UNION TOOL

TECHNICAL INFORMATION

Drill Bit Wearing Investigation between D/S to 10Layers PWB

Issue No. AT0062

UNION TOOL Co.
TECHNICAL RESEARCH
NAGAOKA FACTORY
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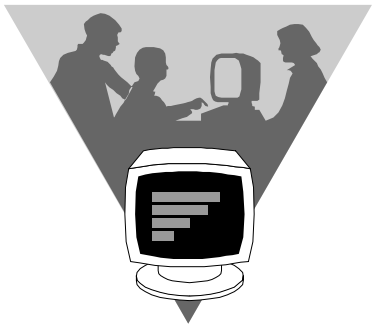


World Largest Leader in PWB Cutting Tools

Drill Bit Wearing Investigation between D/S to 10-Layers PCB

[Recommendation]

From the results of this investigation, we herewith kindly recommend a suitable driling conditions chart for each PC board.

		D/S	4-Layers	6-Layers	8-Layers	10-12-Layers
Machine	Spindle Speed	100 krpm	108 krpm	108 krpm	108 krpm	108 krpm
	Infeed Rate	2.4 m/min	2.0 m/min	1.8 m/min	1.8 m/min	1.4 m/min
	Chipload	24 ㎜/rev.	18.5 ㎜/rev.	16.7 ㎜/rev.	16.7 ㎜/rev.	13.0 ㎜/rev.
	Retract Rate	25 m/min				
Hit count	New	7,000	5,500	3,700	3,000	2,000
	Repointed	7,000	5,500	3,700	3,000	2,000
	Total	14,000	11,000	7,400	6,000	4,000

Infeed rate for 4-layers has increased due to combination within layers.
Although this test was carried out without repointing the drill bits, we recommend one repoint in order to keep the cutting abilities for an improved hole wall quality in production.

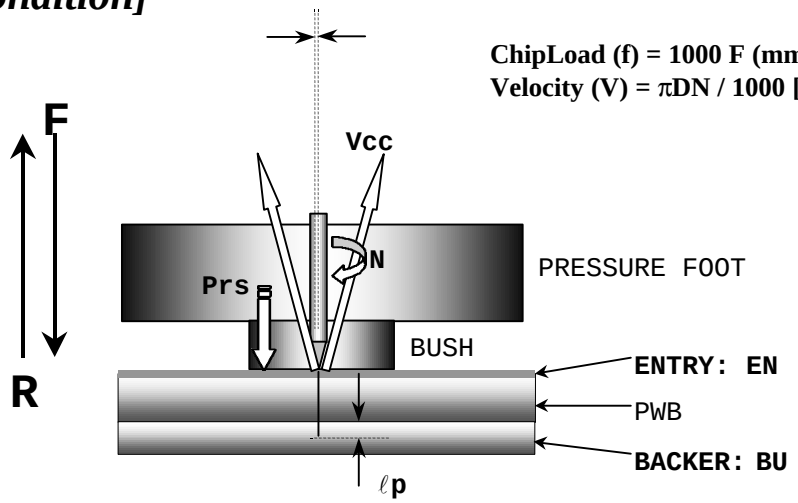
[Test Condition]

Note that all drill bits used in this test, have not been repointed as the purpose of this test is to know the life of the drill bit.

Condition		A	B	C	D	E
Diameter		NTX35 ƒ0.4 x 7				
PWB		FR-4. D/S	FR-4. 4-Layers	FR-4. 6-Layers	FR-4. 8-Layers	FR-4. 10-Layers
Maker		E-comp.				
Stack Heights		1.6 mmx3 boards	1.6 mmx3 boards	1.6 mmx3 boards	1.2 mmx3 boards	1.6 mmx3 boards
Spindle Speed	N	100 krpm	108 krpm	108 krpm	108 krpm	108 krpm
Infeed Rate	F	2.4 m/min	1.8 m/min	1.8 m/min	1.8 m/min	1.4 m/min
Chipload	f	24 ㎜/rev.	16.7 ㎜/rev.	16.7 ㎜/rev.	16.7 ㎜/rev.	13.0 ㎜/rev.
Retract Rate	R	25.0 m/min				
Velocity	V	125.7 m/min	135.7 m/min	135.7 m/min	135.7 m/min	135.7 m/min
Number of Hits ( ):existing hits		26,000 (12,000)	16,000 (12,000)	9,000	9,000	6,000
Entry Board	EN	Aluminum (t= 0.2 mm)				
Backup Board	BU	Bakelite (t= 1.5 mm)				
Depth into Backer	lp	0.3 mm				
Spindle Run Out	RO	Less than 5 microns				
Pressure Foot	Prs	87 N (8.7 kg)				
Vacuum Force	Vcc	150 hpa				
Drilling Machine		HITACHI ND-1W212				

Note : The thickness of the 8 layers board is 1.2 mm. All other boards are 1.6 mm thick. The copper thickness is the same for all boards, 18 ㎜ for outer layers and 35 ㎜ for inner layers.

[Drilling Condition]



ChipLoad (f) = 1000 F (mm) / N (RPM) [*m*m/rev.]
Velocity (V) = πDN / 1000 [m/min]

Test Data included in this report

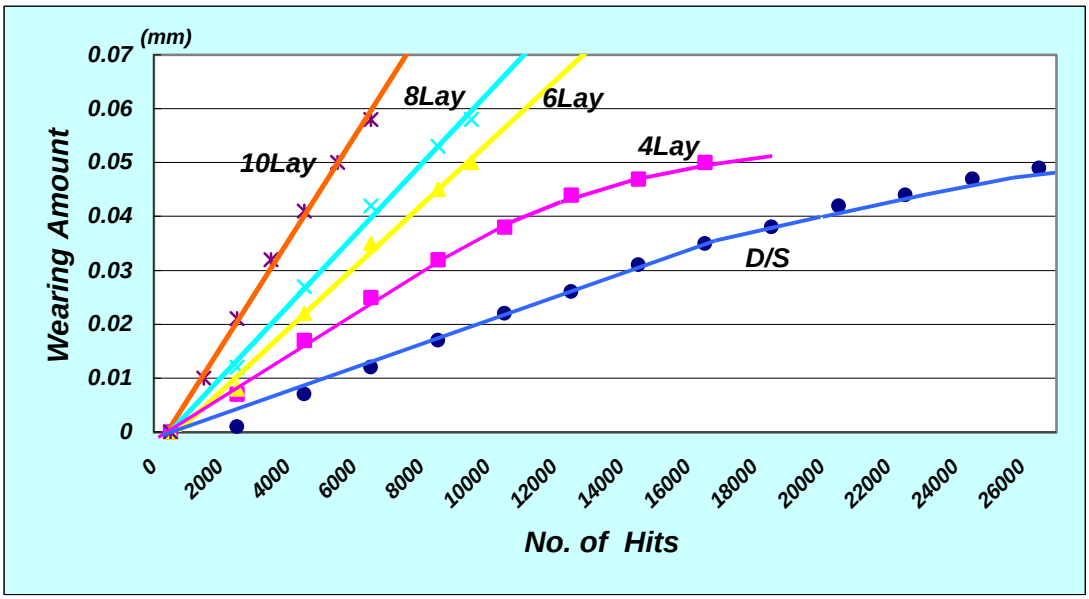
	D/S	*4L*	*6L*	*8L*	*10L*
Wearing Amount	**INCLUDED**	**INCLUDED**	**INCLUDED**	**INCLUDED**	**INCLUDED**
Diameter Wearing	**INCLUDED**	**INCLUDED**	**INCLUDED**	**INCLUDED**	**INCLUDED**
Hole Accuracy	**INCLUDED**	**INCLUDED**	**INCLUDED**	**INCLUDED**	**INCLUDED**
Hole Wall Roughness	**INCLUDED**	**INCLUDED**	**INCLUDED**	**INCLUDED**	**INCLUDED**
Nail Heading	**N/A**	**INCLUDED**	**INCLUDED**	**INCLUDED**	**INCLUDED**

Wearing Amount : NTX35 0.4 x 7

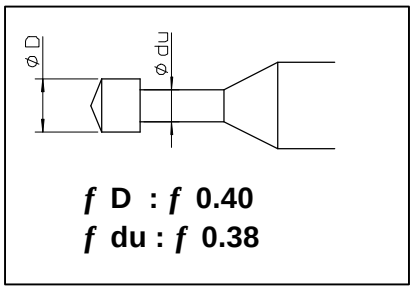
Unit (mm)

layer \ hits	0	1000	2000	3000	4000	5000	6000	8000	9000	10000	12000	14000	16000	18000	20000	22000	24000	26000
D/S	0	—	0.001	—	0.007	—	0.012	0.017	—	0.022	0.026	0.031	0.035	0.038	0.042	0.044	0.047	0.049
4Lay	0	—	0.007	—	0.017	—	0.025	0.032	—	0.038	0.044	0.047	0.05	—	—	—	—	—
6Lay	0	—	0.008	—	0.022	—	0.035	0.045	0.05	—	—	—	—	—	—	—	—	—
8Lay	0	—	0.012	—	0.027	—	0.042	0.053	0.058	—	—	—	—	—	—	—	—	—
10Lay	0	0.01	0.021	0.032	0.041	0.05	0.058	—	—	—	—	—	—	—	—	—	—	—

Wearing Amount equals new drill bit minus the ƒ of a used drill bit.



Note : The thickness of the 8 layers board is 1.2 mm. All other boards are 1.6 mm thick. The copper thickness is the same for all boards, 18 ㎛ for outer layers and 35 ㎛ for inner layers.



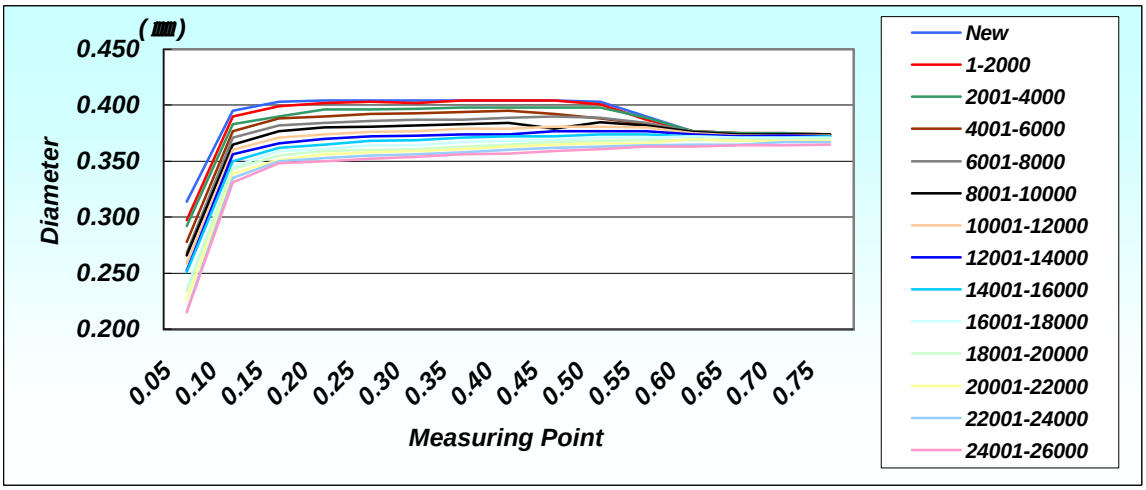
Diameter's Wear (NTX35 0.4 x 7.0)

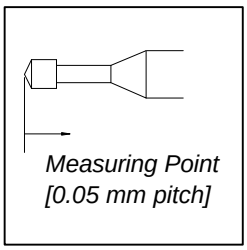
FR-4 (D/S) 1.6 x 3

Unit (mm)

Measuring Point	New	1-2000	2001-4000	4001-6000	6001-8000	8001-10000	10001-12000	12001-14000	14001-16000	16001-18000	18001-20000	20001-22000	22001-24000	24001-26000
0.05	0.314	0.297	0.292	0.278	0.268	0.266	0.259	0.252	0.251	0.236	0.234	0.226	0.216	0.215
0.10	0.395	0.390	0.383	0.377	0.371	0.365	0.360	0.356	0.350	0.345	0.343	0.339	0.335	0.331
0.15	0.403	0.399	0.390	0.388	0.382	0.377	0.371	0.366	0.362	0.359	0.355	0.351	0.350	0.348
0.20	0.404	0.402	0.396	0.390	0.384	0.380	0.374	0.370	0.365	0.361	0.359	0.356	0.353	0.350
0.25	0.404	0.403	0.396	0.392	0.386	0.381	0.376	0.372	0.368	0.364	0.360	0.358	0.355	0.352
0.30	0.404	0.402	0.397	0.393	0.387	0.382	0.377	0.373	0.369	0.364	0.361	0.359	0.356	0.354
0.35	0.404	0.404	0.398	0.394	0.387	0.383	0.379	0.374	0.371	0.367	0.363	0.361	0.358	0.356
0.40	0.404	0.404	0.398	0.395	0.389	0.384	0.379	0.374	0.372	0.368	0.365	0.363	0.360	0.357
0.45	0.404	0.404	0.398	0.392	0.390	0.379	0.381	0.377	0.372	0.369	0.367	0.365	0.362	0.359
0.50	0.403	0.401	0.398	0.388	0.389	0.385	0.381	0.377	0.374	0.371	0.368	0.366	0.363	0.361
0.55	0.390	0.387	0.389	0.383	0.384	0.382	0.380	0.377	0.374	0.371	0.369	0.366	0.364	0.363
0.60	0.377	0.377	0.377	0.374	0.376	0.376	0.375	0.374	0.372	0.372	0.369	0.370	0.365	0.363
0.65	0.375	0.375	0.375	0.374	0.374	0.374	0.373	0.372	0.371	0.371	0.369	0.368	0.365	0.364
0.70	0.374	0.375	0.375	0.374	0.374	0.374	0.373	0.373	0.371	0.371	0.369	0.368	0.367	0.364
0.75	0.374	0.374	0.374	0.374	0.374	0.374	0.373	0.372	0.372	0.371	0.370	0.368	0.367	0.365
AVE.	0.404	0.402	0.396	0.392	0.387	0.381	0.377	0.373	0.369	0.365	0.362	0.360	0.357	0.355

AVERAGE DIAMETER was taken measuring point from 0.15 mm to 0.50 mm within the blue area abo



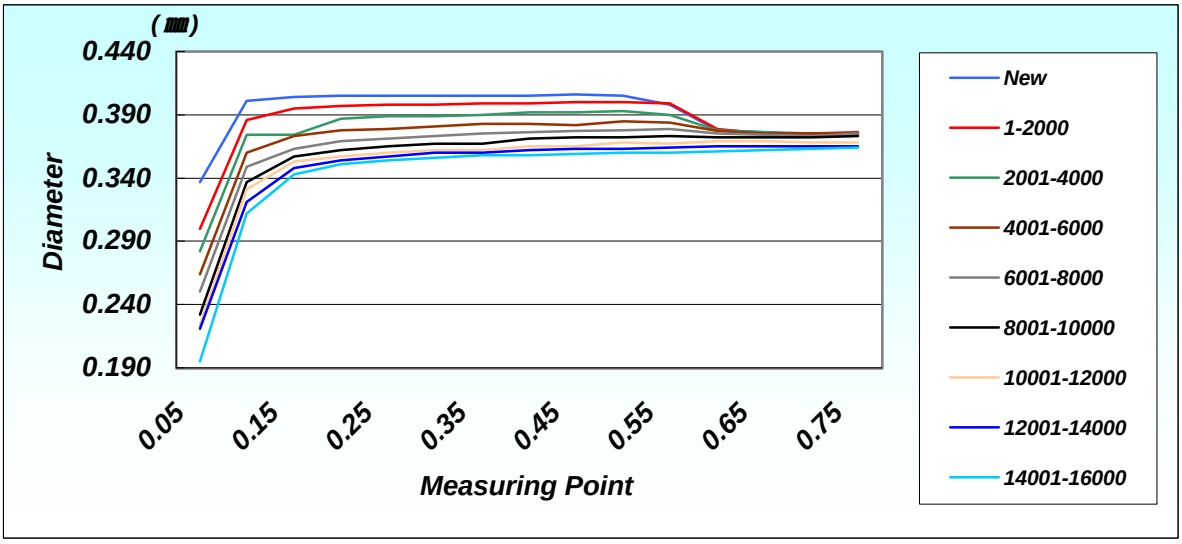


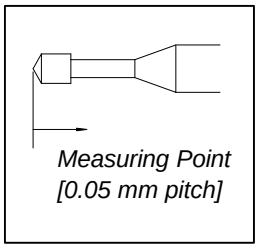
Diameter's Wear (NTX35 0.4 x 7.0)

FR-4 (4Lay) 1.6 x 3

Measuring Point	New	1-2000	2001-4000	4001-6000	6001-8000	8001-10000	10001-12000	12001-14000	14001-16000
0.05	0.337	0.300	0.282	0.264	0.250	0.232	0.224	0.221	0.195
0.10	0.401	0.386	0.374	0.360	0.349	0.337	0.331	0.321	0.312
0.15	0.404	0.395	0.374	0.373	0.363	0.357	0.353	0.348	0.343
0.20	0.405	0.397	0.387	0.378	0.369	0.362	0.357	0.354	0.351
0.25	0.405	0.398	0.389	0.379	0.371	0.365	0.360	0.357	0.354
0.30	0.405	0.398	0.389	0.381	0.373	0.367	0.362	0.360	0.356
0.35	0.405	0.399	0.390	0.383	0.375	0.367	0.362	0.360	0.358
0.40	0.405	0.399	0.392	0.383	0.376	0.371	0.365	0.362	0.358
0.45	0.406	0.400	0.392	0.382	0.377	0.372	0.365	0.363	0.359
0.50	0.405	0.400	0.393	0.385	0.378	0.372	0.368	0.363	0.360
0.55	0.398	0.399	0.390	0.384	0.379	0.373	0.367	0.364	0.360
0.60	0.378	0.379	0.378	0.377	0.375	0.372	0.369	0.365	0.361
0.65	0.376	0.375	0.376	0.375	0.374	0.372	0.369	0.365	0.362
0.70	0.375	0.375	0.374	0.375	0.373	0.372	0.368	0.365	0.363
0.75	0.375	0.376	0.375	0.375	0.375	0.373	0.368	0.365	0.364
AVE.	0.405	0.398	0.388	0.381	0.373	0.367	0.362	0.358	0.355

AVERAGE DIAMETER was taken measuring point from 0.15 mm to 0.50 mm within the blue area abo



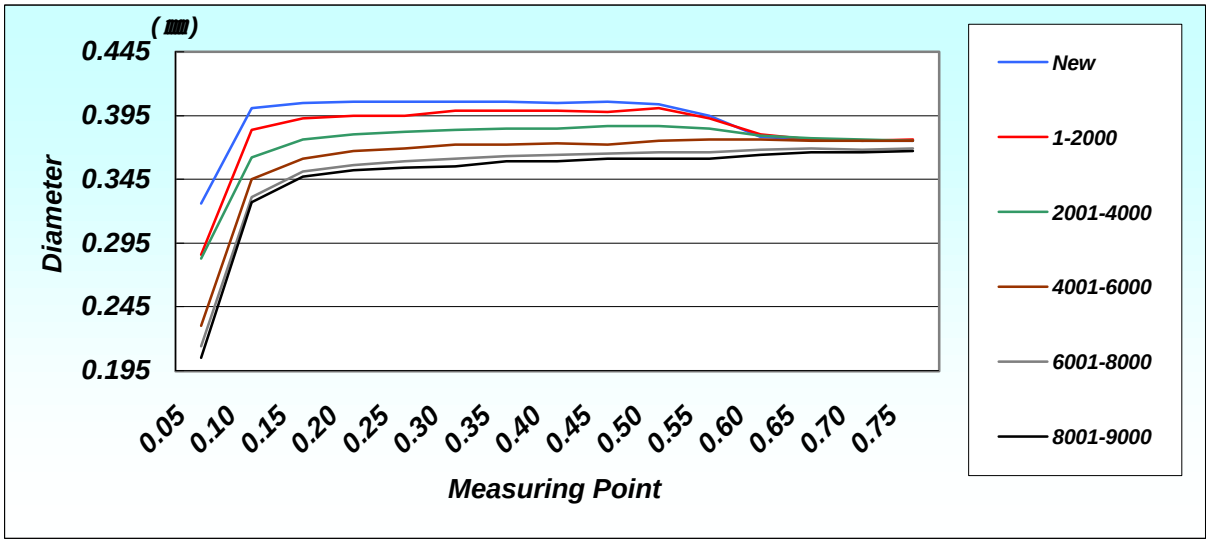


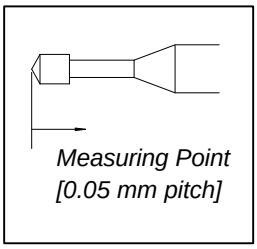
Diameter's Wear (NTX35 0.4 x 7.0)

FR-4 (6Lay) 1.6 x 3

Measuring Point	New	1-2000	2001-4000	4001-6000	6001-8000	8001-9000
0.05	0.326	0.286	0.283	0.230	0.214	0.205
0.10	0.401	0.384	0.362	0.345	0.331	0.327
0.15	0.405	0.393	0.376	0.361	0.351	0.347
0.20	0.406	0.395	0.380	0.367	0.356	0.352
0.25	0.406	0.395	0.382	0.369	0.359	0.354
0.30	0.406	0.399	0.384	0.372	0.361	0.355
0.35	0.406	0.399	0.385	0.372	0.363	0.359
0.40	0.405	0.399	0.385	0.373	0.364	0.359
0.45	0.406	0.398	0.387	0.372	0.365	0.361
0.50	0.404	0.401	0.387	0.375	0.366	0.361
0.55	0.395	0.393	0.385	0.376	0.366	0.361
0.60	0.378	0.380	0.379	0.376	0.368	0.364
0.65	0.376	0.376	0.377	0.375	0.369	0.366
0.70	0.375	0.375	0.376	0.375	0.368	0.366
0.75	0.375	0.376	0.375	0.375	0.369	0.367
AVE.	0.406	0.397	0.383	0.370	0.361	0.356

AVERAGE DIAMETER was taken measuring point from 0.15 mm to 0.50 mm within the blue area above.





Diameter's Wear (NTX35 0.4 x 7.0)

FR-4 (8Lay) 1.2 x 3

Measuring Point	New	1-2000	2001-4000	4001-6000	6001-8000	8001-9000
0.05	0.328	0.278	0.256	0.244	0.227	0.220
0.10	0.401	0.376	0.354	0.338	0.326	0.321
0.15	0.405	0.387	0.369	0.354	0.344	0.340
0.20	0.405	0.391	0.376	0.359	0.348	0.344
0.25	0.405	0.393	0.378	0.362	0.350	0.347
0.30	0.406	0.394	0.379	0.365	0.352	0.348
0.35	0.406	0.395	0.381	0.367	0.354	0.349
0.40	0.406	0.395	0.381	0.367	0.355	0.351
0.45	0.406	0.395	0.382	0.366	0.356	0.351
0.50	0.404	0.395	0.381	0.369	0.357	0.351
0.55	0.389	0.388	0.378	0.369	0.357	0.352
0.60	0.378	0.378	0.377	0.369	0.358	0.353
0.65	0.377	0.376	0.376	0.370	0.358	0.354
0.70	0.376	0.376	0.375	0.371	0.359	0.355
0.75	0.376	0.376	0.377	0.371	0.362	0.357
AVE.	0.405	0.393	0.378	0.364	0.352	0.348

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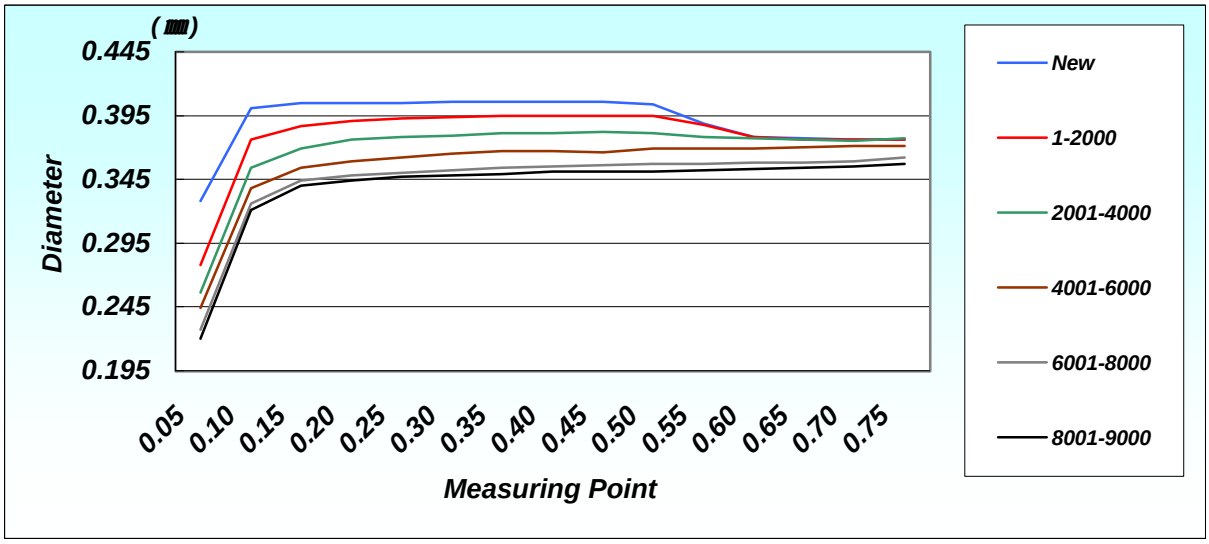

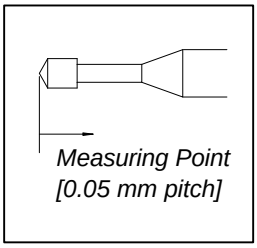

Diameter's Wear (NTX35 0.4 x 7.0)

FR-4 (10Lay) 1.6 x 3

Measuring Point	New	1-1000	1001-2000	2001-3000	3001-4000	4001-5000	5001-6000
0.05	0.330	0.282	0.268	0.260	0.246	0.248	0.234
0.10	0.401	0.383	0.368	0.355	0.343	0.335	0.327
0.15	0.404	0.392	0.378	0.365	0.356	0.347	0.340
0.20	0.405	0.394	0.382	0.368	0.359	0.351	0.342
0.25	0.405	0.394	0.383	0.371	0.362	0.352	0.344
0.30	0.406	0.396	0.383	0.373	0.364	0.354	0.346
0.35	0.405	0.396	0.385	0.375	0.365	0.357	0.349
0.40	0.405	0.396	0.386	0.376	0.367	0.358	0.350
0.45	0.406	0.397	0.386	0.376	0.367	0.358	0.351
0.50	0.400	0.393	0.386	0.377	0.368	0.359	0.353
0.55	0.386	0.381	0.381	0.378	0.370	0.361	0.354
0.60	0.380	0.378	0.377	0.376	0.370	0.362	0.355
0.65	0.377	0.376	0.377	0.376	0.371	0.363	0.355
0.70	0.377	0.377	0.376	0.376	0.370	0.363	0.355
0.75	0.377	0.376	0.375	0.375	0.371	0.363	0.357
AVE.	0.405	0.395	0.384	0.373	0.364	0.355	0.347

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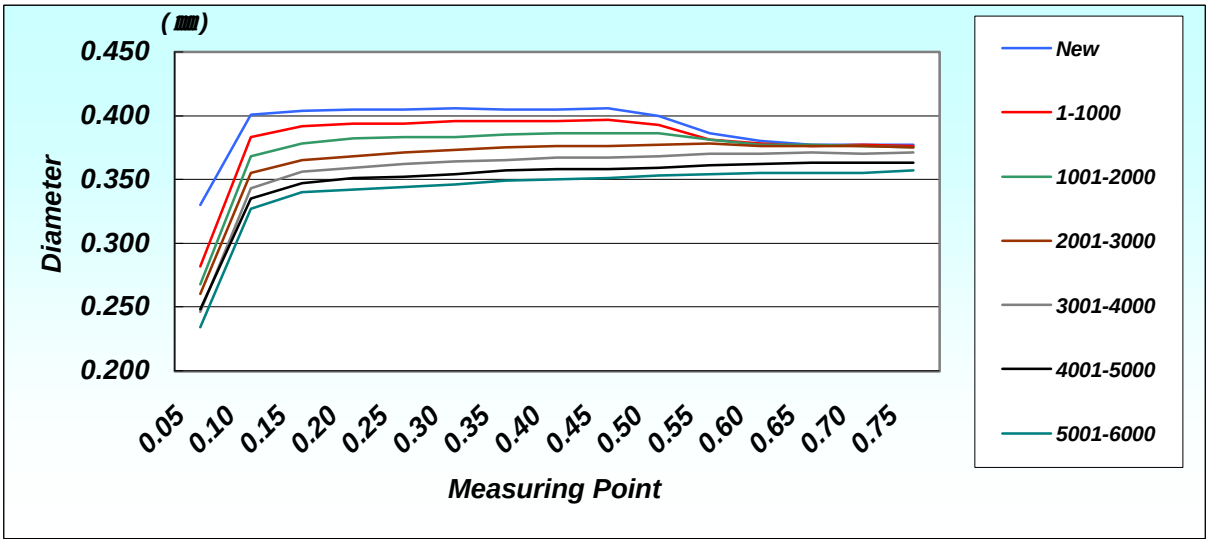
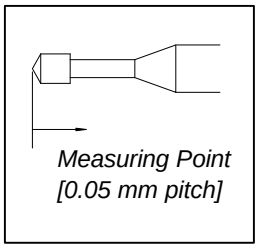


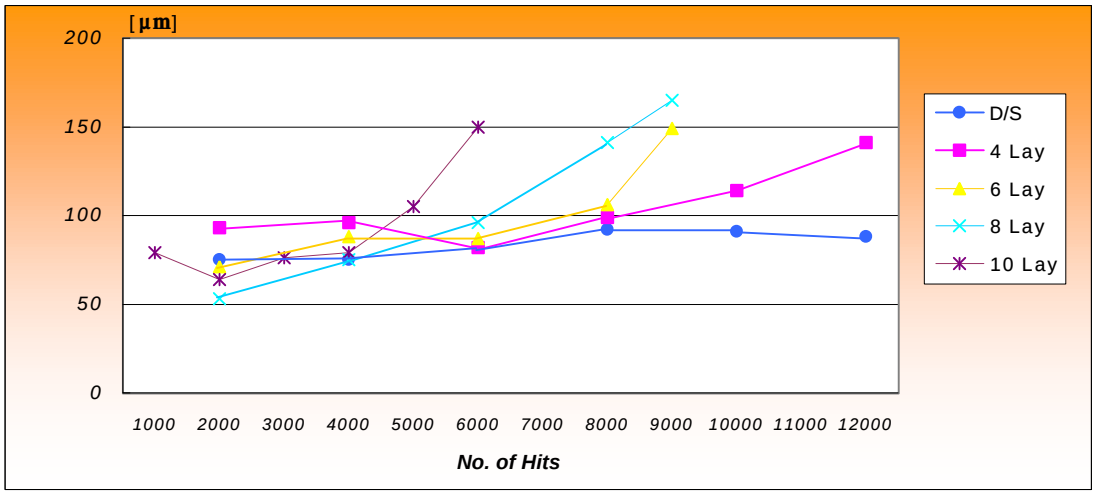


HOLE ACCURACY

<HOLE ACCURACY OF MAX.>

Unit [mm]

	1000	2000	3000	4000	5000	6000	8000	9000	10000	12000
D/S	—	75	—	75	—	82	92	—	91	88
4 Lay	—	93	—	96	—	82	99	—	114	141
6 Lay	—	71	—	88	—	87	106	149	—	—
8 Lay	—	53	—	75	—	96	141	165	—	—
10 Lay	79	64	76	79	105	150	—	—	—	—



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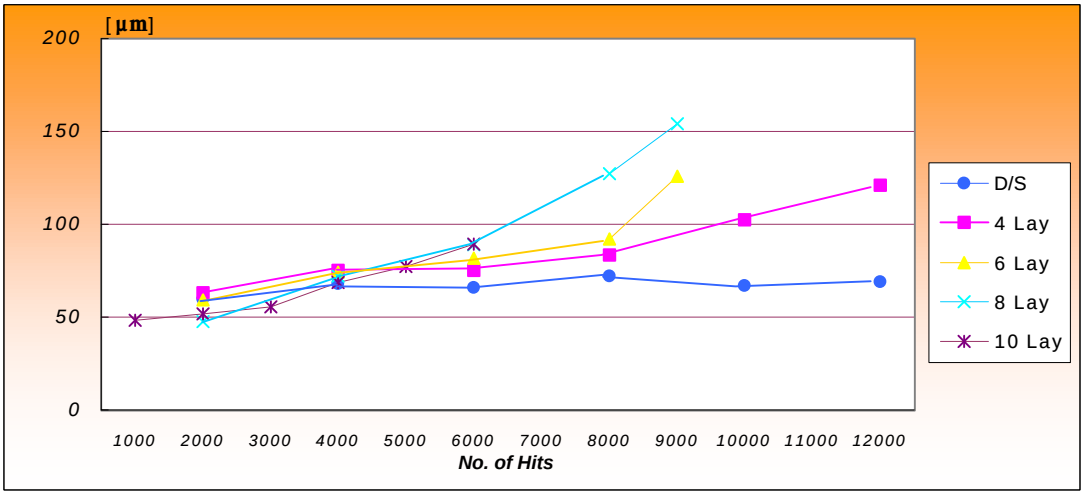
Unit [mm]

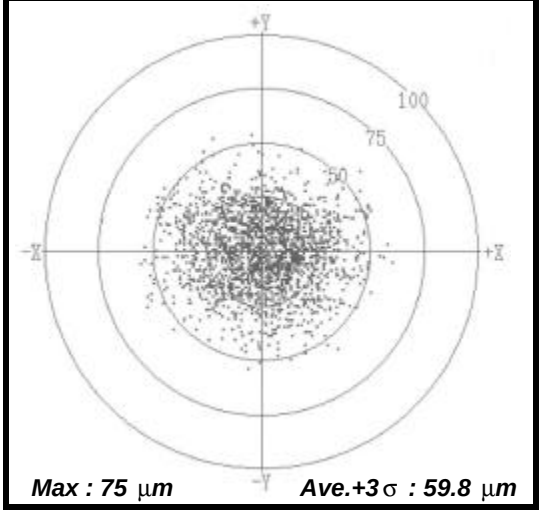
	1000	2000	3000	4000	5000	6000	8000	9000	10000	12000
D/S	—	59.8	—	68.0	—	65.9	72.2	—	66.9	68.9
4 Lay	—	63.1	—	75.3	—	75.2	83.3	—	102.3	121.2
6 Lay	—	59.2	—	74.0	—	81.8	92.0	126.0	—	—
8 Lay	—	47.6	—	71.9	—	89.1	127.2	154.1	—	—
10 Lay	48.2	51.6	55.5	68.6	77.1	89.3	—	—	—	—



HOLE DEVIATION CHART (NTX35 0.4 x 7)

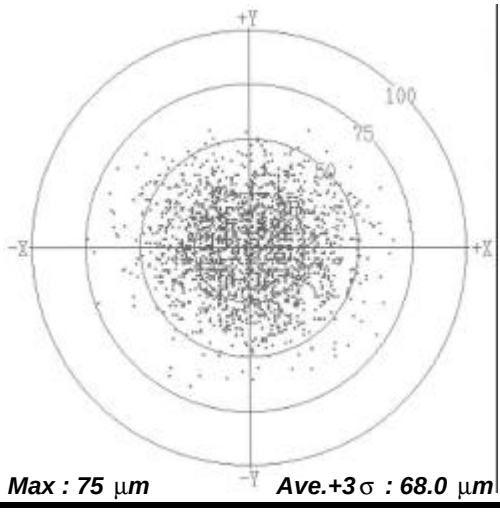
FR4 (D/S) t1.6 x 3

1- 2,000 hits



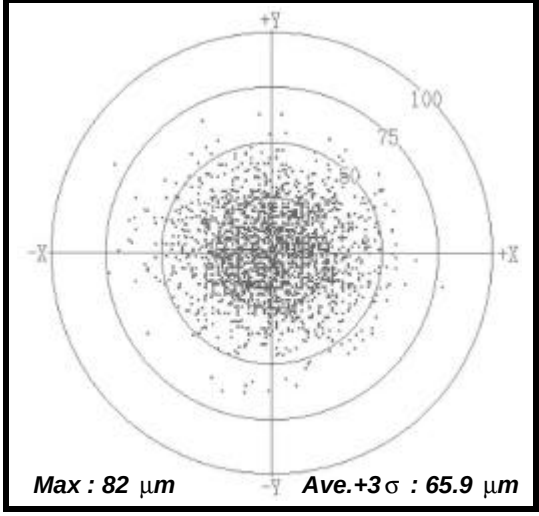
Max : 75 μm Ave.+3σ : 59.8 μm

2,001- 4,000 hits



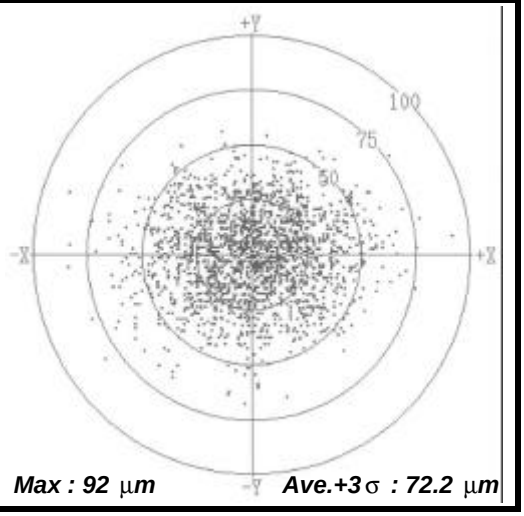
Max : 75 μm Ave.+3σ : 68.0 μm

4,001- 6,000 hits



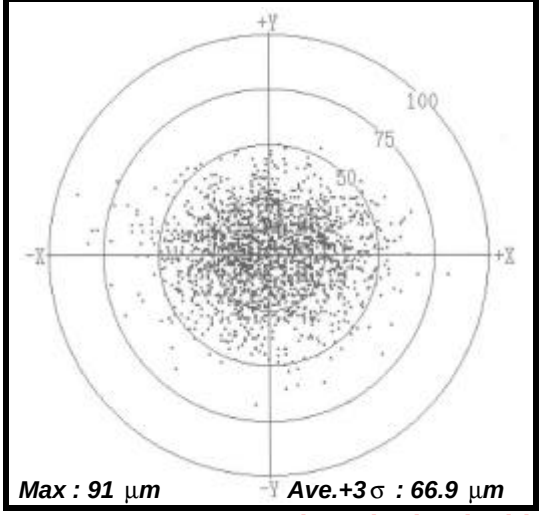
Max : 82 μm Ave.+3σ : 65.9 μm

6,001- 8,000 hits



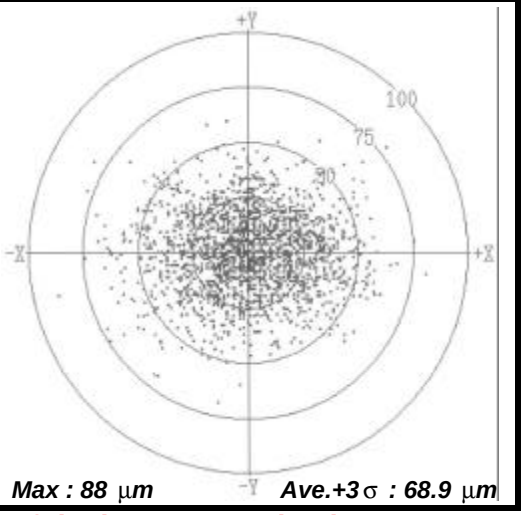
Max : 92 μm Ave.+3σ : 72.2 μm

8,001- 10,000 hits



Max : 91 μm Ave.+3σ : 66.9 μm

10,001- 12,000 hits

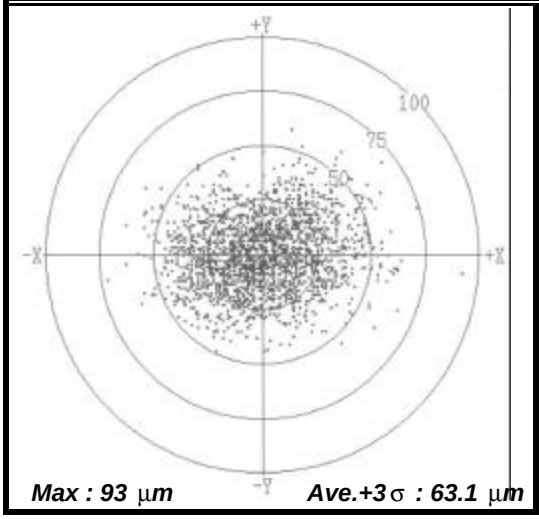
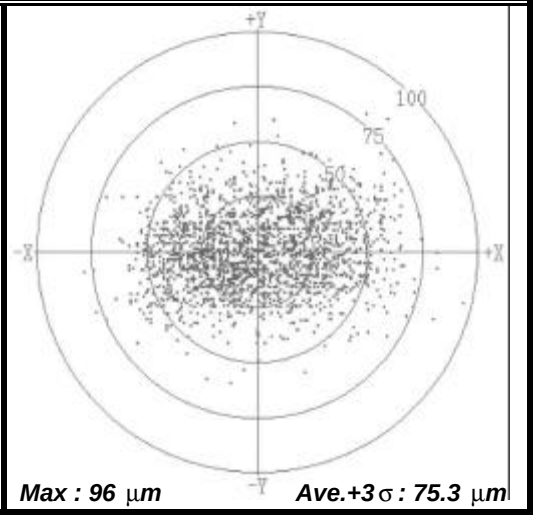


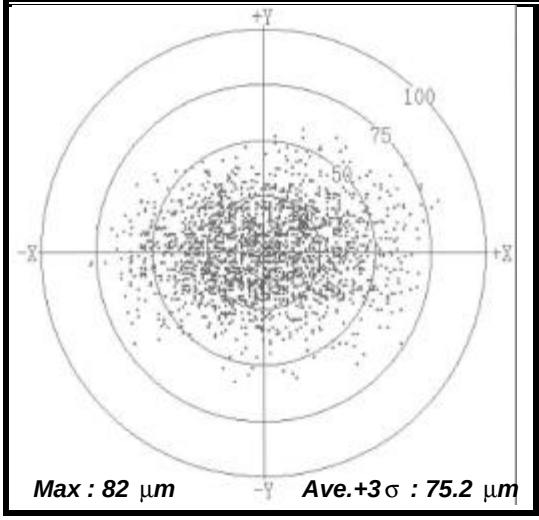
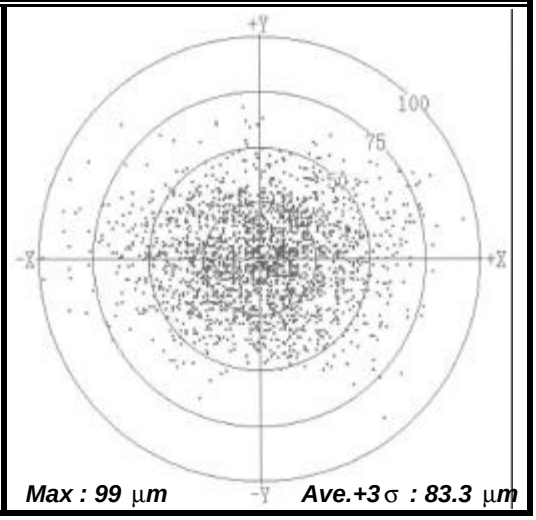
Max : 88 μm Ave.+3σ : 68.9 μm

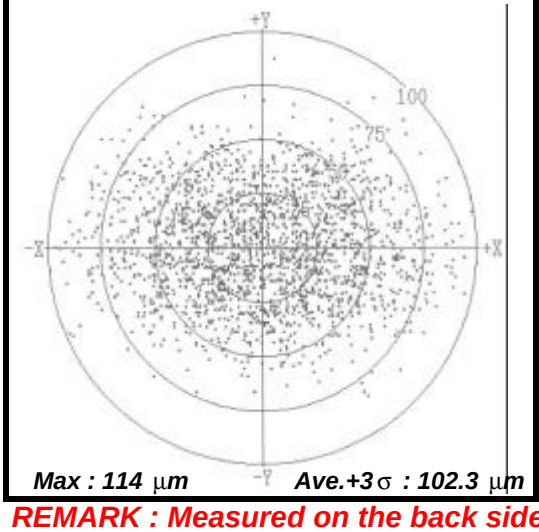
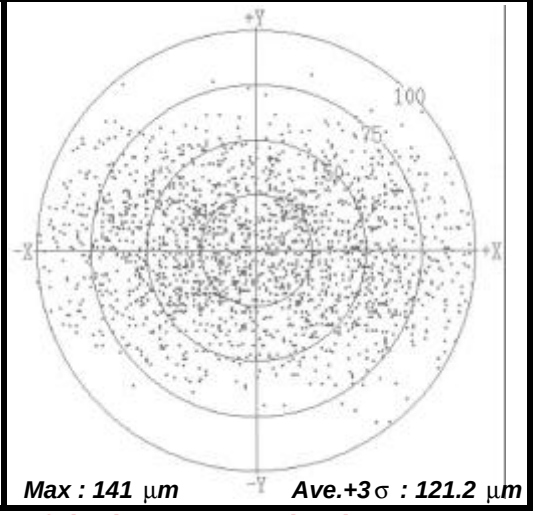
REMARK : Measured on the back side of the bottom panel only.

HOLE DEVIATION CHART (NTX35 0.4 x 7)

FR4 (4Lay) t1.6 x 3

1- 2,000 hits	2,001- 4,000 hits
	
Max : 93 μm Ave.+3σ : 63.1 μm	Max : 96 μm Ave.+3σ : 75.3 μm

4,001- 6,000 hits	6,001 ~ 8,000 hits
	
Max : 82 μm Ave.+3σ : 75.2 μm	Max : 99 μm Ave.+3σ : 83.3 μm

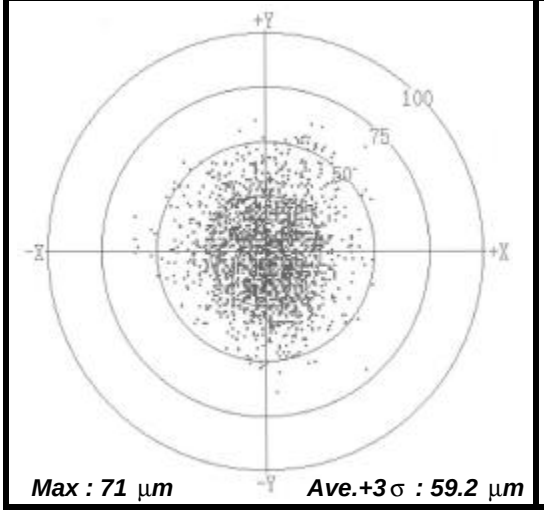
8,001 ~ 10,000 hits	10,001 ~ 12,000 hits
	
Max : 114 μm Ave.+3σ : 102.3 μm	Max : 141 μm Ave.+3σ : 121.2 μm

REMARK : Measured on the back side of the bottom panel only.

HOLE DEVIATION CHART (NTX35 0.4 x 7)

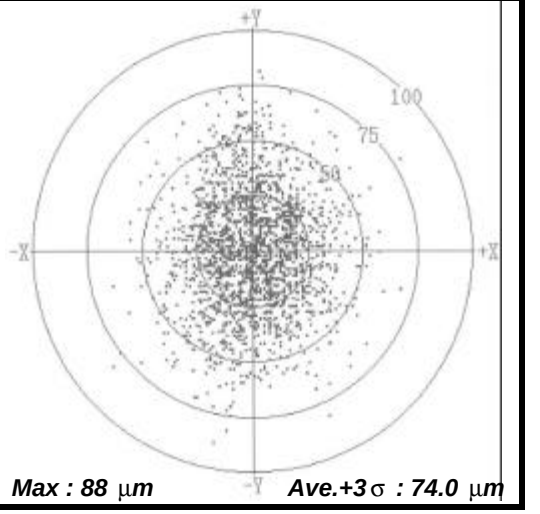
FR4 (6Lay) t1.6 x 3

1- 2,000 hits



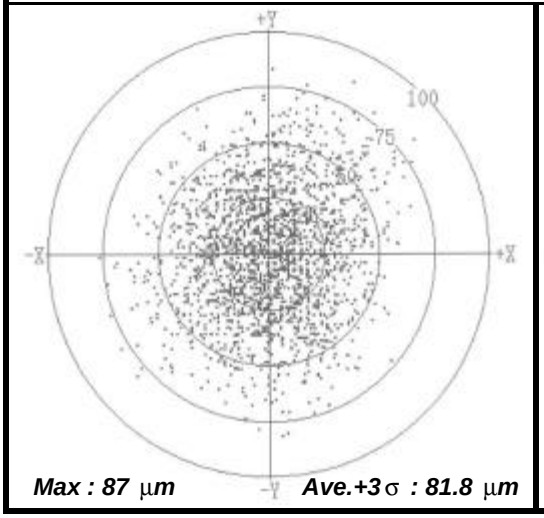
Max : 71 μm Ave.+3σ : 59.2 μm

2,001- 4,000 hits



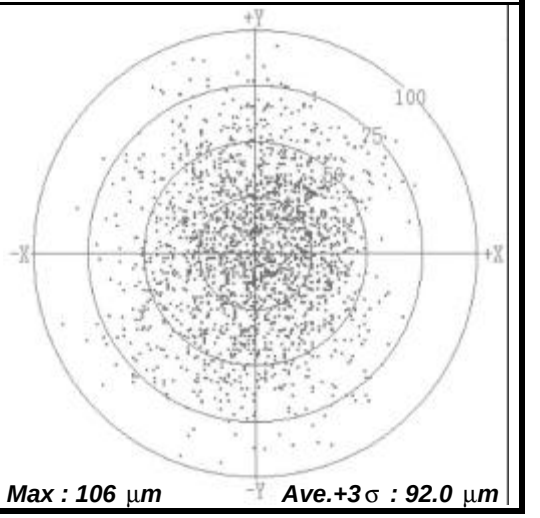
Max : 88 μm Ave.+3σ : 74.0 μm

4,001- 6,000 hits



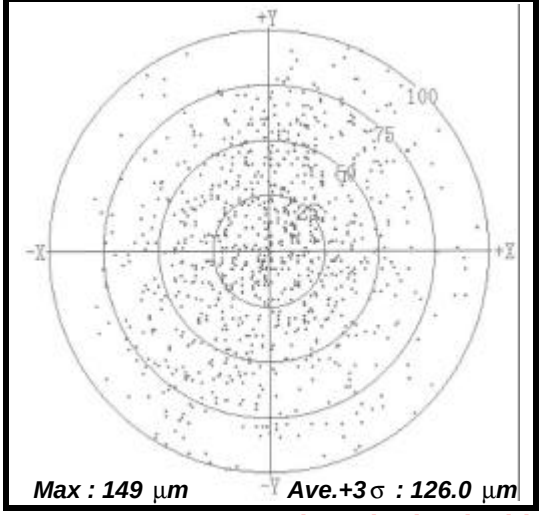
Max : 87 μm Ave.+3σ : 81.8 μm

6,001-8,000 hits



Max : 106 μm Ave.+3σ : 92.0 μm

8,001-9,000 hits



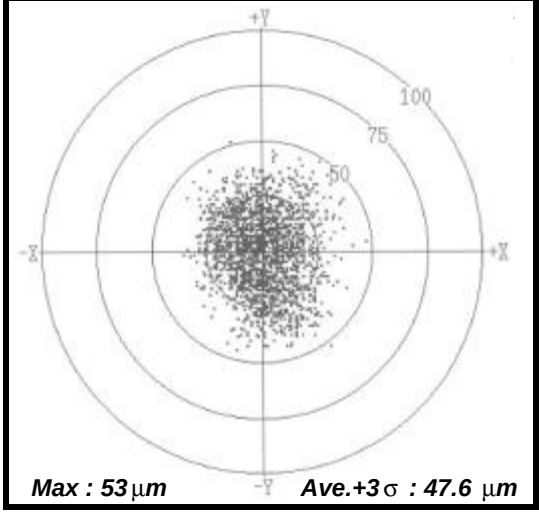
Max : 149 μm Ave.+3σ : 126.0 μm

REMARK : Measured on the back side of the bottom panel only.

HOLE DEVIATION CHART (NTX35 0.4 x 7)

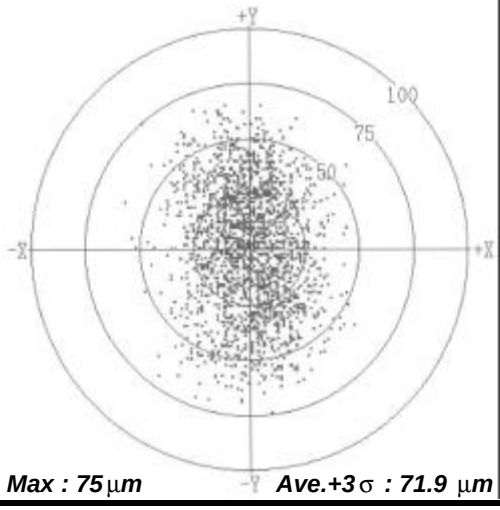
FR4 (8Lay) t1.2 x 3

1- 2,000 hits



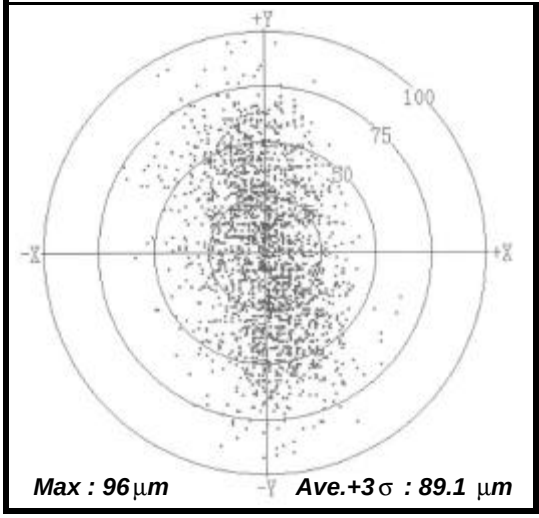
Max : 53 μm Ave.+3σ : 47.6 μm

2,001- 4,000 hits



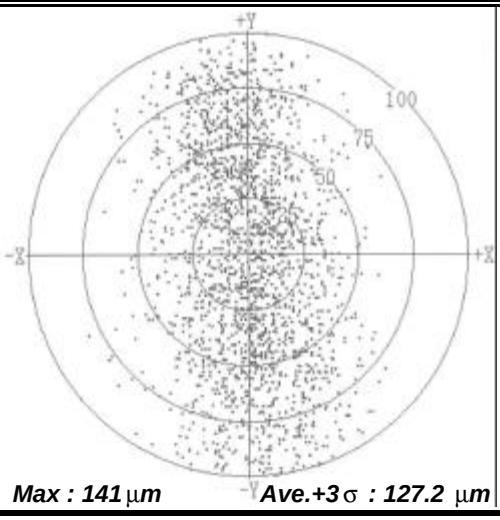
Max : 75 μm Ave.+3σ : 71.9 μm

4,001-6,000 hits



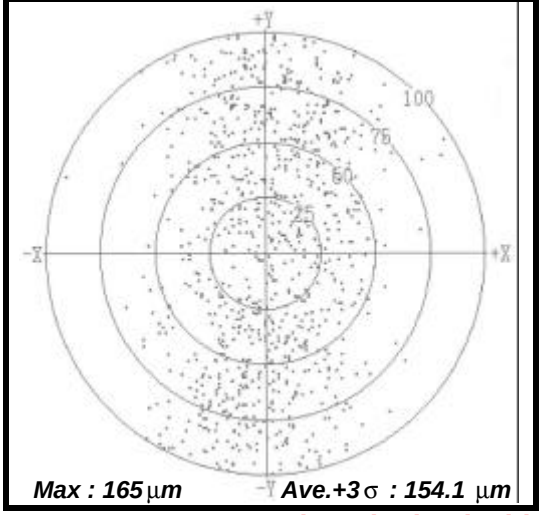
Max : 96 μm Ave.+3σ : 89.1 μm

6,001- 8,000 hits



Max : 141 μm Ave.+3σ : 127.2 μm

8,001- 9,000 hits



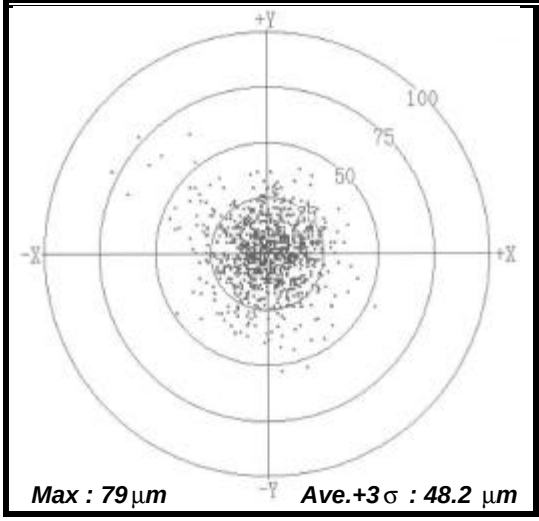
Max : 165 μm Ave.+3σ : 154.1 μm

REMARK : Measured on the back side of the bottom panel only.

HOLE DEVIATION CHART (NTX35 0.4 x 7)

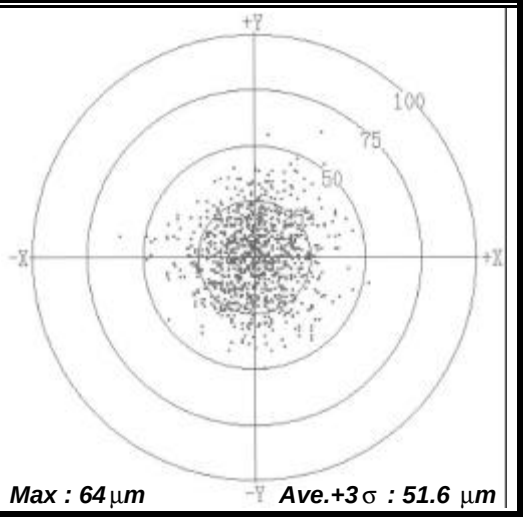
FR4 (10Lay) t1.6 x 3

1- 1,000 hits



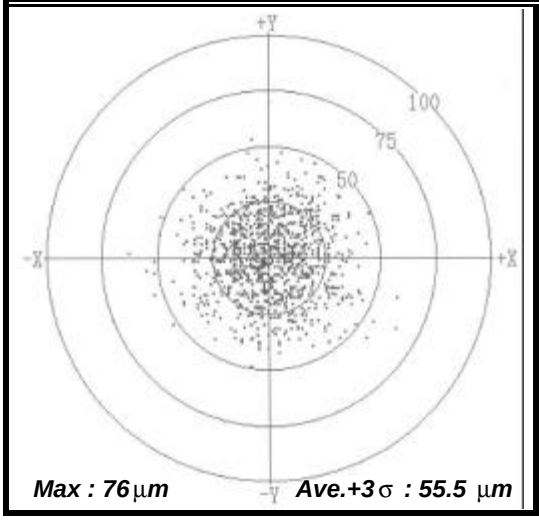
Max : 79 μm Ave.+3σ : 48.2 μm

1,001- 2,000 hits



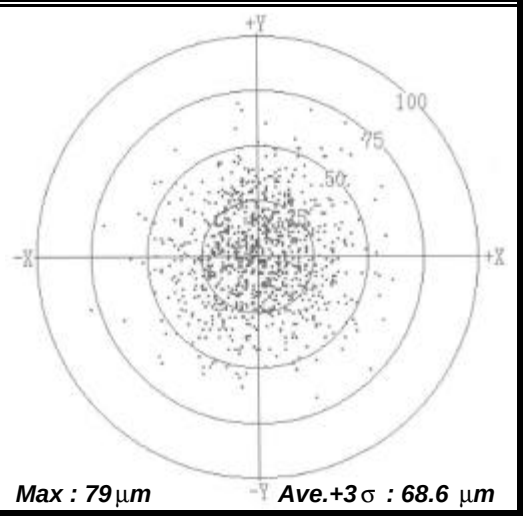
Max : 64 μm Ave.+3σ : 51.6 μm

2,001- 3,000 hits



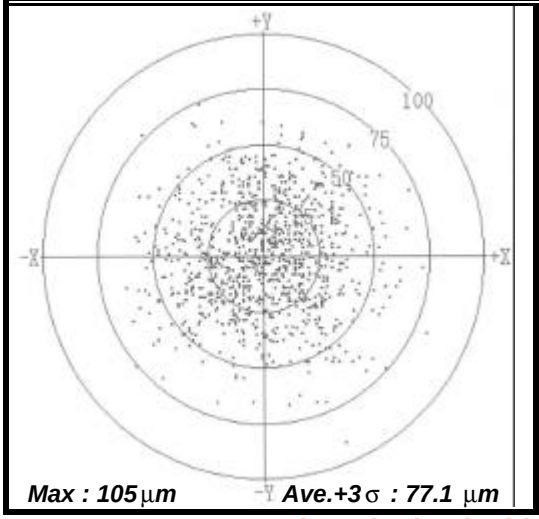
Max : 76 μm Ave.+3σ : 55.5 μm

3,001- 4,000 hits



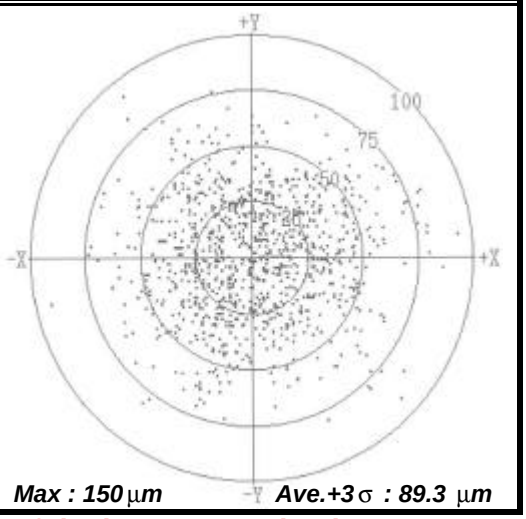
Max : 79 μm Ave.+3σ : 68.6 μm

4,001- 5,000 hits



Max : 105 μm Ave.+3σ : 77.1 μm

5,001- 6,000 hits



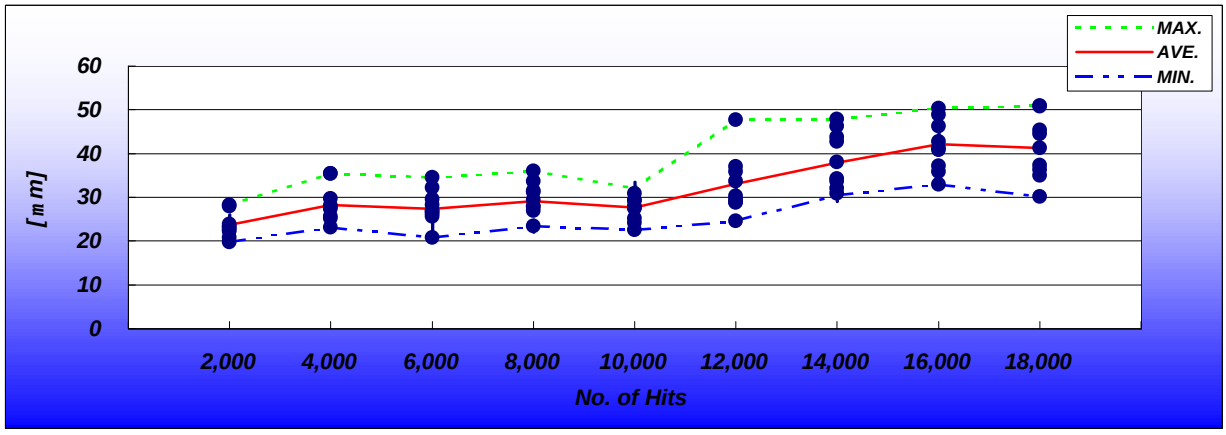
Max : 150 μm Ave.+3σ : 89.3 μm

REMARK : Measured on the back side of the bottom panel only.

HOLE WALL ROUGHNESS (NTX35 0.4 x 7)

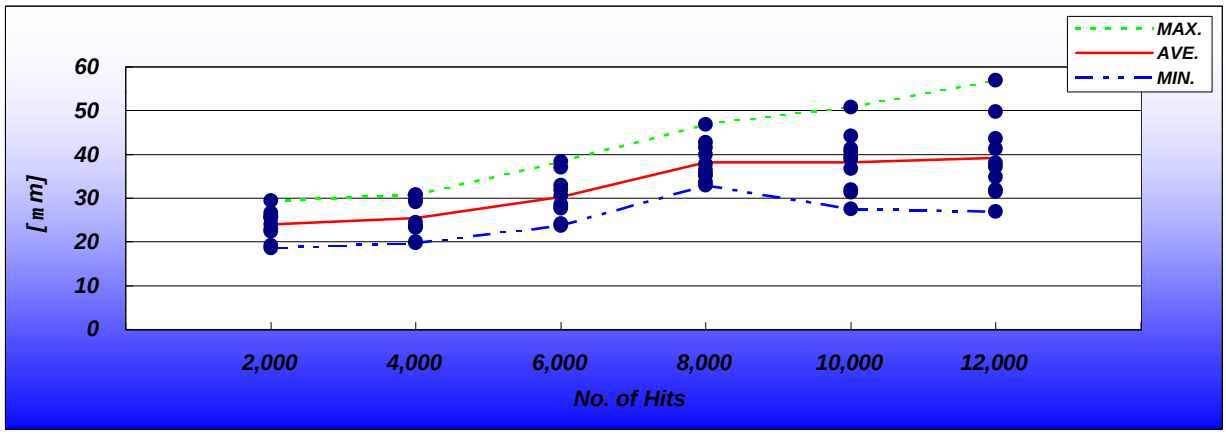
FR4 (D/S) t1.6 x 3

	2,000	4,000	6,000	8,000	10,000	12,000	14,000	16,000	18,000
MAX.	28.2	35.4	34.5	36.0	32.0	47.7	47.8	50.3	51.0
AVE.	23.7	28.2	27.4	29.1	27.6	33.0	38.0	42.1	41.3
MIN.	19.7	23.1	20.8	23.4	22.6	24.6	30.5	32.9	30.2



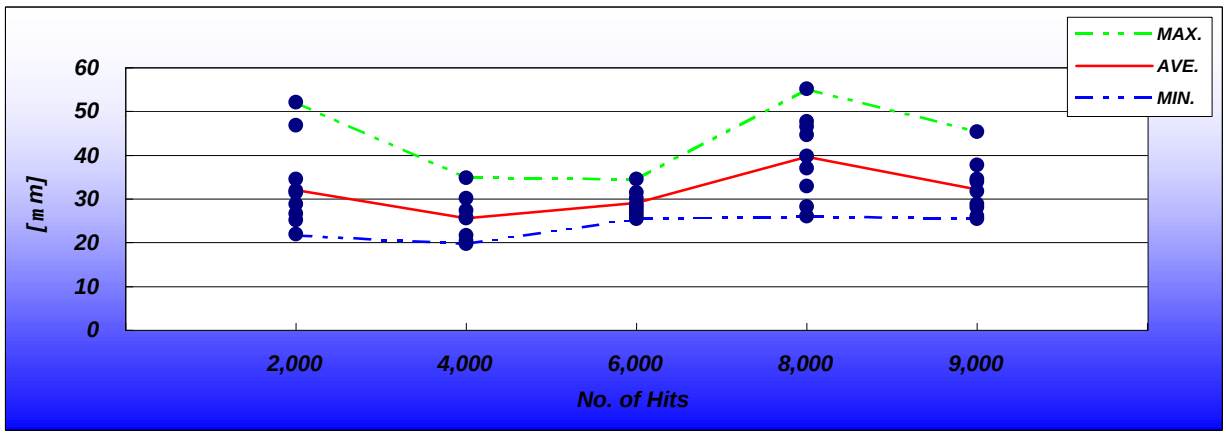
FR4 (4Lay) t1.6 x 3

	2,000	4,000	6,000	8,000	10,000	12,000
MAX.	29.4	30.7	38.4	46.8	50.8	57.0
AVE.	24.0	25.5	30.3	38.3	38.3	39.2
MIN.	18.6	19.7	23.7	33.0	27.5	27.0



FR4 (6Lay) t1.6 x 3

	2,000	4,000	6,000	8,000	9,000
MAX.	52.1	34.9	34.5	55.2	45.3
AVE.	32.1	25.6	29.2	39.6	32.2
MIN.	21.6	19.8	25.4	26.0	25.4

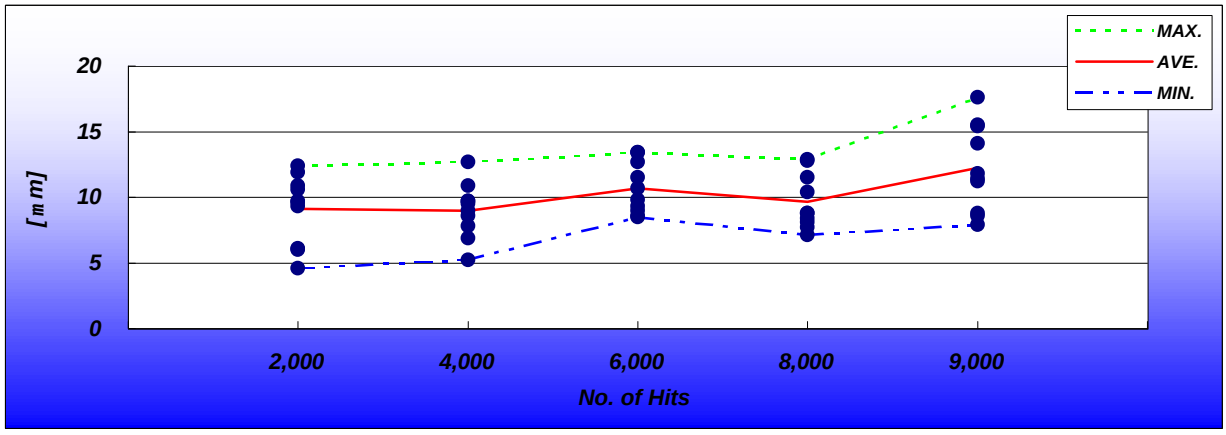


Remark : Measured after desmearing treatment and on the top panel only.

HOLE WALL ROUGHNESS (NTX35 0.4 x 7)

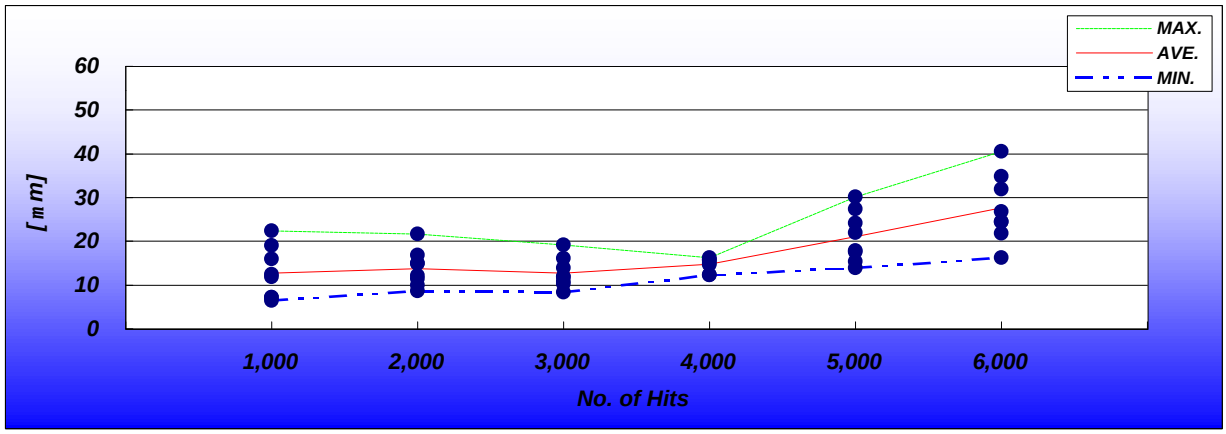
FR4 (8Lay) t1.2 x 3

	2,000	4,000	6,000	8,000	9,000
MAX.	12.4	12.7	13.4	12.9	17.6
AVE.	9.1	9.0	10.7	9.7	12.2
MIN.	4.6	5.2	8.5	7.1	7.9



FR4 (10Lay) t1.6 x 3

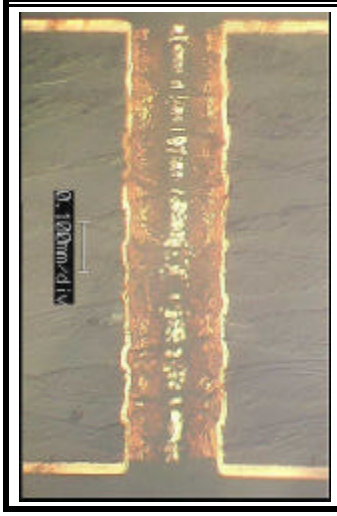
	1,000	2,000	3,000	4,000	5,000	6,000
MAX.	22.4	21.7	19.2	16.3	30.2	40.5
AVE.	12.8	13.8	12.8	14.7	21.0	27.7
MIN.	6.4	8.6	8.4	12.3	13.9	16.3

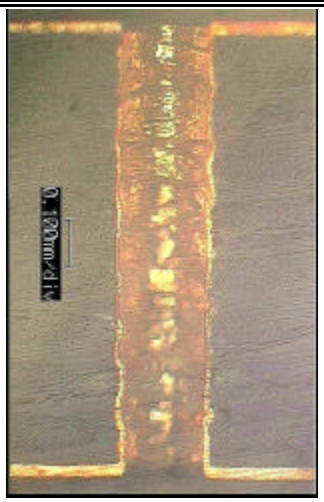


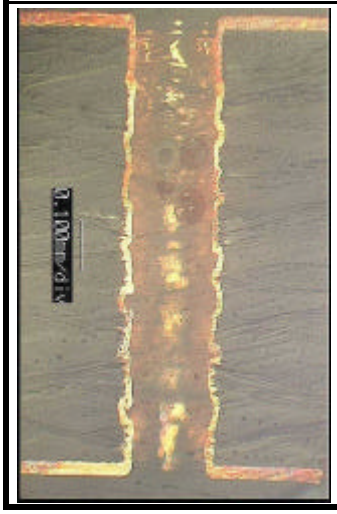
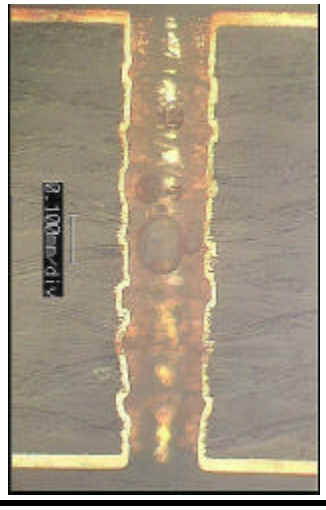
Remark : Measured after desmearing treatment and on the top panel only.

HOLE WALL ROUGHNESS (NTX35 0.4 x 7)

FR4 (D/S) t1.6 x 3

2,000 hits	4,000 hits	6,000 hits
		

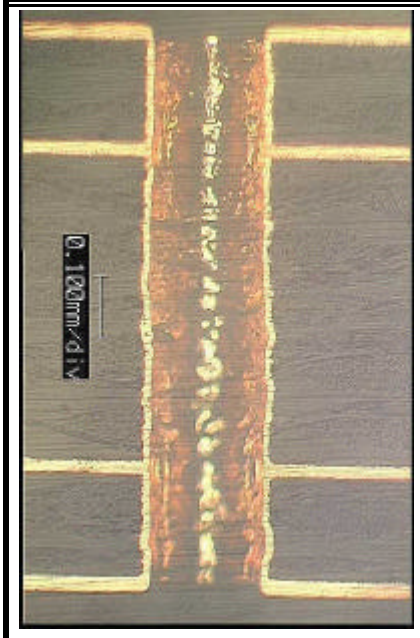
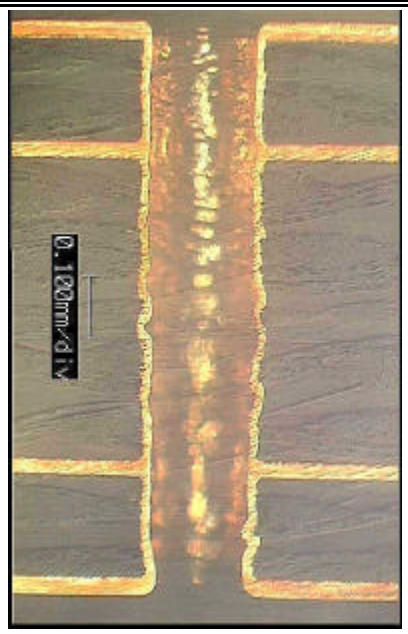
8,000 hits	10,000 hits	12,000 hits
		

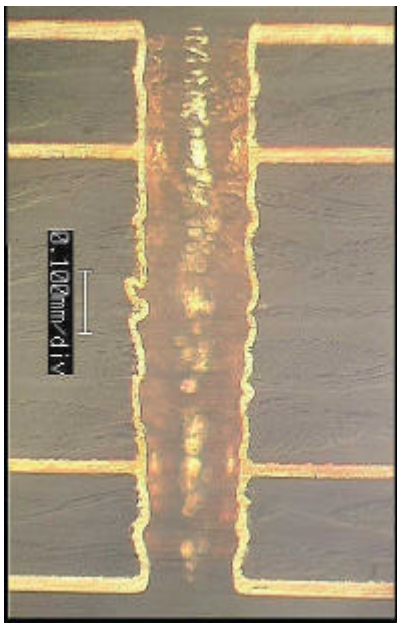
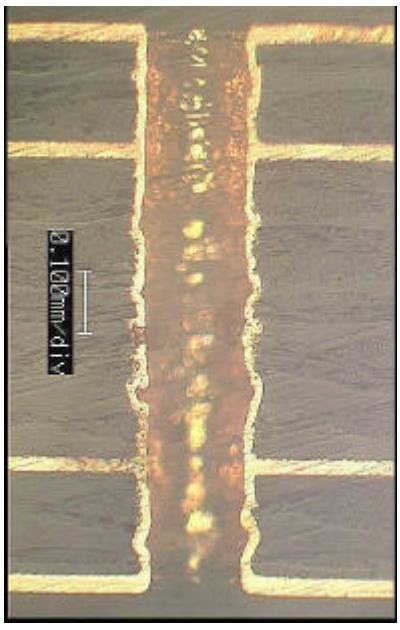
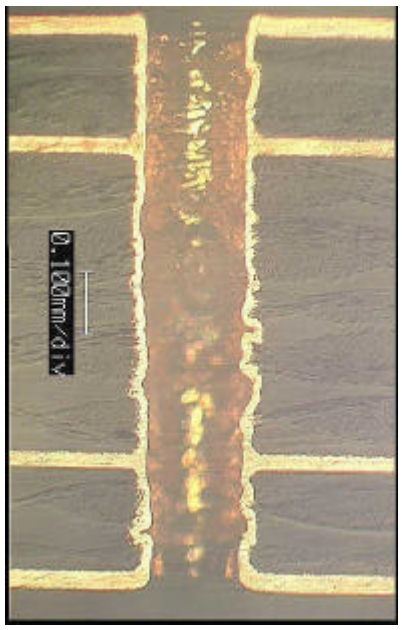
14,000 hits	16,000 hits	18,000 hits
		

REMARK : Measured after desmearing treatment and on the top panel only.

HOLE WALL ROUGHNESS (NTX35 0.4 x 7)

FR4 (4Lay) t1.6 x 3

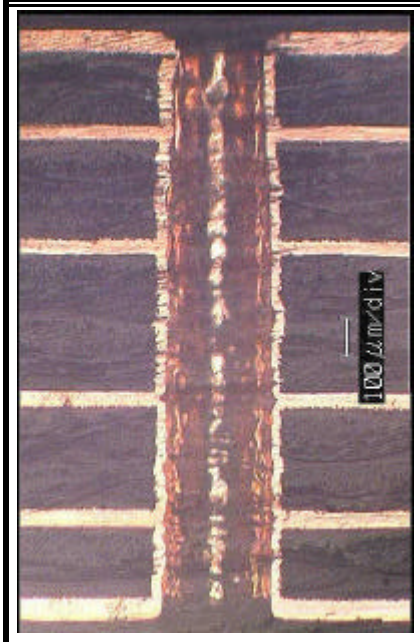
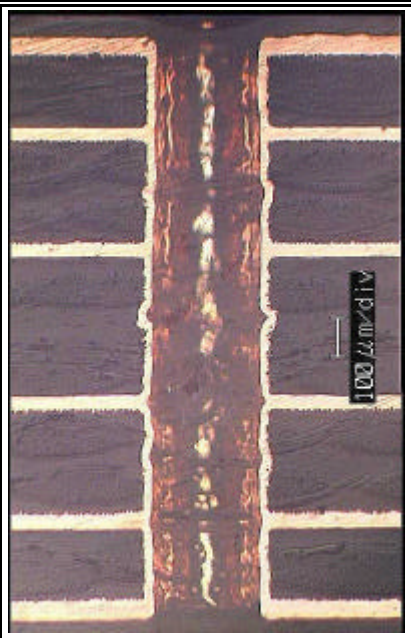
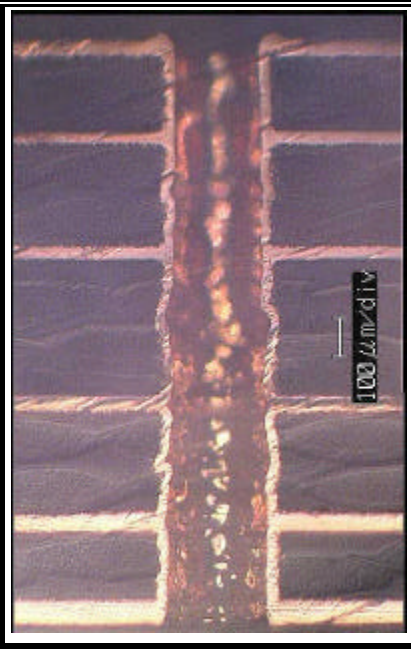
2,000 hits	4,000 hits	6,000 hits
		

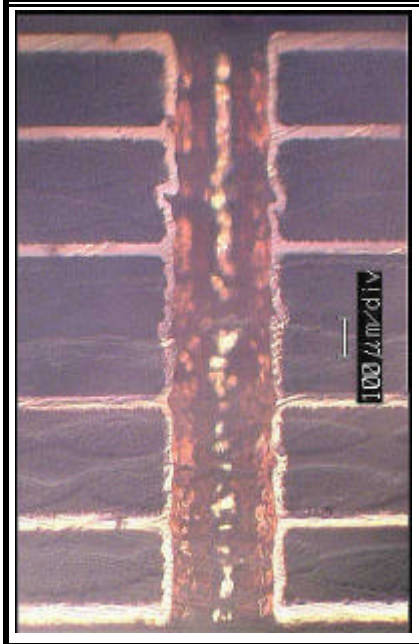
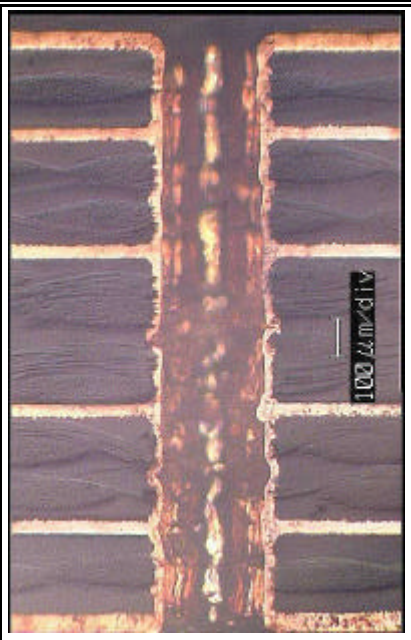
8,000 hits	10,000 hits	12,000 hits
		

REMARK : Measured after desmearing treatment and on the top panel only.

HOLE WALL ROUGHNESS (NTX35 0.4 x 7)

FR4 (6Lay) t1.6 x 3

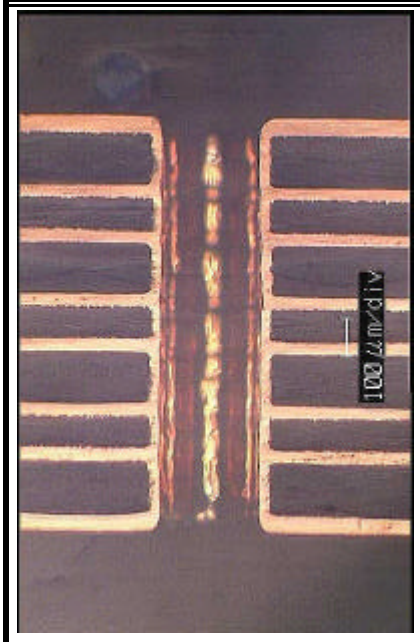
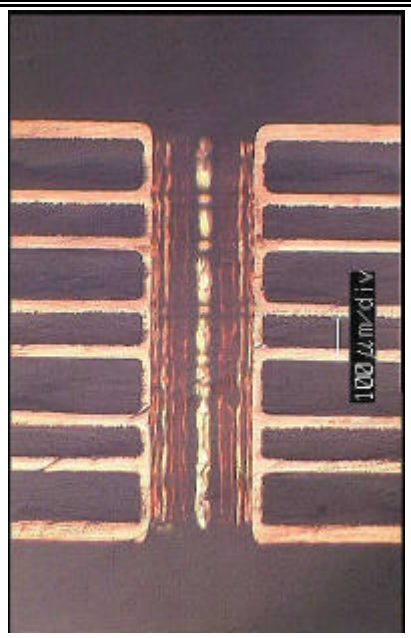
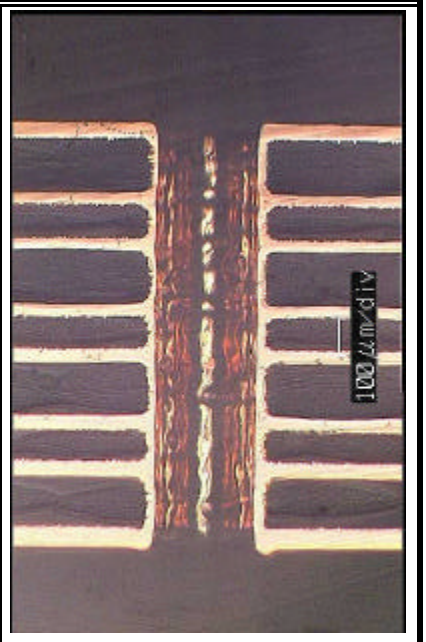
2,000 hits	4,000 hits	6,000 hits
		

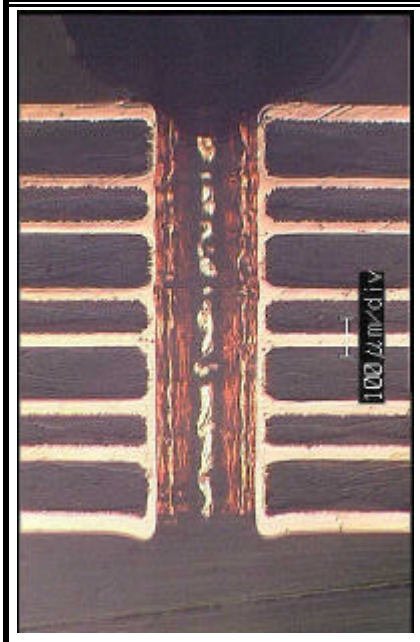
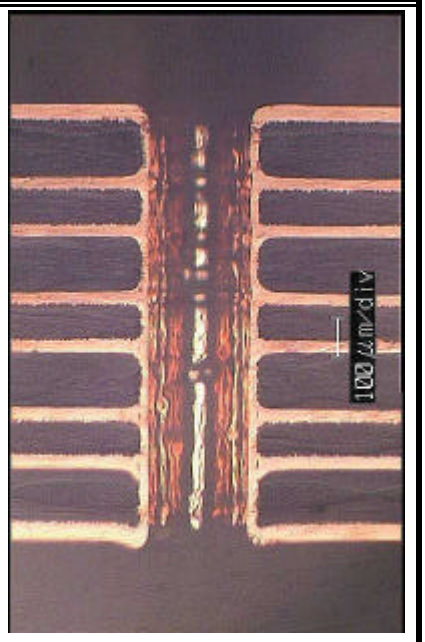
8,000 hits	9,000 hits
	

REMARK : Measured after desmearing treatment and on the top panel only.

HOLE WALL ROUGHNESS (NTX35 0.4 x 7)

FR4 (8Lay) t1.2 x 3

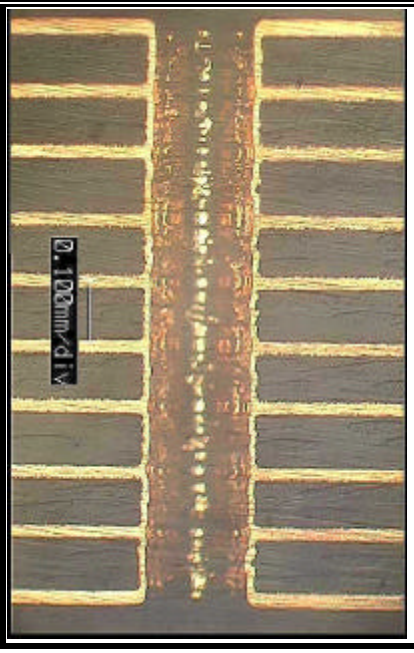
2,000 hits	4,000 hits	6,000 hits
		

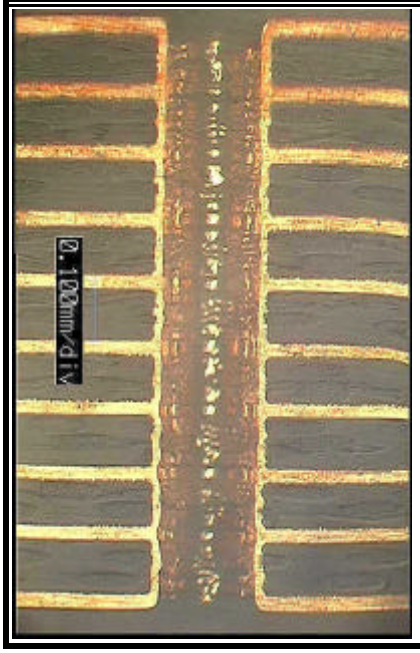
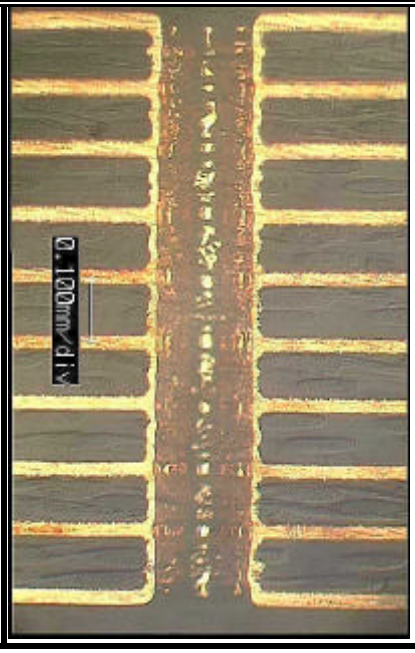
8,000 hits	9,000 hits
	

REMARK : Measured after desmearing treatment and on the top panel only.

HOLE WALL ROUGHNESS (NTX35 0.4 x 7)

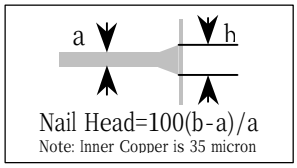
FR4 (10Lay) t1.6 x 3

1,000 hits	2,000 hits	3,000 hits
		

4,000 hits	5,000 hits	6,000 hits
		

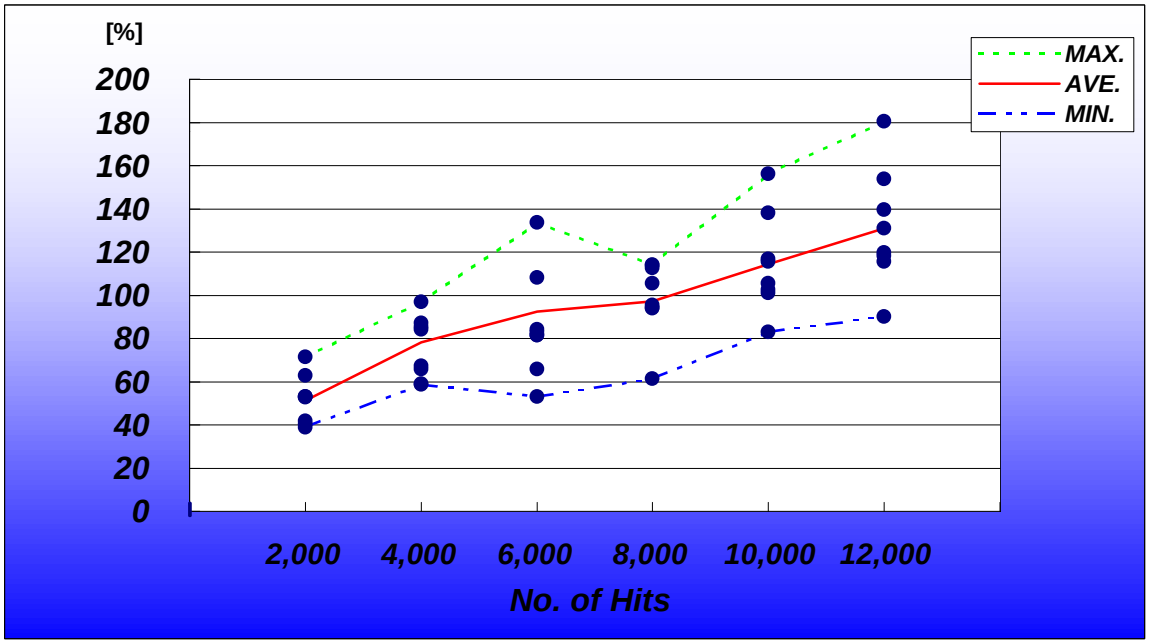
REMARK : Measured after desmearing treatment and on the top panel only.

NAIL HEADING (NTX35 0.4 x 7)



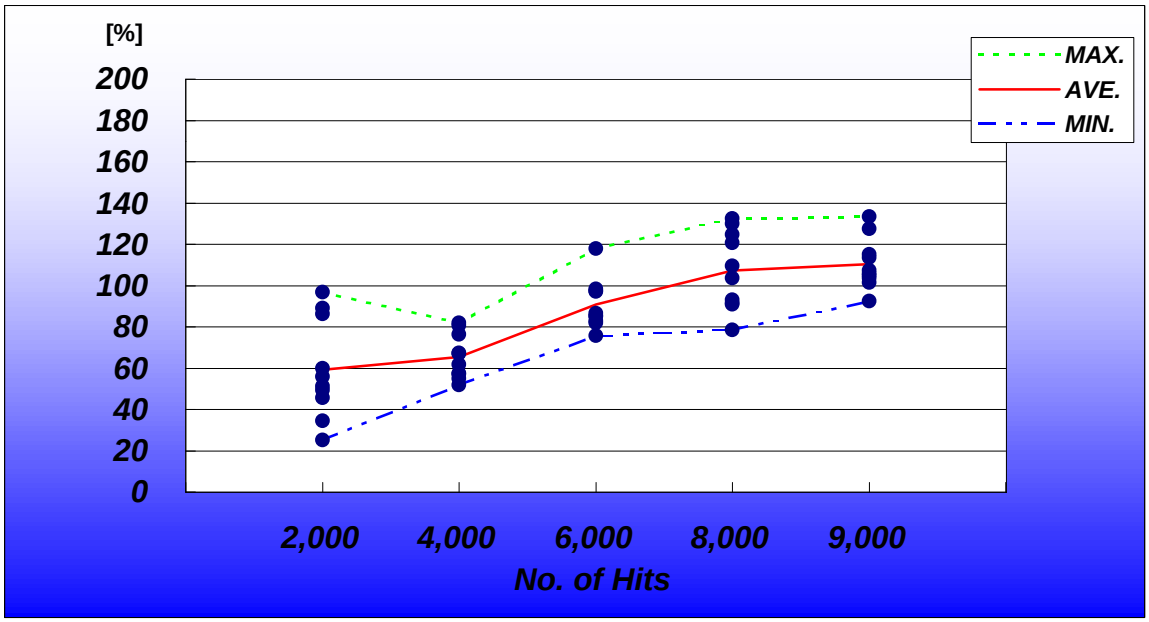
FR4 (4Lay) t1.6 x 3

	2,000 hits	4,000 hits	6,000 hits	8,000 hits	10,000 hits	12,000 hits
MAX.	71.4	96.9	133.7	114.0	156.3	180.6
AVE.	51.1	78.2	92.4	97.1	114.2	130.9
MIN.	38.9	58.6	53.1	61.4	82.9	90.0



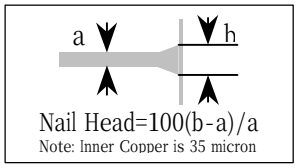
FR4 (6Lay) t1.6 x 3

	2,000 hits	4,000 hits	6,000 hits	8,000 hits	9,000 hits
MAX.	96.9	81.7	117.7	132.3	133.4
AVE.	59.3	65.5	90.8	107.4	110.5
MIN.	25.1	51.7	75.7	78.6	92.3



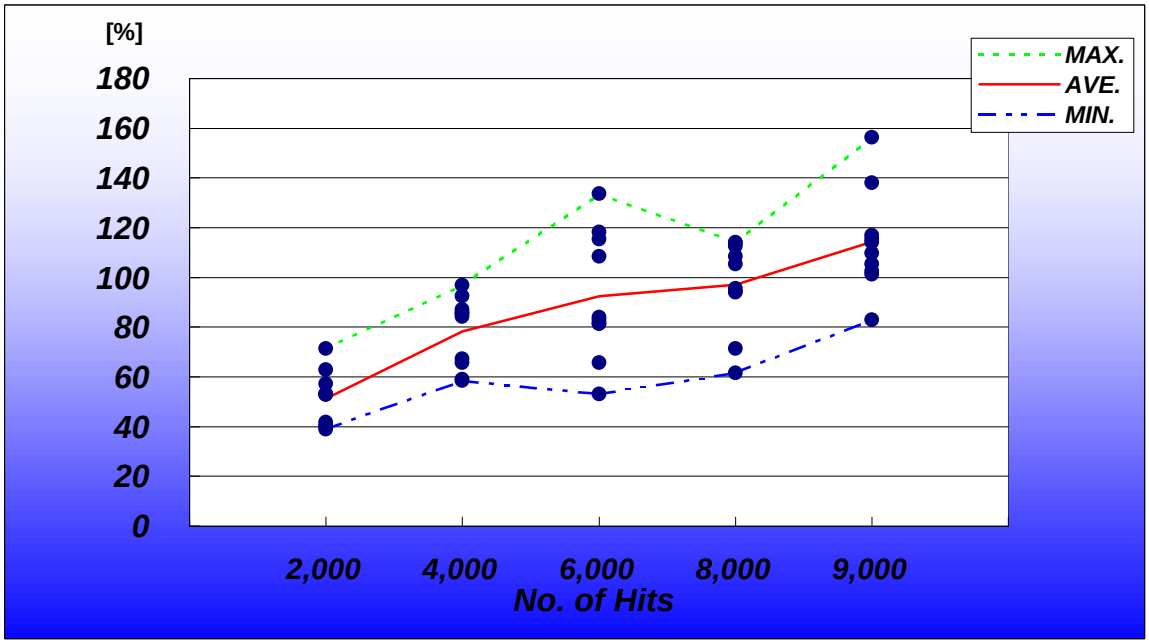
Remark : Measured after desmearing treatment and on the top panel only.

NAIL HEADING (NTX35 0.4 x 7)



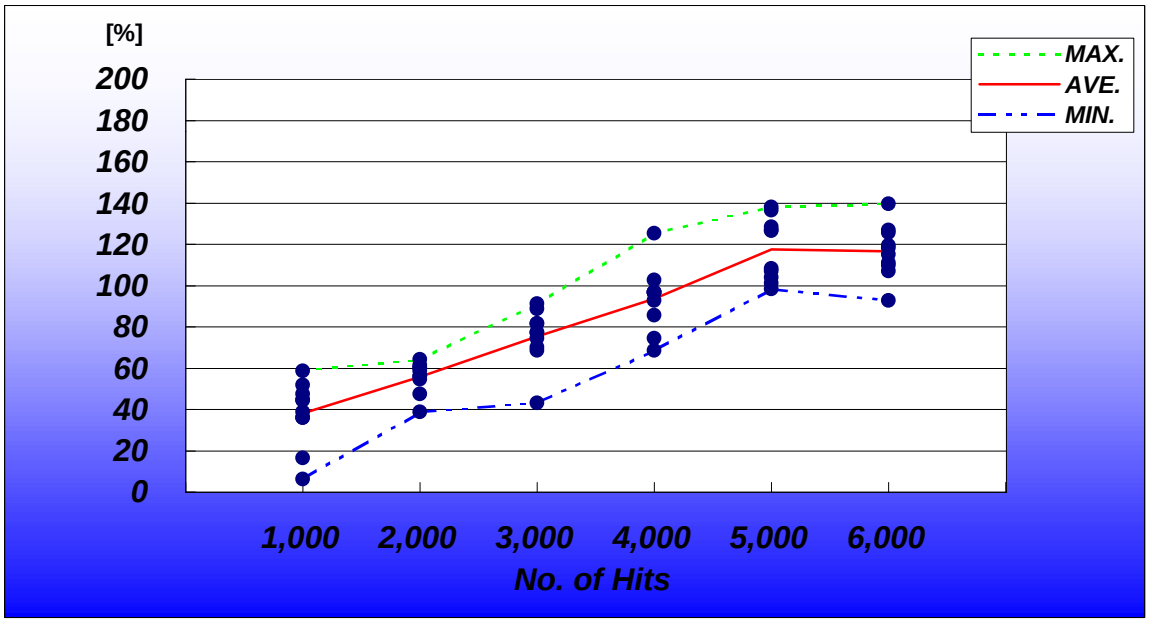
FR4 (8Lay) t1.2 x 3

	2,000 hits	4,000 hits	6,000 hits	8,000 hits	9,000 hits
MAX.	71.4	96.9	133.7	114.0	156.3
AVE.	51.1	78.2	92.4	97.1	114.2
MIN.	38.9	58.6	53.1	61.4	82.9



FR4 (10Lay) t1.6 x 3

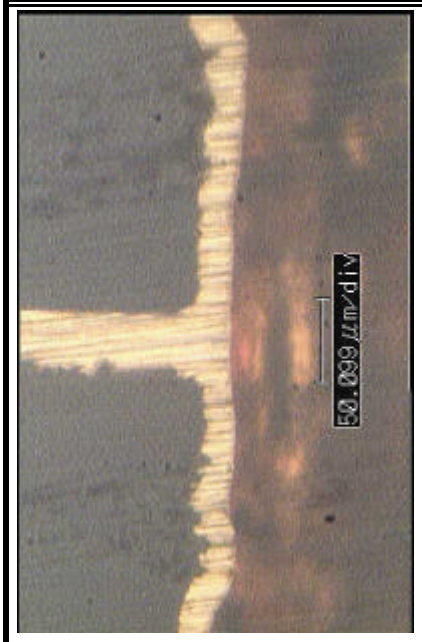
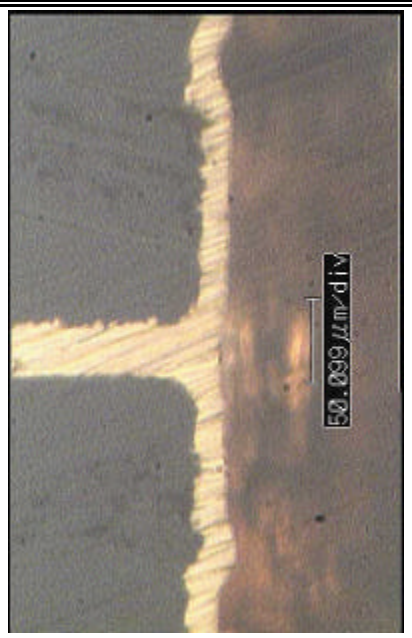
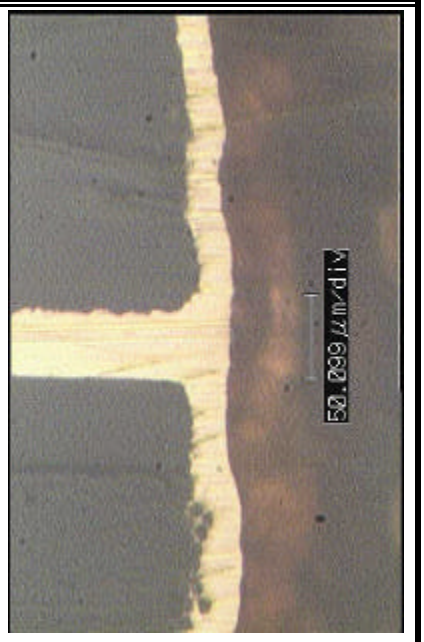
	1,000 hits	2,000 hits	3,000 hits	4,000 hits	5,000 hits	6,000 hits
MAX.	58.6	64.3	91.1	125.1	138.0	139.4
AVE.	38.0	55.7	75.3	93.6	117.5	116.5
MIN.	6.3	38.9	43.1	68.6	98.3	92.9

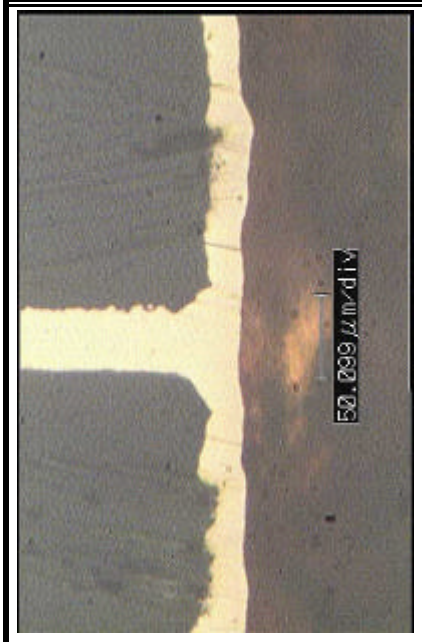
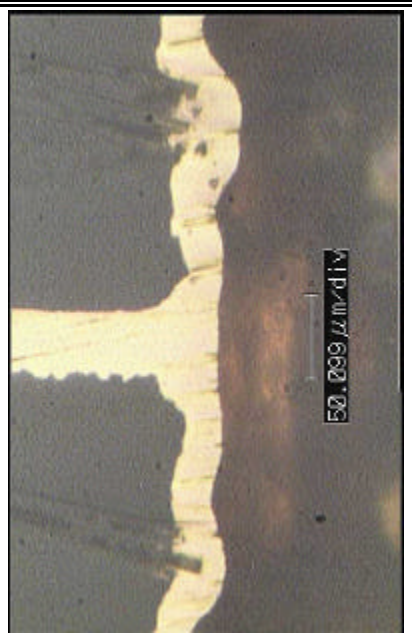


Remark : Measured after desmearing treatment and on the top panel only.

NAIL HEADING (NTX35 0.4 x 7)

FR4 (4Lay) t1.6 x 3

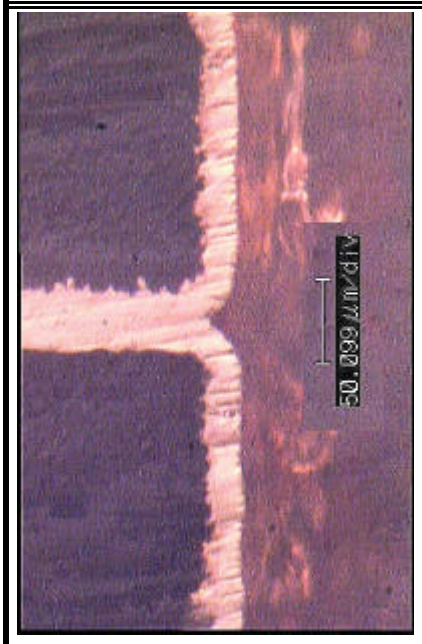
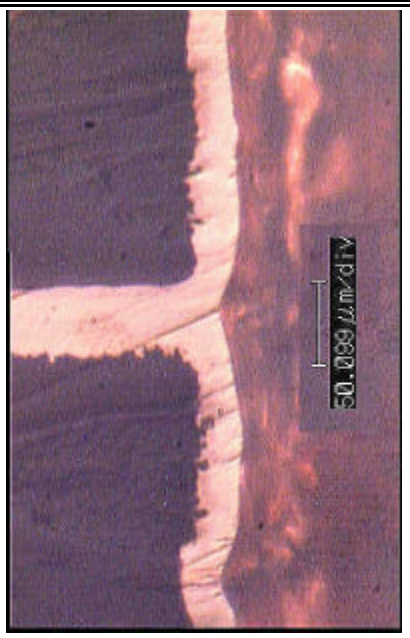
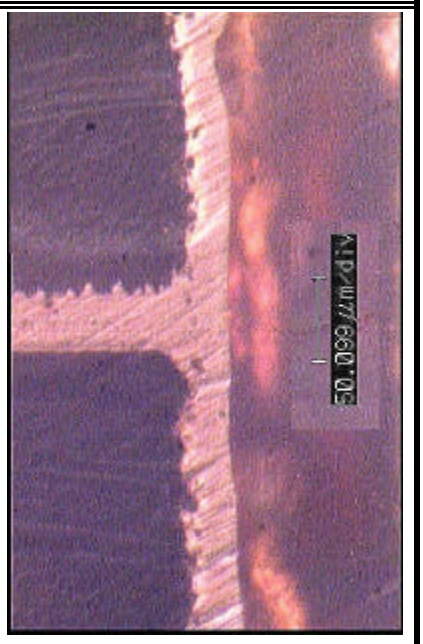
2,000 hits	4,000 hits	6,000 hits
		

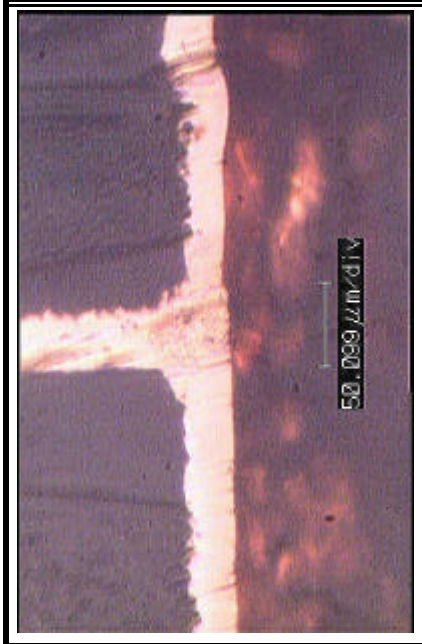
8,000 hits	10,000 hits	12,000 hits
		

REMARK : Measured after desmearing treatment and on the top panel only.

NAIL HEADING (NTX35 0.4 x 7)

FR4 (6Lay) t1.6 x 3

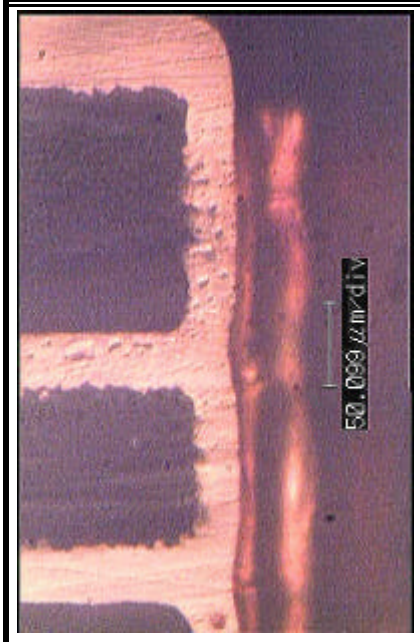
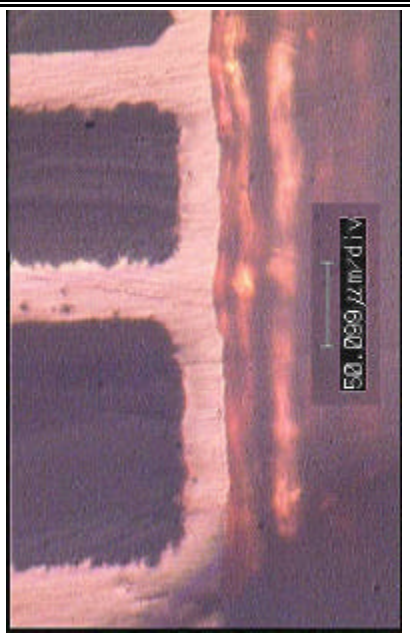
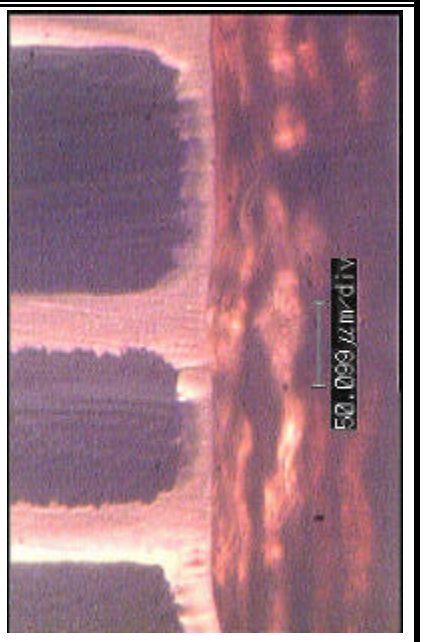
2,000 hits	4,000 hits	6,000 hits
		

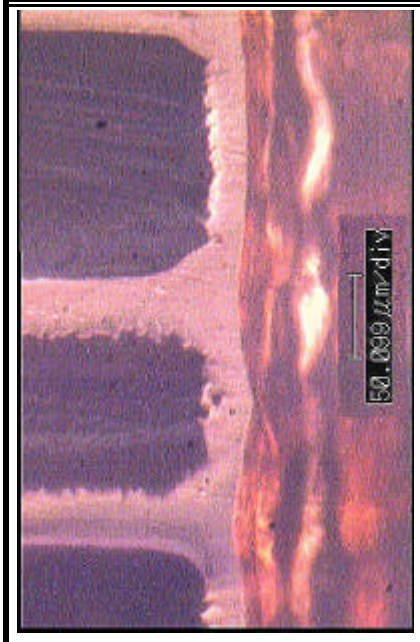
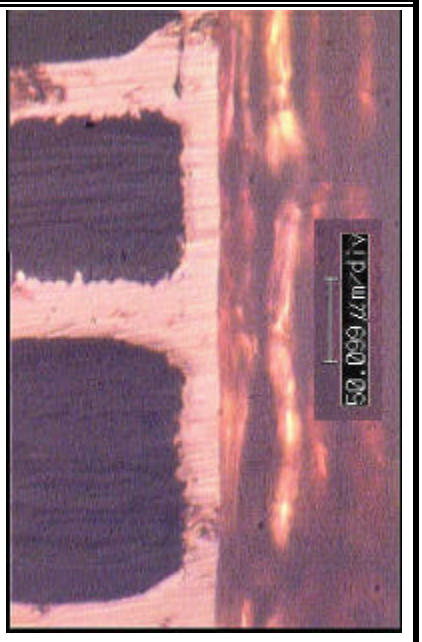
8,000 hits	9,000 hits
	

REMARK : Measured after desmearing treatment and on the top panel only.

NAIL HEADING (NTX35 0.4 x 7)

FR4 (8Lay) t1.2 x 3

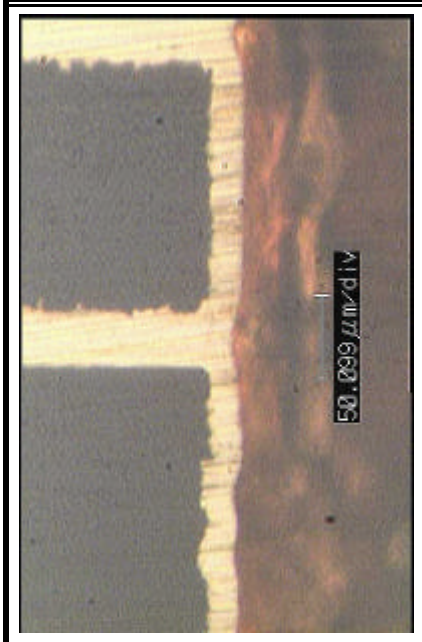
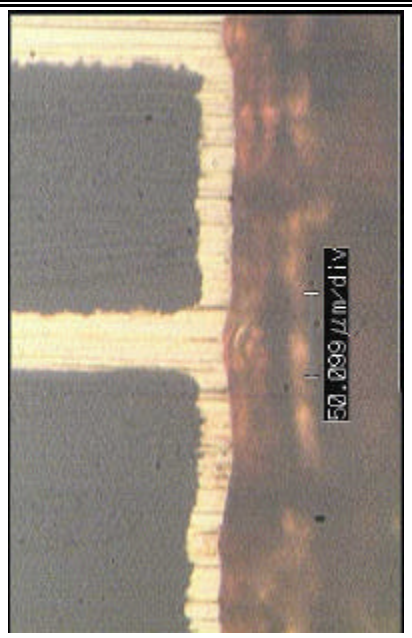
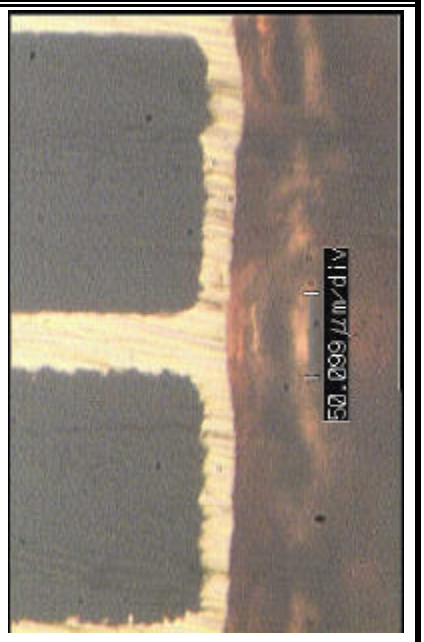
2,000 hits	4,000 hits	6,000 hits
		

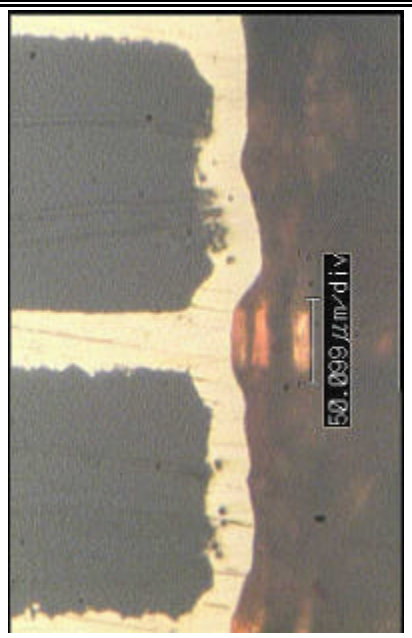
8,000 hits	9,000 hits
	

REMARK : Measured after desmearing treatment and on the top panel only.

NAIL HEADING (NTX35 0.4 x 7)

FR4 (10Lay) t1.6 x 3

1,000 hits	2,000 hits	3,000 hits
		

4,000 hits	5,000 hits	6,000 hits
		

REMARK : Measured after desmearing treatment and on the top panel only.