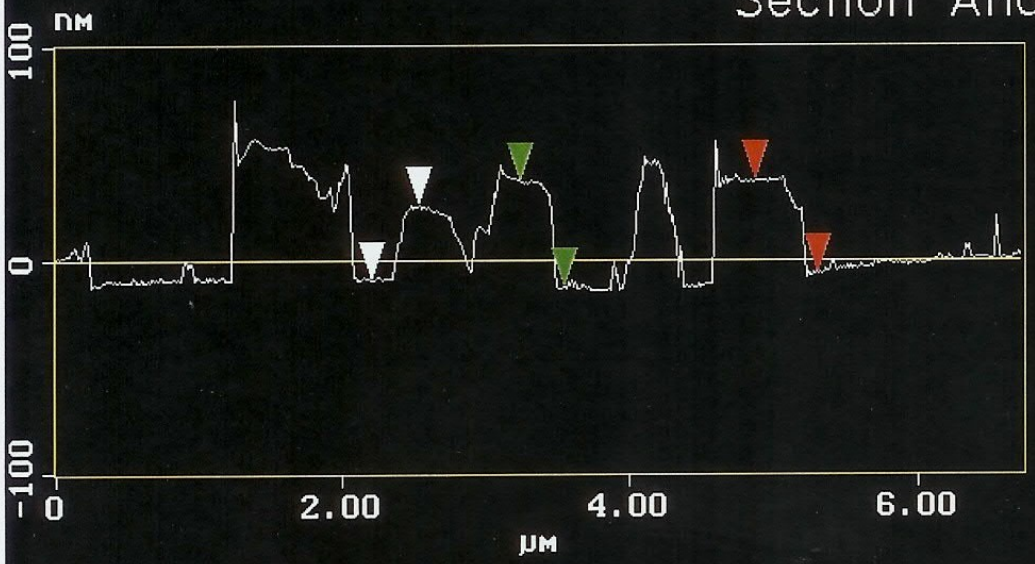




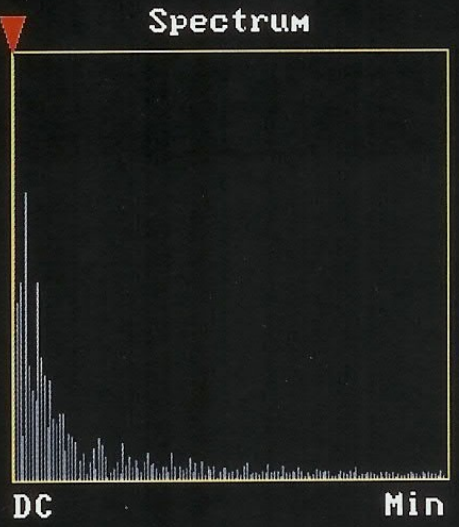
Examination of the multi-pass milled synthetic graphite with laser diffraction (LD) and scanning electron microscopy (SEM): (a) high-pressure mill (LD), (b) high-pressure mill (SEM), (c) modified high-pressure mill (LD), (d) modified high-pressure mill (SEM)

Cursor Marker Spectrum Zoom Center Line Offset Clear

Section Analysis



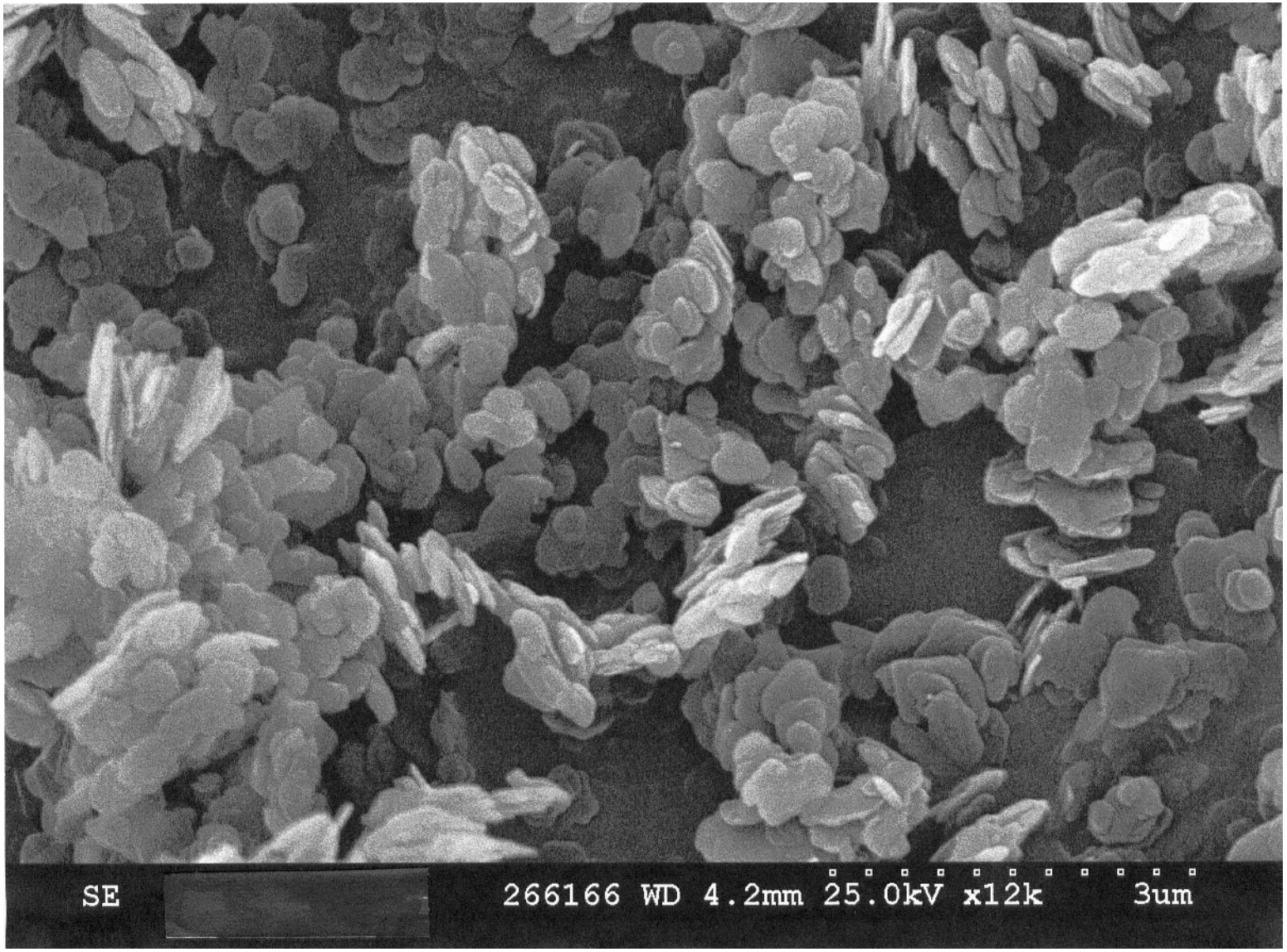
L	328.13 nm
RMS	14.842 nm
lc	DC
Ra(lc)	4.334 nm
Rmax	20.148 nm
Rz	10.924 nm
Rz Cnt	6
Radius	341.24 nm
Sigma	11.729 nm



Surface distance	448.67 nm
Horiz distance(L)	433.59 nm
Vert distance	43.715 nm
Angle	5.757 deg
Surface distance	323.26 nm
Horiz distance	304.69 nm
Vert distance	49.818 nm
Angle	9.286 deg
Surface distance	336.78 nm
Horiz distance	328.13 nm
Vert distance	34.529 nm
Angle	6.007 deg
Spectral period	DC
Spectral freq	0 Hz
Spectral RMS amp	0.016 nm

ct4.012

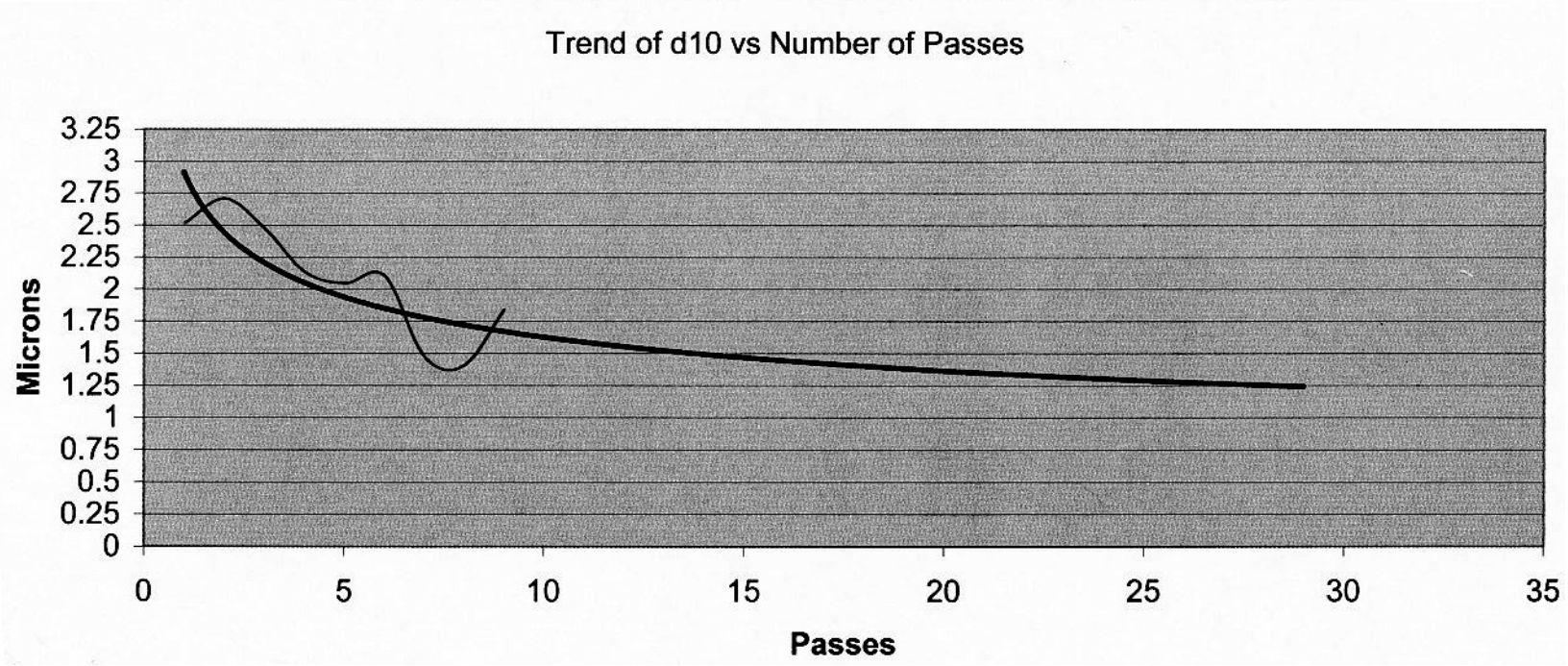
Cursor: fixed Zoom: 2:1 Cen line: Off Offset: Off


SE
266166 WD 4.2mm 25.0kV x12k
3um

Opposite Jet Milling **Nozzles** .014" -> -> -> -> .011" -> ->

Analysis and Trend of d10's For Recirculation of Boron Nitride

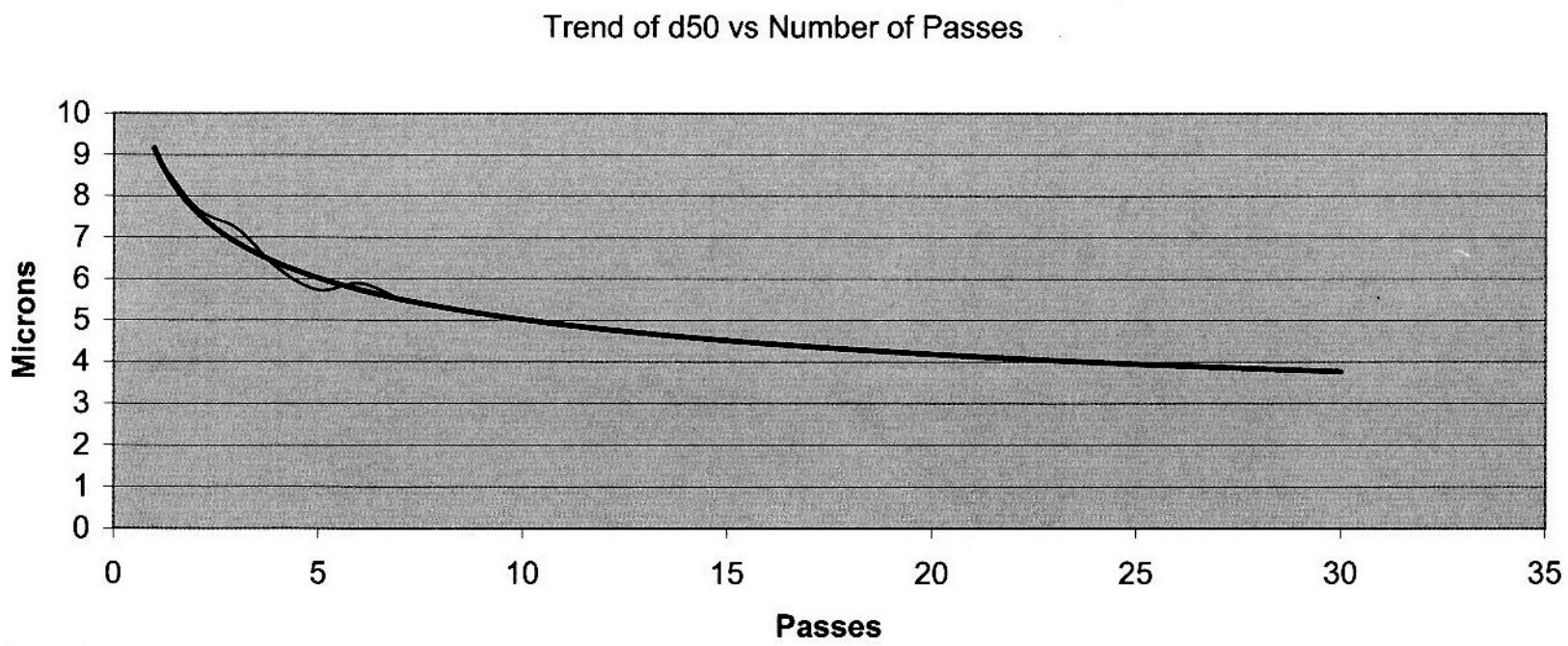
	Raw	1st Pass (recirc)	2nd Pass (recirc)	3rd Pass (recirc)	4th Pass (recirc)	5th Pass (recirc)	6th Pass (recirc)	7th Pass (recirc)	8th Pass (recirc)
Pass Number	1	2	3	4	5	6	7	8	9
Test Numbers	Lot 109	GM551-552	GM553-556	GM557-560	GM561-564	GM565-568	GM569-572	GM573-576	GM577-580
	2.515	2.568	2.424	2.057	2.111	2.168	1.47	1.509	1.798
		2.847	2.385	2.171	2.015	2.054	1.599	1.32	1.953
			2.427	1.981	1.919	2.069	1.611	1.33	1.749
			2.656	2.325	2.147	2.128	1.209	1.464	1.872
Averages of d10's	2.515	2.7075	2.473	2.1335	2.048	2.10475	1.47225	1.40575	1.843
Standard Deviation		0.19728279	0.10694625	0.129602276	0.088741197	0.045811434	0.1617272	0.08237832	0.07713948



Opposite Jet Milling **Nozzles** .014" -> -> -> -> .011" -> ->

Analysis and Trend of d50's For Recirculation of Boron Nitride

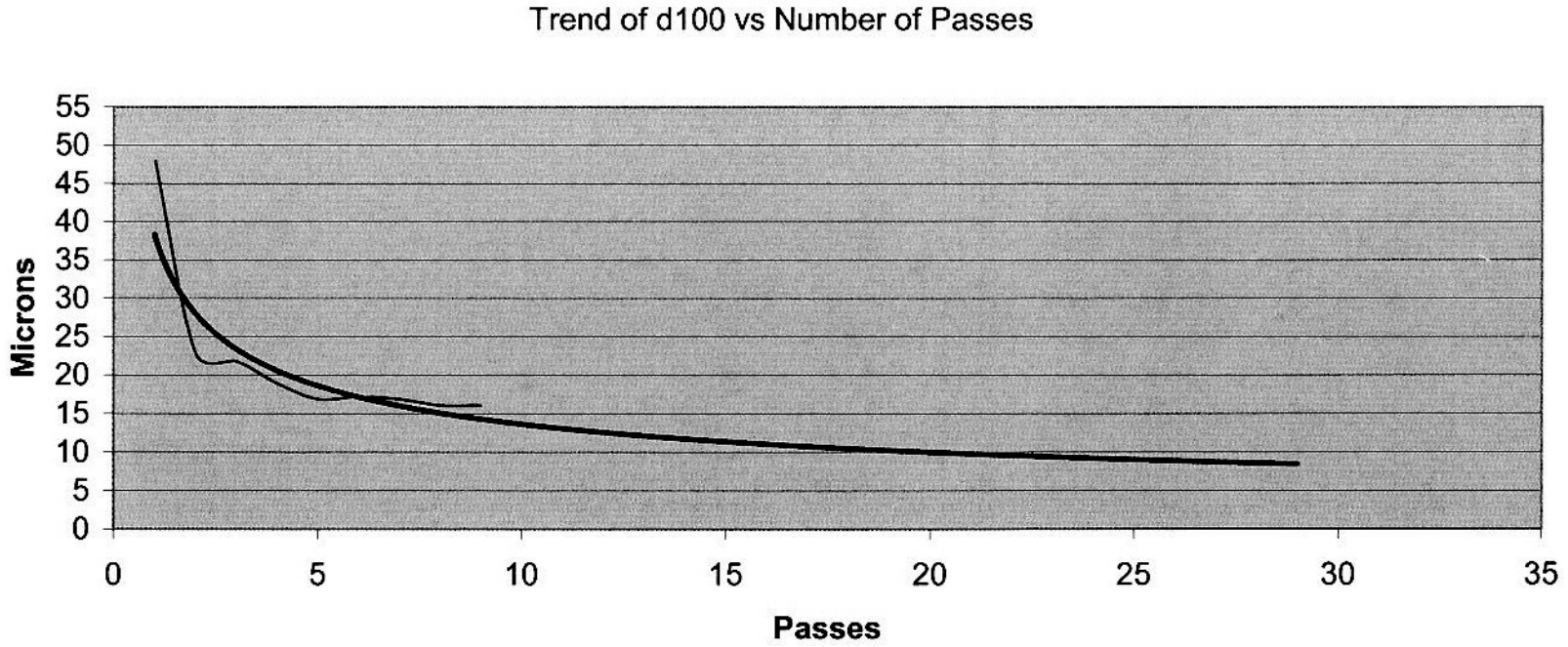
	Raw	1st Pass (recirc)	2nd Pass (recirc)	3rd Pass (recirc)	4th Pass (recirc)	5th Pass (recirc)	6th Pass (recirc)	7th Pass (recirc)	8th Pass (recirc)
Pass Number	1	2	3	4	5	6	7	8	9
Test Numbers	Lot 109	GM551-552	GM553-556	GM557-560	GM561-564	GM565-568	GM569-572	GM573-576	GM577-580
	9.022	7.272	7.066	6.039	6.12	5.792	5.359	5.632	4.954
		8.151	6.927	6.234	5.513	5.731	5.718	5.053	5.218
			7.006	5.941	5.43	5.927	6.136	5.213	5.152
			7.823	6.76	5.836	6.111	4.885	5.429	5.192
Averages of d50's	9.022	7.7115	7.2055	6.2435	5.72475	5.89025	5.5245	5.33175	5.129
Standard Deviation		0.62154686	0.35990589	0.316302466	0.2740049	0.14585502	0.46035991	0.21875257	0.10373524



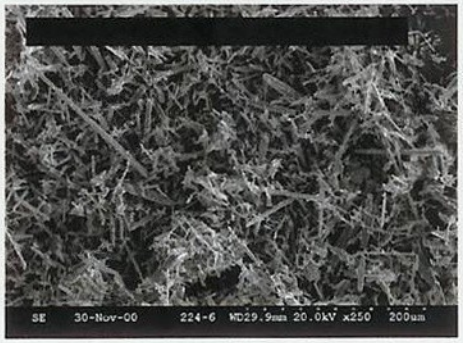
Opposite Jet Milling **Nozzles** .014" -> -> -> -> .011" -> ->

Analysis and Trend of d100's For Recirculation of Boron Nitride

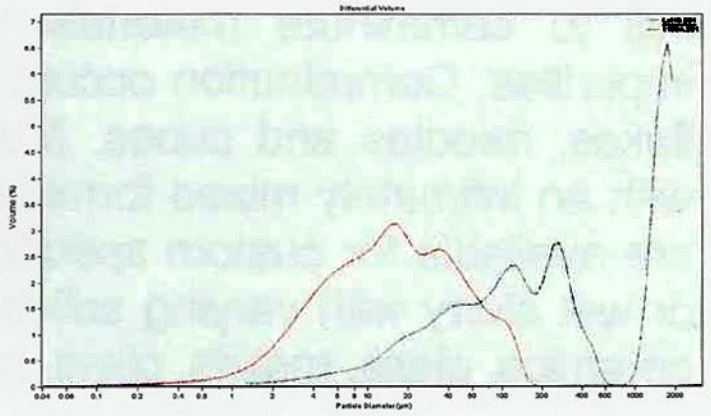
	Raw	1st Pass (recirc)	2nd Pass (recirc)	3rd Pass (recirc)	4th Pass (recirc)	5th Pass (recirc)	6th Pass (recirc)	7th Pass (recirc)	8th Pass (recirc)
Pass Number	1	2	3	4	5	6	7	8	9
Test Numbers	Lot 109	GM551-552	GM553-556	GM557-560	GM561-564	GM565-568	GM569-572	GM573-576	GM577-580
	47.94	20.71	20.71	18.86	17.18	17.18	15.65	17.18	17.18
		24.95	20.71	18.86	15.65	17.18	17.18	15.65	15.65
			20.71	18.86	15.65	17.18	18.86	15.65	15.65
			24.95	18.86	18.86	17.18	15.65	15.65	15.65
Averages of d100's	47.94	22.83	21.77	18.86	16.835	17.18	16.835	16.0325	16.0325
Standard Deviation		2.99813275	2.12	0	1.53058812	0	1.53058812	0.765	0.765



FE-SEM micrograph at 250x magnification.



FE-SEM micrograph of typical product at 250x magnification. Note the very high aspect ratio needles created. Further comminution to produce lower aspect ratios can be achieved.



Raw Feedstock d_{50} = 188 µm, d_{100} = 2000 µm
Milled material d_{50} = 15 µm, d_{100} = 194 µm

Material Name	Raw Material [µm]				Product [µm]			
	d10	d50	d90	d100	d10	d50	d90	d100
Barium Titanate	2,383	*4,429*	8,026	*22,73*	0,362	*2,44*	4,208	*7,421*
Boron Nitride	0,993	*2,962*	5,111	*8,943*	1,704	*5,759*	9,991	*17,18*
Boron Nitride	2,515	*9,022*	24,68	*47,94*	2,496	*7,816*	13,48	*22,73*
Boron Nitride	1,872	*7,159*	17,48	*33,01*	8,906	*21,65*	34,59	*47,94*
Calcium Carbonate	0,175	*1,648*	8,036	*20,71*	0,185	*1,774*	6,41	*18,86*
Cordierite	6,615	*40,57*	168,6	*309,6*	2,178	*11,86*	33,19	*121,8*
Dental Glass	0,45	*2,5*	40,68	*111*	0,39	*2,496*	4,021	*5,61*
Dental Glass	0,506	*89,26*	213,8	*373,1*	0,239	*2,713*	6,214	*24,95*
Dental Glass	2,642	*7,898*	22,01	*63,41*	2,106	*5,262*	16,56	*52,62*
Electronic Glass Frit	-	-	-	*<2mm*	10,13	*59,28*	137,4	*786,9*
Graphite	49,02	*399*	907,6	*1 822*	2,806	*7,195*	22,25	*52,62*
Graphite	310,2	*477,7*	774,3	*1 660*	9,273	*19,29*	32,02	*43,67*
Graphite	368,1	*638,6*	991,5	*1 660*	6,57	*19,95*	63,61	*121,8*
Graphite	87,17	*343,9*	782,8	*1 041*	8,372	*20,8*	46,15	*92,09*
Graphite	387,9	*590,6*	891,8	*1 660*	2,903	*7,222*	15,8	*39,78*
Graphite	-	-	-	*>2mm*	9,394	*19,31*	35,11	*52,62*
Graphite	302	*556,7*	942,1	*1 377*	7,849	*17,41*	29,57	*39,78*
Amorphous Graphite	-	-	-	*>2mm*	3,285	*8,177*	20,63	*63,41*
High Purity Alumina	-	-	-	*~2mm*	1,51	*2,825*	5,539	*24,95*
Pin Milled Graphite	248,8	*441,3*	756	*1 660*	9,085	*18,71*	32,12	*47,94*
Pyrex B	6,69	*23,3*	61,59	*161,2*	1,499	*6,914*	21,25	*57,77*
Silica	90,22	*665,4*	1 636	*2 000*	4,638	*24,45*	73,11	*194,2*
Silica	508,6	*777,2*	1 172	*1 660*	0,522	*28,33*	126,3	*786,9*
Silver	7,091	*56,57*	327,8	*786,9*	2,579	*4,634*	7,501	*17,18*
Titanium Dioxide	1,168	*2,73*	4,9	*8,943*	1,52	*2,737*	4,455	*6,76*
Zirconium Oxide	486,3	*759,9*	1 093	*1 660*	8,727	*107,9*	334,1	*1 143*
Zirconium Titanate	16,27	*30,94*	52,98	*111*	3,196	*15,39*	29,86	*57,77*

Characterization (LD) of particles of selected materials milled by single-pass through the high-pressure mill