OMVPE III Run #iii 308 date: 1/7/98 operator: JAS

description: REPEAT of iii 305

program used for this run: -MANUAL-

growth segment	time	actual susceptor temp	TC temp	RF amps
1hr Clean	10min			46
9 GaN	60min			46

rotation speed : -0.1 cell press: 75 vent press: +1

zone I manifold temp: 57.6 OM3 heat tape: 52.5

NH3 cylinder: (left/right) start weight/press: 29 lbs/ 96 psi heat tape voltage: Ø
finish weight/press: 28 lbs/ 80 psi

	OM1	OM2	OM3	OM4	OM5	OM6
temp			30.0		16.5	
grams used			[illegible]			
mfcoffset			0.0		0.1	
Pres. closed			161.6		688.6	

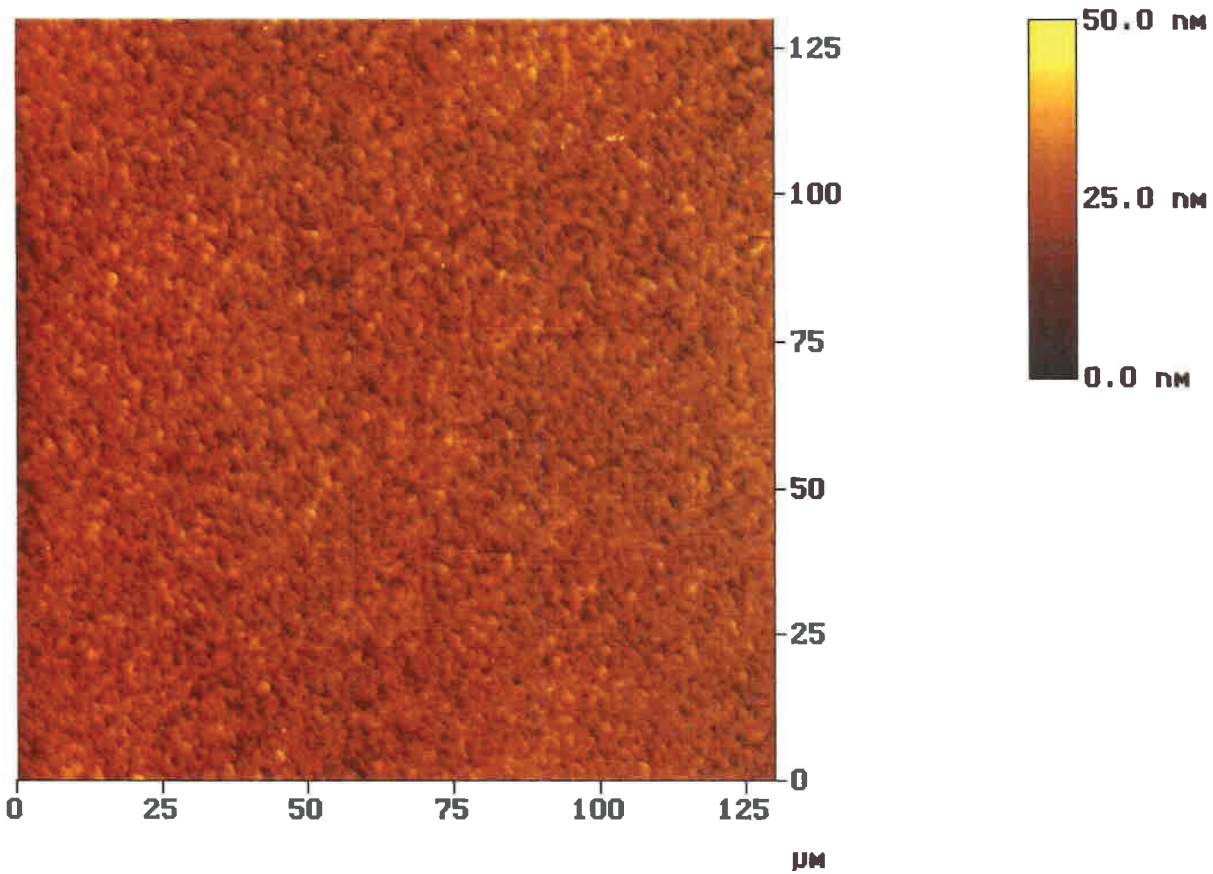
wafers:

1 SiC wafer
Cleaved in UDB
from larger 1/4 wafer
Solvent + RCA prep on 12/26/97
from wafer AEØØ 56-7

1 sapphire pc
1/4 wafer pc from 2" sapphire
from box 97-1033
Solvent clean.

time		volts	comments	TEG (OM3)	NH3 zone I	NH3 block	~~Cell~~ ~~Throttle~~	RF lead Can (TC)
		30A	RF ON					16.4 / 26
	115	30A.	TMA to VENT				24.9 / 699.1	18.3 / 26
13:32	80 / 180	30A -	BALANCE IN					
13:34	100 / 215	↑48A	TURNED UP RF				24.9 / 689.2	23.2 / 27
13:40	627 / 794	48A	NH_3 ENGAGED Line Charged				25.1 / 690.5	50.1 / 29
13:41:45	700 / 837	↓46A	START 10min bake.					
13:43:45	732 / 845.	46A	TEG to VENT	24.1 / 151.9			25.0	55.2 / 30
13:49:45	781 / 859	46A	TURNED UP TEG	89.2 / 160.7			25.2	59.5 / 31
13:52:45	800 / 864	46A	NH_3 line to cell 2 sec delay TMA & TEG to CELL wait 4min then Activate NH_3 line * VERIFIED Rotation*	89.1 / 164.9	15.4	8.3	25.1	60.5 / 31
13:56:45	805 / 868	46A	TURN ON NH_3 Thro V101	89.1 / 169.1	15.5	8.9	25.0 / 689.2	60.9 / 32
14:05	812 / 872	46A		89.1	15.3	8.1	25.1 / 688.2	61.3 / 32
14:12	809 / 869	46A		89.2	15.3	8.2	25.1 / 689.5	61.5 / 32
14:27	810 / 868	46A		89.2	15.3	8.2	25.1 / 689.1	61.4 / 32
14:42	809 / 870	45-6A		89.2	15.3	8.2	25.2 / 688.8	61.9 / 32
14:52:45	811 / 871	46A		89.2 / 161.6	15.3	8.2	25.2 / 688.6	/ 32

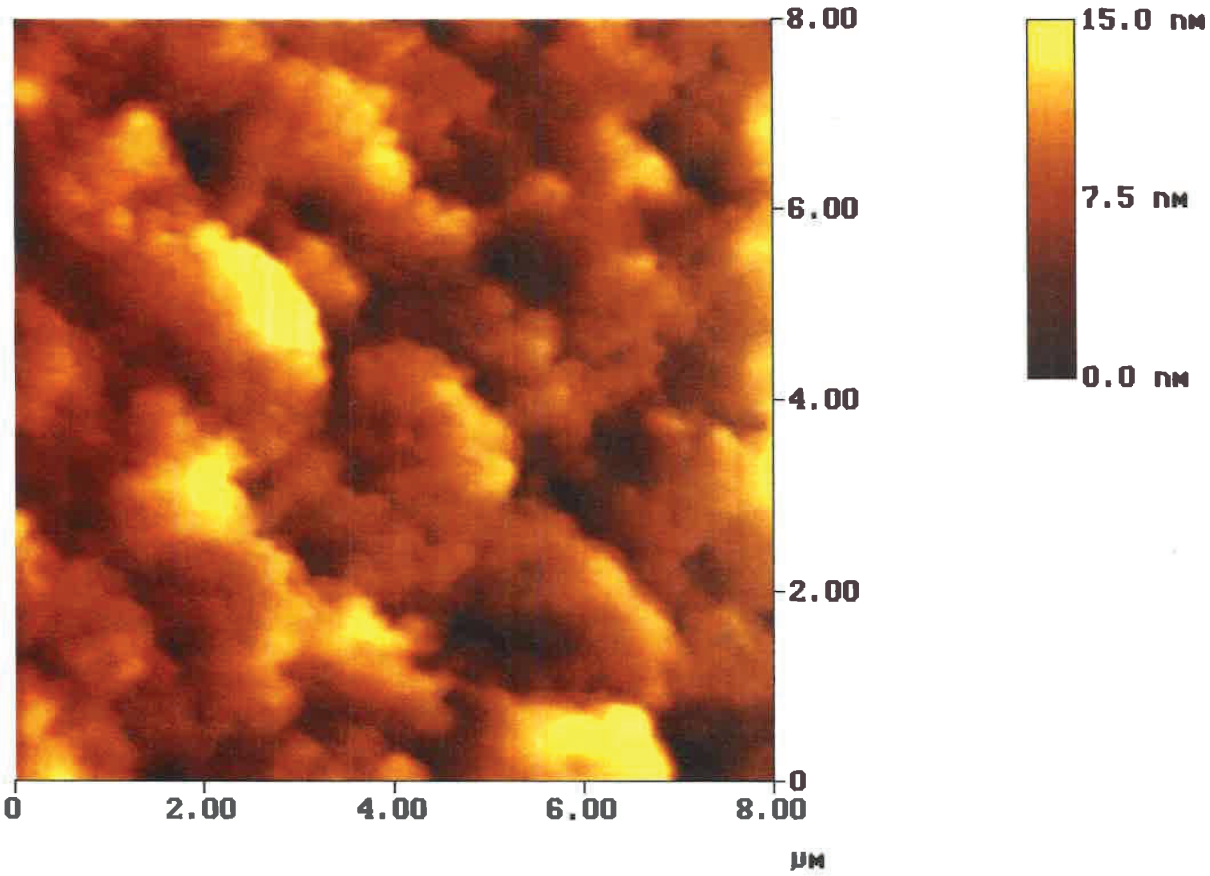
Height Angle Surface Normal Clear Calculator



iii308w1: ~~Bulk GaN growth on SiC~~
AlGaN LAYER w/om PREflow

Height

Height Angle Surface Normal Clear Calculator



iii308w1: ~~Bulk GaN growth on SiC~~
ALGaN LAYER w/ om preflow

Height

OMVPE III Run #iii310 date: 1/8/98 operator: JAS

description: thick GaN layer on top of ≈ 2000Å of AlGaN AlGaN is linearly graded to GaN @ interface.

program used for this run: -MANUAL-

growth segment	time	actual susceptor temp	TC temp	RF amps
H2 GaN	10min			46
AlGaN	30.5 min			46
GaN.	270min			46

rotation speed: -0.1 cell press: 75 vent press: +1

zone I manifold temp: 63.3 OM3 heat tape: 52.1

NH3 cylinder: (left/right) start weight/press: 27 lbs / 96 psi heat tape voltage: Ø up to 60 volts 16:22.

finish weight/press:

	OM1	OM2	OM3	OM4	OM5	OM6
temp			30.0		16.5	
grams used			16.5			
mfcoffset			0.0		0.0	
Pres. closed						

wafers:
1 SiC N+ wafer 1/6th wafer from wafer # AAØ1Ø9-1Ø solvents + RCA prep on 1/8/98

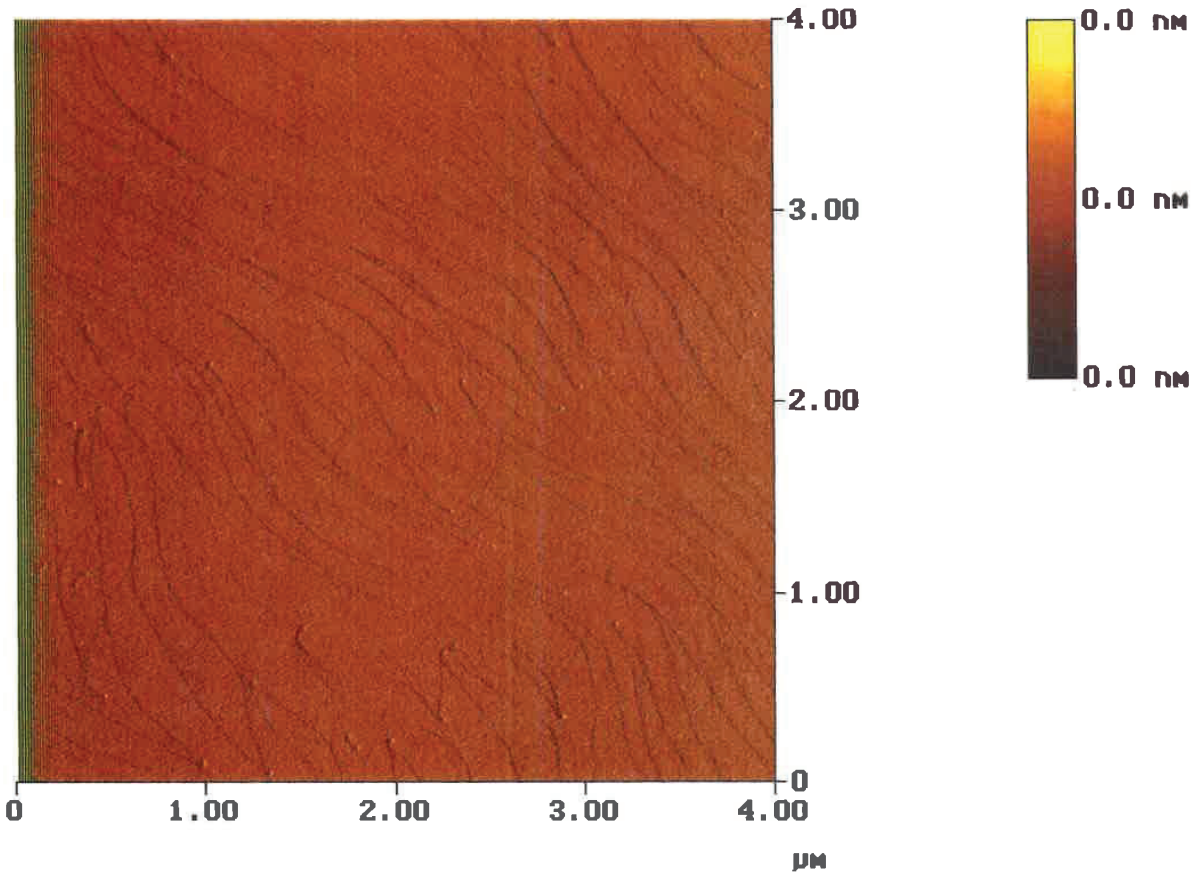
1 SiC SI wafer 1/4 wafer from 1 3/8" SI SiC # F0728-2 solvents + RCA prep on 1/8/98.

1 sapphire wafer 1/4 wafer from 2" from box # 97-1033

95Å/min = 263min for 2.5um

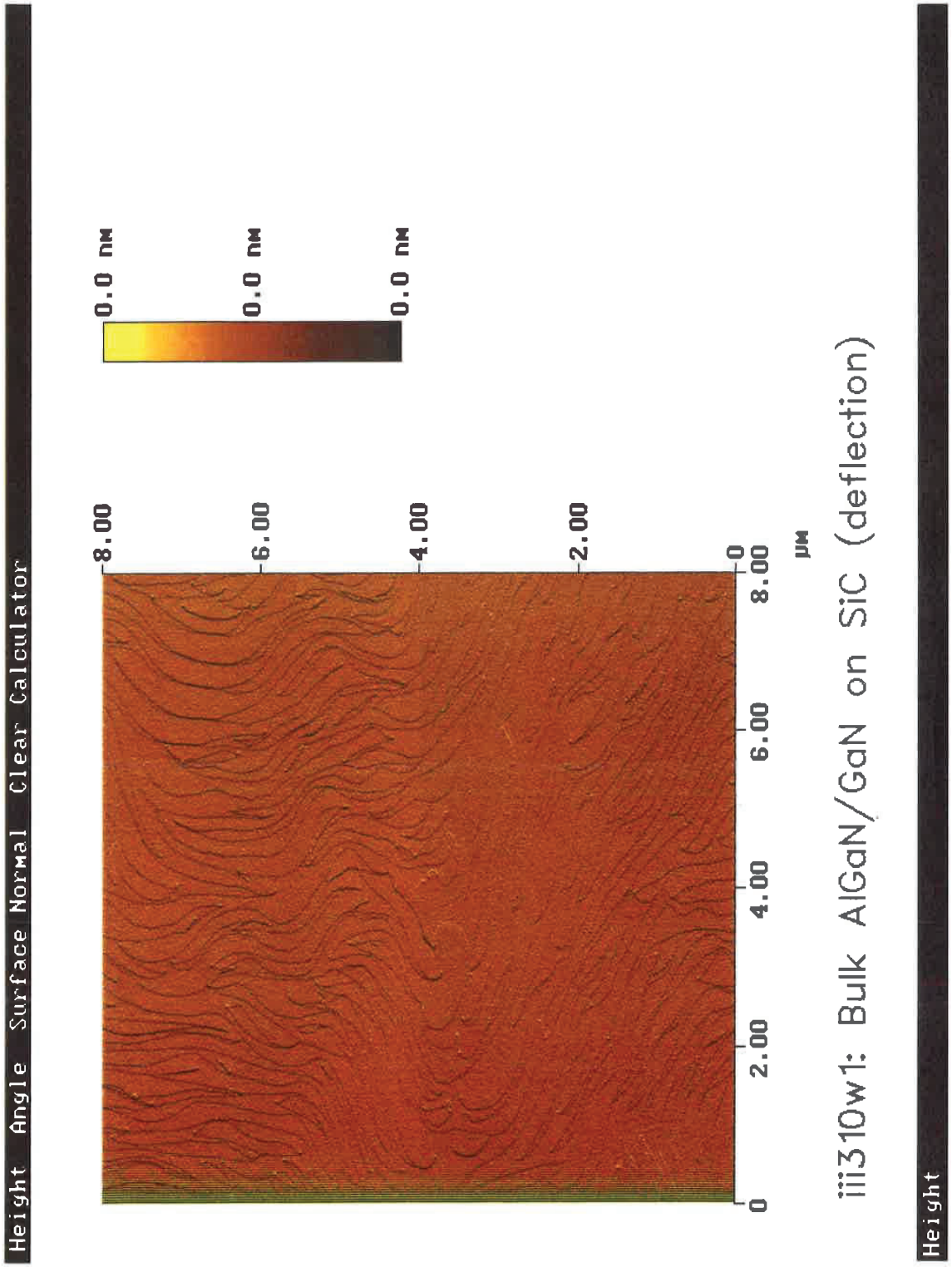
time	TC temp	RF: amps/volts	comments	TEG (OM3)	NH3 zone I	NH3 block	~~Cell~~ TMA ~~Throttle~~	RF lead Can (TC)
15:51	693/72	30A						12.7
15:52		30A	TMA to vent.				24.9/693.7	
15:53	50/146	30A	BALANCE IN				25.0/694.4	16.9/25
15:56	100/272	48A ↑	TURNED UP RF.					20.2/26
16:03	655/815	48A	VISUALLY CHECKED ROTATION. TEG IN	25.3/151.5	–	–	25.0	48.4/29
16:04	710/842	↓46A	START 10 min Hz CLEAN.					
16:08	768/860	46A	TURN UP TEG (16:12)	25.1 ↑ 89.0	–	–	25.0	53.0/30
16:14:00	777/873	46A	4 min delay then inject NH3.	89.2/164.4	15.2	8.9	24.7/692	55.9
16:19:00	808/877	46A.	Al Gan started 30.5 min.	89.2	15.4	9.2	25.1/693.5	56.9/31
16:29	815/880	46A		89.3	15.2.	8.5	25.2/693.6	57.8/31
16:34	819/882	46A		89.3	~~24~~ 15.2	8.5	25.2	57.7/31
16:49:00	811/878	46A	START grading back Al down to 2% in 40 sec (4.5 hrs) then switched out.					
16:51:00	816/883	46A.	increase NH3 flows.					
			Finished turning up NH3	89.3	30.4	17.5	TMA isolated 689.2T	58.2/32.
			NH3 LP line up to 16 psi	up to 95%				
16:53	815/877	46A		↑ 89.3/177.4	30.4	17.0		57.9/32.
17:34	813/875	46A		95.6/177.4				
18:02	809/872	46A		95.6/177.1	30.4	17.0		57.1/32
19:17	813/879	46A		95.6/177.0	30.4	17.1		57.6/32
19:18	816/883	46A		95.7/177.2	30.4	17.1		57.8/32
20:11	814/880	46A		95.6/177.2	30.4	17.0		57.8/32
21:19:00	814/878	46A.	Run over	95.6/	30.4.	17.1		57.8/32

Height Angle Surface Normal Clear Calculator



iii310w1: Bulk AlGaN/GaN on SiC (deflection)

Height


Height Angle Surface Normal Clear Calculator
0.0 nm
0.0 nm
0.0 nm
8.00
6.00
4.00
2.00
0
0
2.00
4.00
6.00
8.00
µm
iii310w1: Bulk AlGaN/GaN on SiC (deflection)
Height

OMVPE III Run #iii313 date: 1/18/98 operator: DAS

description: This run was first aborted on 1/17/98 due to rotation problem with reactor

program used for this run: - manual -

growth segment	time	actual susceptor temp	TC temp	RF amps
H_2 clean	10min	1040		46
AlGaN	30.5min	1040		46
(4min preflow of OM's)				~~46~~

rotation speed: -0.1 cell press: 75 vent press: +1

zone I manifold temp: 51.3 OM3 heat tape: 52.5

NH3 cylinder: (left/right) start weight/press: 94psi / 50lbs heat tape voltage: Ø

finish weight/press: ____

	OM1	OM2	OM3	OM4	OM5	OM6
temp			30.0		16.5	
grams used			[illegible]			
mfcoffset			0.0		0.0	
Pres. closed						

wafers:

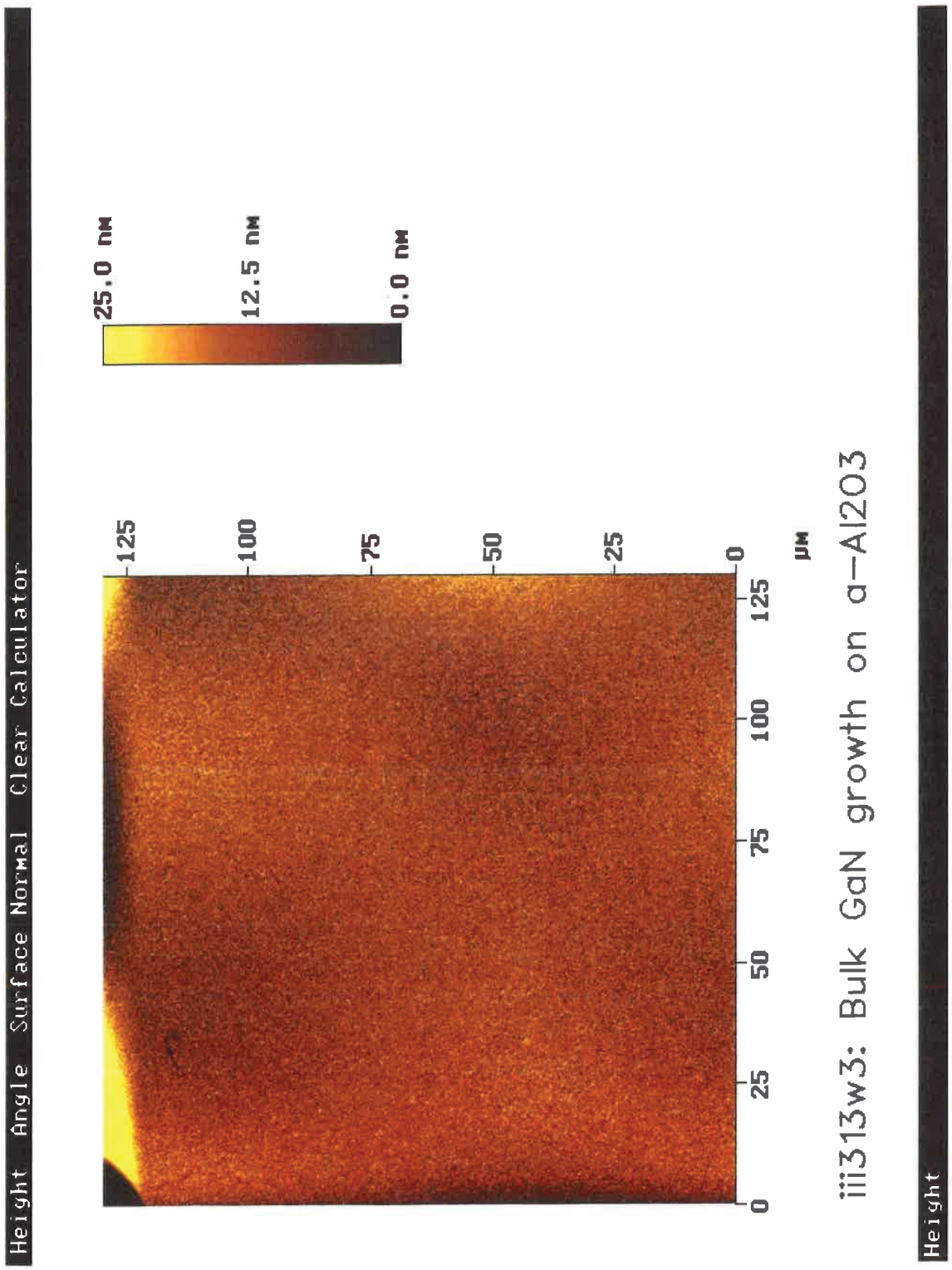
1 SiC N+ wafer

1/6th wafer pc from wafer #AAØ1Ø9-1Ø solvents + RCA prep on 1/14/98

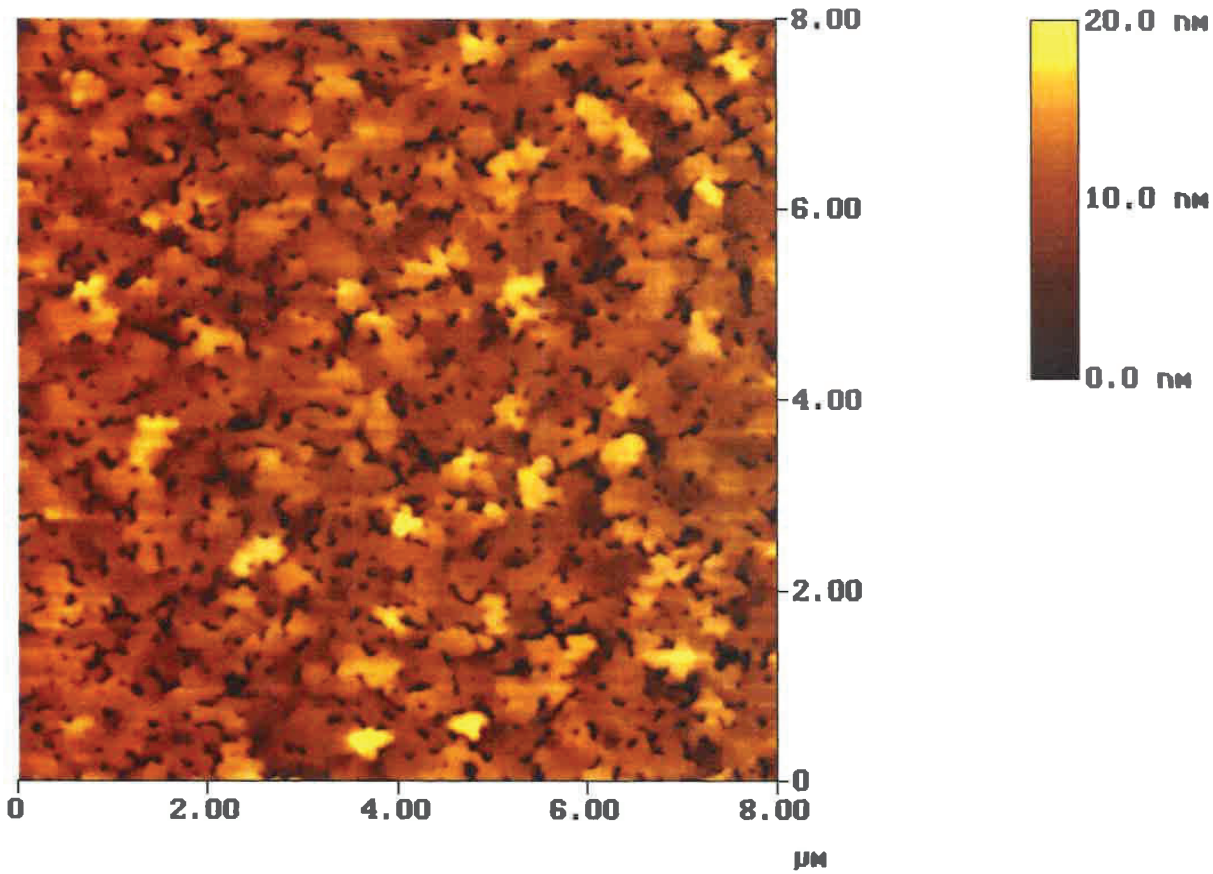
1 sapphire wafer

1/4 wafer pc from 2" wafer from box 97-1033 solvent clean.

time	TC temp	RF: amps/volts	comments	TEG (OM3)	NH3 zone I	NH3 block	~~Cell~~ ...tle	RF lead Cal (TC)
12:09	32/56	30A	RF ON					
12:13	42/177	30A	start NH3 purge Start TMA.				25.3/297.6	
12:14	51/221	30A	balance in					18.
12:16	100/307	30A↑48A	increase RF				25.2/297.5	22.3/26
12:21	565/813	48A	NH3 to vent		15.3		25.3/298.3	
12:24	725/894	↓46A	increased TMA flow start 10min	H2 clean	15.0		48.0/305.1	52.8
12:26	749/902	46A	Start TEG	26.1/152.3	15.0		47.5	56.3/29.
12:29	785/909	46A	increase TEG	26.1↑ 89.3	15.0		47.6	59.2/30.
12:35:00	804/916	46A	4min on preflow	89.2/165.1	15.1	8.8	47.5/305.6	61.5/30
12:39:00	806/915	46A.	NH3 into Zone I + Block	89.3	15.2	8.9	47.6/306.1	62.7/31
12:43	813/920	46A		89.3	15.1	8.8	47.6/306.3	63.4/31
12:56	820/916	46A		89.3	15.1	8.8	47.5/306.4	63.5/31
13:05	820/916	46A		89.3	15.1	8.8	47.6/306.4	63.8/31
13:09:30	624/917	↓off	Run over	89.3/161.9	15.1	8.8	47.6/306.4	—

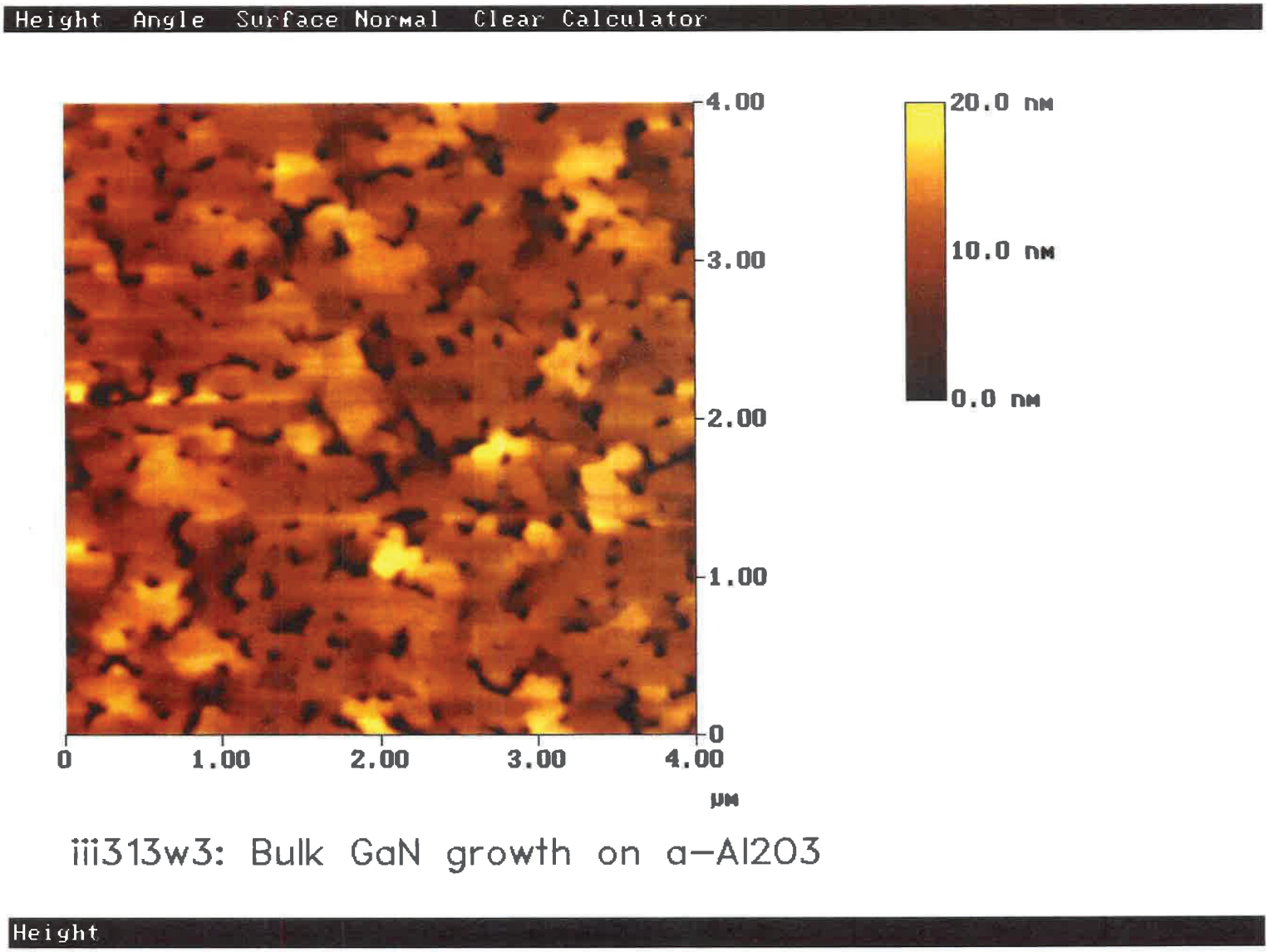

Height Angle Surface Normal Clear Calculator
25.0 nm
12.5 nm
0.0 nm
125
100
75
50
25
0
0
25
50
75
100
125
µm
iii313w3: Bulk GaN growth on a-Al2O3
Height

Height Angle Surface Normal Clear Calculator



iii313w3: Bulk GaN growth on a-Al2O3

Height


Height Angle Surface Normal Clear Calculator
4.00
3.00
2.00
1.00
0
0
1.00
2.00
3.00
4.00
µm
20.0 nm
10.0 nm
0.0 nm
iii313w3: Bulk GaN growth on a-Al2O3
Height

iii 333

OMVPE III Run #iii333 date: 2/24/98 operator: JAS

description: PATTERNED SUBSTRATES. ELO Project.
Problems with NH3 line between AlGaN buffer and GaN Layer.

program used for this run: -MANUAL-

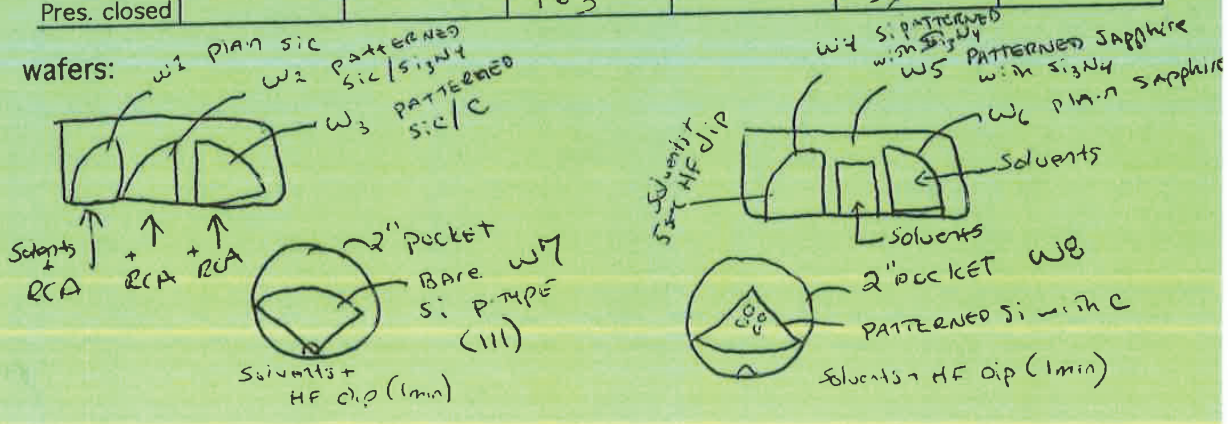
V/III RATIO	growth segment	time	actual susceptor temp	TC temp	RF amps
—	H2 bake	10min			43-4
Ø	Om Preflow	4min			44
≈900	AlGaN Buffer (≈6-7% Al)	30min			44
≈~~3~~ 1800	GaN Layer	420min			43
≈1800	AlGaN cap layer (200-250Å)	2min			43

rotation speed: -0.1 cell press: 75 vent press: ±1
zone I manifold temp: 52.5 OM3 heat tape: 59.0

NH3 cylinder: (left/right) start weight/press: 39lbs/95psi heat tape voltage: 60v
finish weight/press: _____

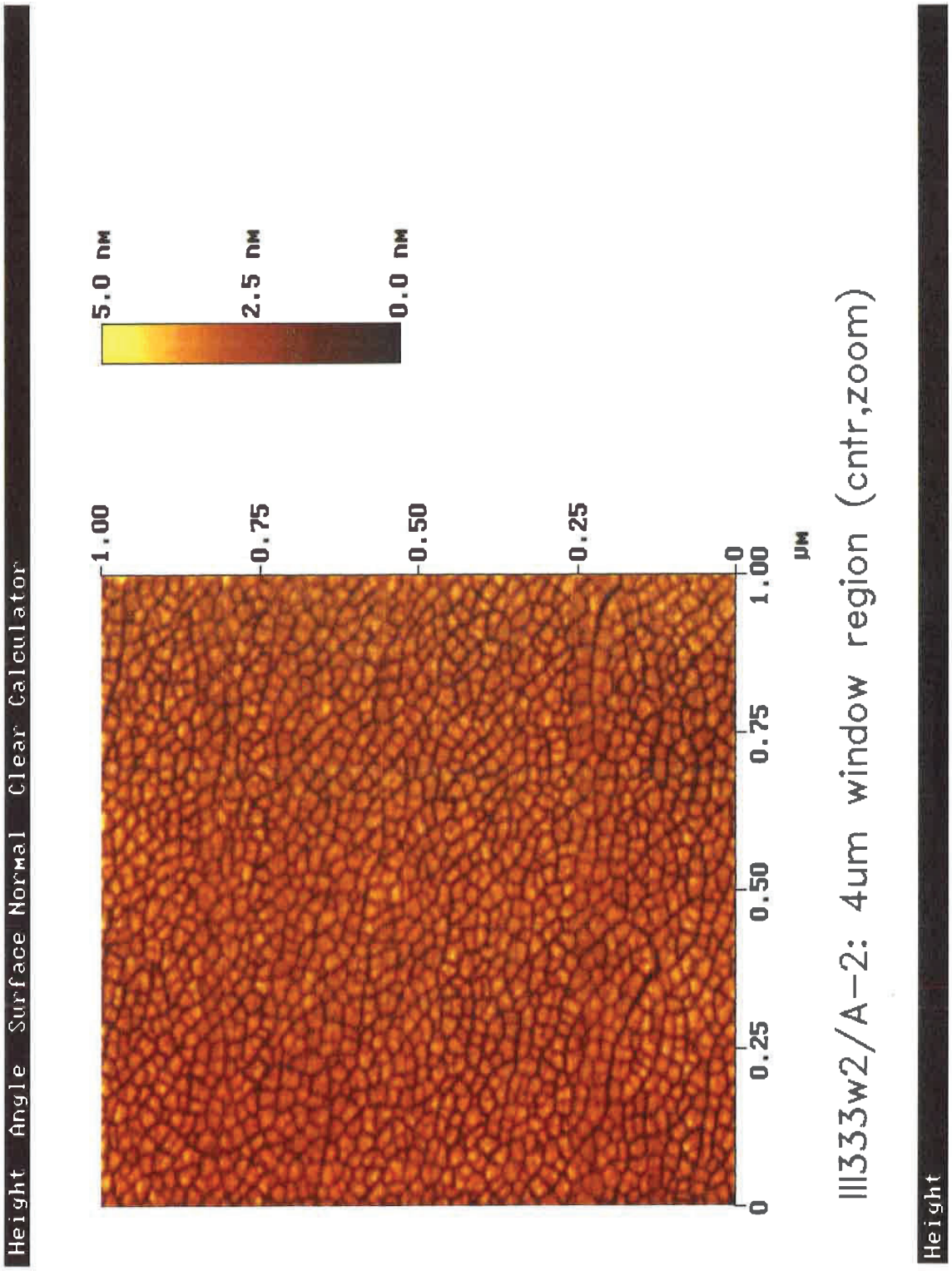
	OM1	OM2	OM3	OM4	OM5	OM6
temp			30.1		16.4	
grams used						
mfcoffset			0.0		0.0	
Pres. closed			163		159	

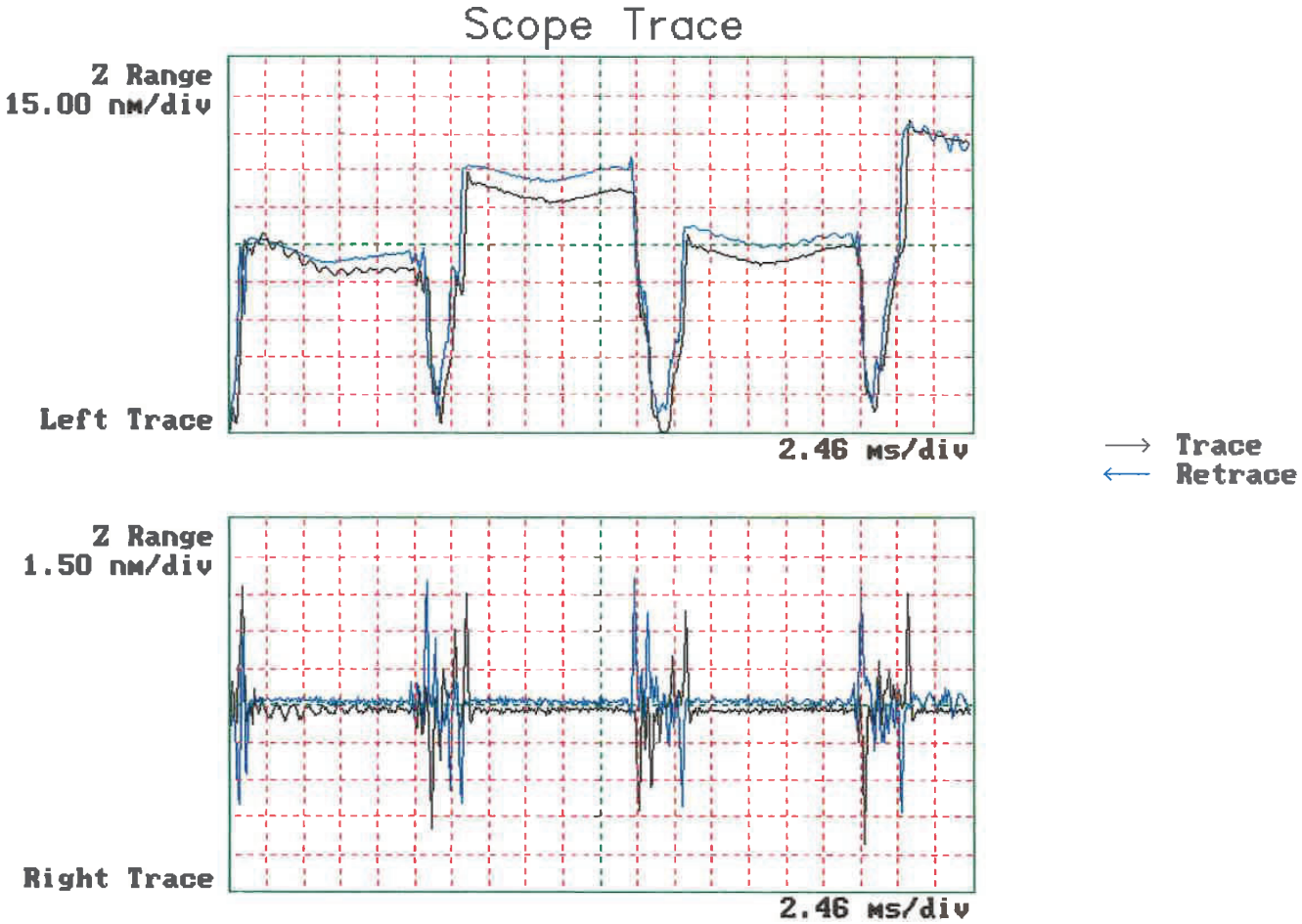
wafers:



	Temp	RF	comments	TMA	TEG (OM3)	NH3 zone I	NH3 block	Cell Throttle	RF lead Can (TC)
		30A	RF on					4.9	12.9/35
		30A	Balance in purge NH3 line					5.3	19.4/36
	100/–	↑48A	Turn up RF.					5.3	20.0/26
12:28	493/970	48A	Charged NH3 line.						
12:30	639/1038	48A	NH3 to vent gettering in			2.9		4.8	52.1/28
12:32	725/1055	43A↓	Start bake. 10 min.			3.1↑		4.8	55.1/29
12:33	757/1019	TMA on 43A	Change over pressure.!!	25.3/1575	—700				
12:35	775/1023	TEG on 43-44	TEG ON	25.4/713↓	25.1/151.7	↑15.0	–	4.8	56.7/29
12:46:00	793/1034	44A.	Run preflow 4 min	25.1/696.3	89.4/157.4	15.3	–	5.3	59.0/30
12:48:00	796/1038	44A		25.3	89.4	15.3	–	5.4	59.4/30
12:50:00	800/1039	44A	NH3 into tube Algaas buffer	25.0/689.7	89.4	15.4	0.0	5.5.	59.7/30
12:52	801/1039	44A		25.2/695.8	89.4/164.6	15.2	5.6	5.6	59.9/30
13:00	801/1036	44A		25.1/692	89.4	15.2	5.7	5.7	60.1/31
13:20	800/1037	44A	Ramp out Al down to 2% then increase V/III ratio	↓2%	89.4/164.5	15.1	5.6	5.9	60.5/31
13:33	48/1036	44A	TMA isolated	69.1	89.4/.	30.0	17.0	6.3	60.6/31
			HAD BIG Problem with NH3 !!!						
			Got flow up to 60% in ZONE I,						
			lost DP across GETTERING MECT,						
			then dropped to 5 TORR!! sent						
			the machine into oscillations!!!						
			Could have lost NH3 flow in the block!						
14:17	805/1040	44		11.2/X	89.4/172	30.0	17.0	6.4	61.1/31
14:37	802/1043	44		X	89.4/172.1	30.0	17.0	6.4	60.9/31
15:11	803/1042	44			89.4/172	30.0	17.1	6.4	61.5/30
15:50	802/1041	43A			89.4/172.9	30.0	17.1	6.4	61.3/32

13:40


Height Angle Surface Normal Clear Calculator
5.0 nm
2.5 nm
0.0 nm
1.00
0.75
0.50
0.25
0
0
0.25
0.50
0.75
1.00
µm
III333w2/A-2: 4um window region (cntr,zoom)
Height

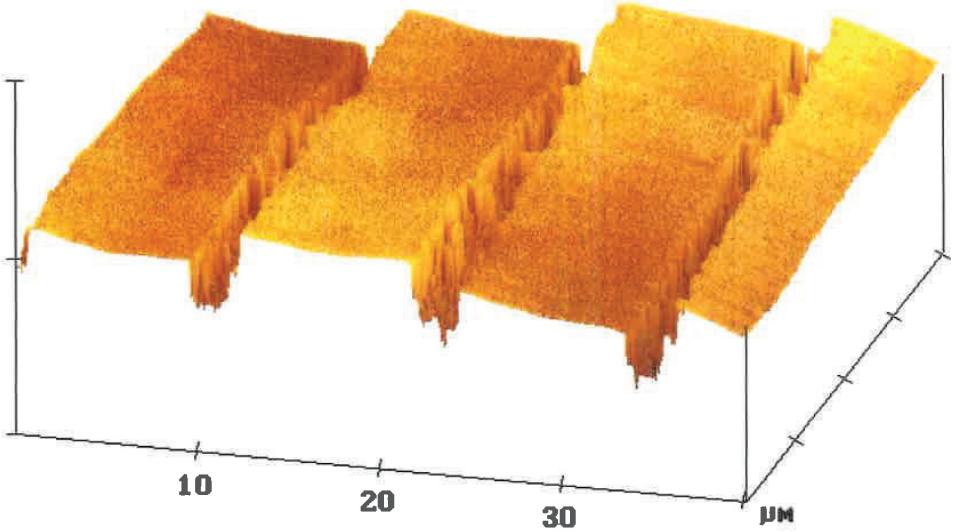


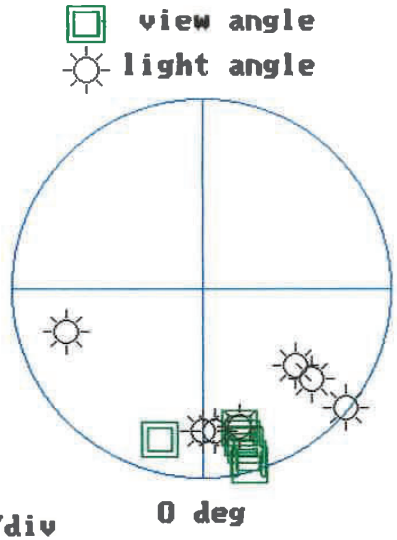
III333w2/A-2: Semi-coalesced 4:8 ELO stripes

333w2a2.004

Scan date: 2-27-98

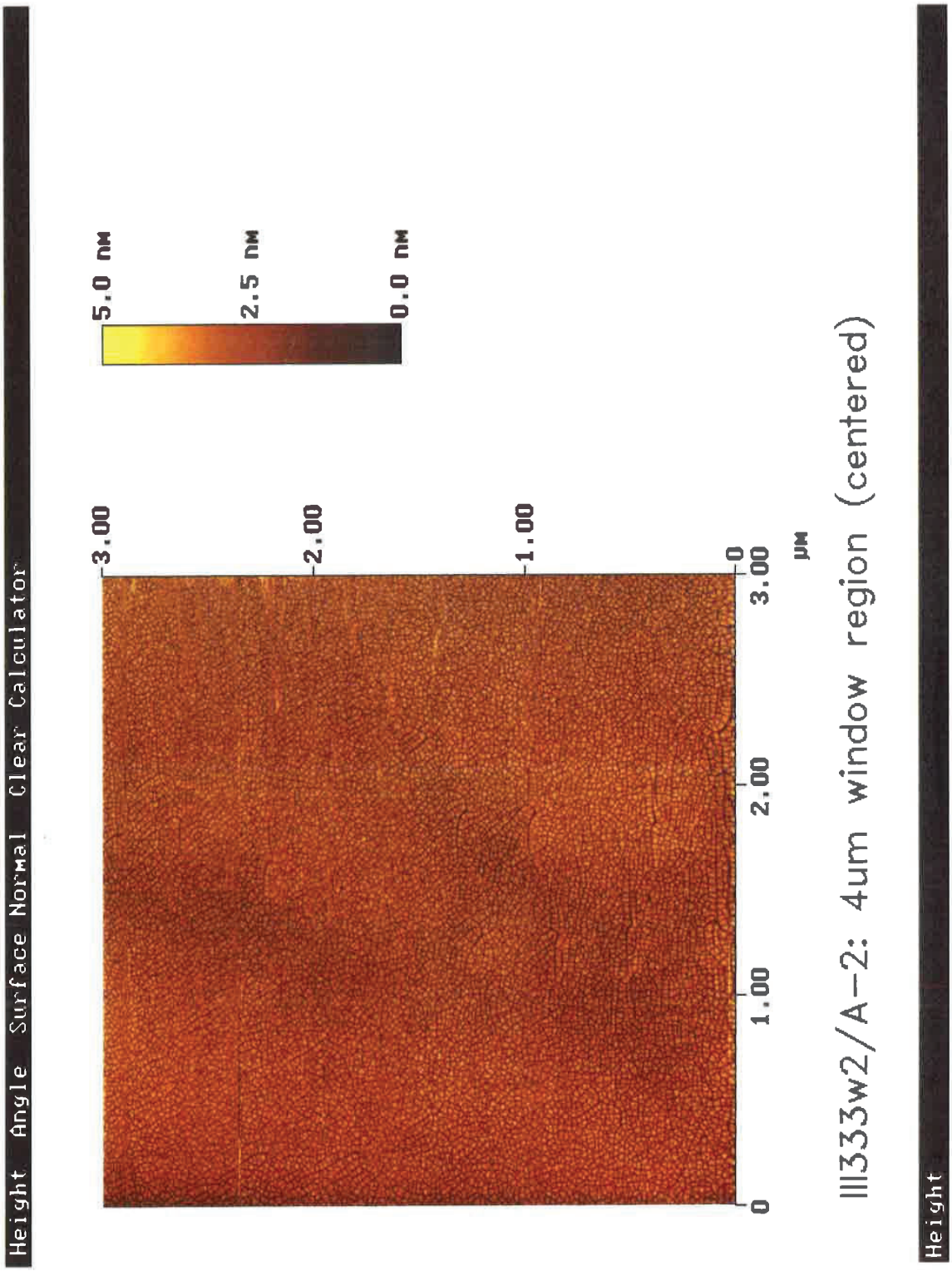
NanoScope	Contact AFM
Scan size	39.97 µm
Setpoint	0 V
Scan rate	1.969 Hz
Number of samples	512



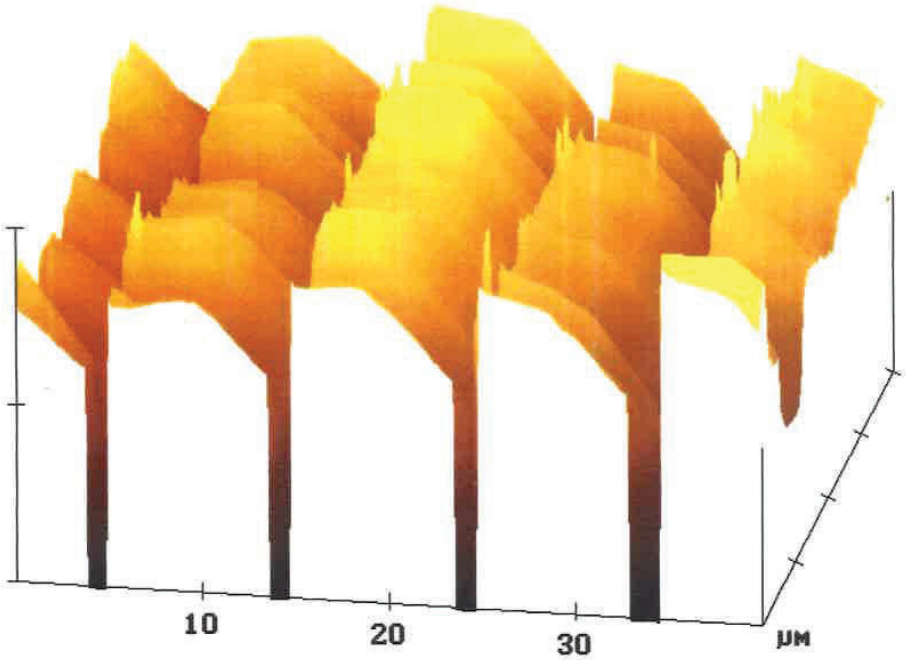


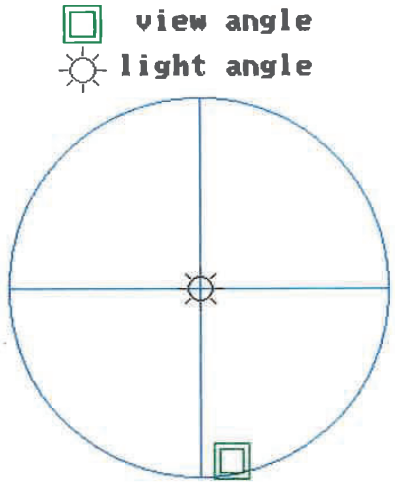
X 10.000 µm/div
Z 200.000 nm/div

III333w2/A-2: Semi-coalesced 4:8 ELO stripes on α-Al_2O_3 w/ Si_3N_4 mask


Height Angle Surface Normal Clear Calculator
5.0 nM
2.5 nM
0.0 nM
3.00
2.00
1.00
0
0
1.00
2.00
3.00
µM
III333w2/A-2: 4um window region (centered)
Height

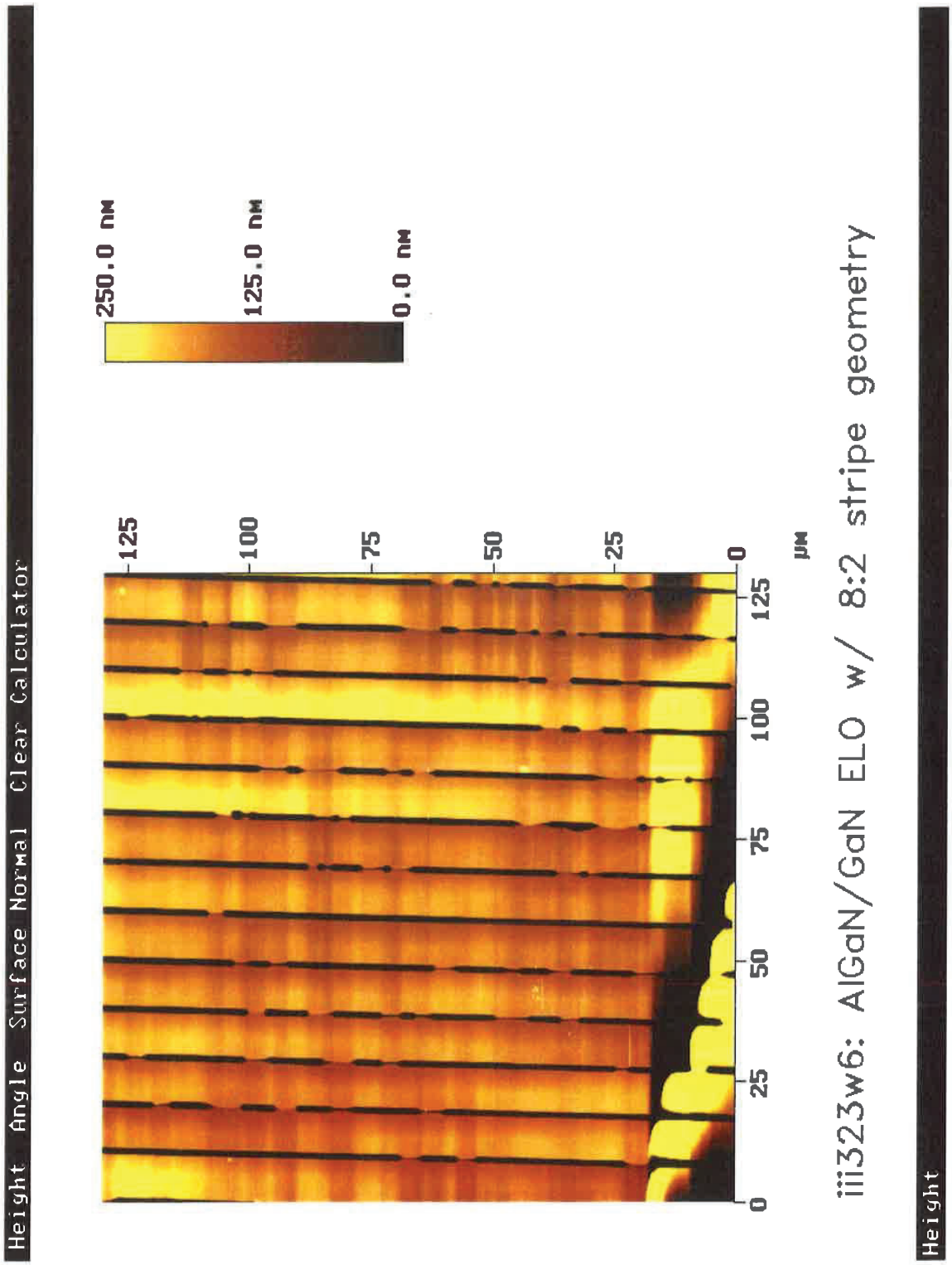
NanoScope	Contact AFM
Scan size	40.00 µm
Setpoint	0 V
Scan rate	1.969 Hz
Number of samples	512





X 10.000 µm/div
Z 100.000 nm/div

iii323w6: AlGaN/GaN ELO w/ 8:2 stripe geometry


Height Angle Surface Normal Clear Calculator
250.0 nm
125.0 nm
0.0 nm
125
100
75
50
25
0
0
25
50
75
100
125
µm
iii323w6: AlGaN/GaN ELO w/ 8:2 stripe geometry
Height