

# 12" T/M Wafer 측정 및 분석 성적서 관련

## 1. Spec

12" , P / Boron , Thickness : 750-800um , Resistivity : 1-100ohm.cm

Double Side Polished, Notch type,

Particle : > 0.2um@Max 20EA

Laser Mark : hard laser mark T7+OCR

Label : Dummy 표기이나 실질적으로는 Test 품질 수준으로 결론

검사 성적서 측정 방식 : 전수 검사

	Items	Wafer Specification	Remarks
1	General Characteristics		
1.1	Growth Method	CZ or MCZ	
1.2	Crystal Orientation	<100> +/- 1.0 degrees	
1.3	Conductivity Type	NA	
1.4	Dopant	NA	
1.5	Edge Exclusion	3mm	
2	Chemical Characteristics		
2.1	Oxygen Concentration	NA	
2.2	Radial Oxygen Concentration	NA	
2.3	Carbon Concentration	NA	
2.4	Bulk Fe Concentration	NA	
3	Structural Characteristics		
3.1	Slip, Swirl	NA	
3.2	OiSF (Wafer)	NA	
4	Wafer Preparation Characteristics		
4.1	Wafer ID Marking	T7+OCR	
4.2	Marking Side	Backside	
4.3	Annealing	NA	
5	Mechanical Characteristics		
5.1	Diameter	300 ± 0.2mm	
5.2	Notch Depth	1 +0.25, -0.00mm	
5.3	Notch Orientation	<110> ± 1.0 or <100> ± 1.0 degrees	
5.4	Notch Angle	90 +5, -1 degrees	
5.5	Edge Shape	Cy=194	By SEMI M1.15-1000
5.6	Edge Surface Finish	Polished	
5.7	Thickness	775 ± 25um	
5.8	Thickness Variation (GBIR)	< =10um	By Wafersight II
5.9	BOW	NA	
5.10	Warp	< =100um	By Wafersight II, ASTM F 1390, Reference Plane : Best Fit
5.11	SFQR (Cell Size 25*25) PUA 95%	NA	By Wafersight II, ASTM F 1530, Reference Plane : Best Fit
6	Front Surface Chemistry		
6.1	Surface Metal Contamination : Na, Al, Ca, K	< 1.0E10/cm3	VPD ICP-MS
6.2	Surface Metal Contamination : Fe, Cr, Cu, Ni, Zn	< 1.0E10/cm3	VPD ICP-MS
7	Front Surface Criteria		
7.1	Scratch (Macro)	None	
7.2	Scratch (Micro)	< = 35mm	Total length
7.3	LLS (Localized Light Scatter) / >=0.2um	< = 20ea / wf	By SP3/SP5, Exclude LPD-N Defect
8	Back Surface Criteria		
8.1	Scratch (Macro)	NA	
8.2	Scratch (Micro)	NA	
8.3	Backside Localized Light Scatter	NA	
9	Others		
9.1	Shipping Box-Auto FOSB Type	SEP MW 300GT or Entegris SB300-SA00-06EN5	

## 2 . ZingSemi 입고 사진



3 Zingsemi 월 캐파 : 1만장 / 월

4. Zingsemi 메이커 Particle 제조 능력 : 65nm급

5 . 현 국내 재고 보유량 : 9,500장

## 6. ZingSemi Particle 측정 Data

측정 장비 : SP2

	65nm	120nm
1	9	4
2	24	6
3	27	14
4	22	7
5	20	3
6	21	3
7	33	13
8	37	11
9	38	13
10	51	17
11	26	8
12	25	12
13	46	15
14	18	4
15	32	17
16	21	7
17	15	5
18	9	5
19	9	4
20	14	2
21	30	9
22	14	5
23	15	2
24	18	6
25	15	3

[그림1-1]

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12
0.1000 ~ 0.1200	651	587	616	591	624	573	620	596	623	650	632	642
0.1200 ~ 0.1400	131	133	125	121	126	135	143	159	140	138	153	137
0.1800 ~ 0.2000	1	1	2	3	2	4	5	0	1	6	3	1
0.2000 ~ 0.2200	1	1	2	1	1	1	2	1	1	0	1	2

	#13	#14	#15	#16	#17	#18	#19	#20	#21
0.1000 ~ 0.1200	0	5	3	3	0	93	3	390	377
0.1200 ~ 0.1400	0	0	0	1	1	13	1	118	129
0.1800 ~ 0.2000	0	2	1	0	0	1	0	3	6
0.2000 ~ 0.2200	0	0	0	0	0	0	0	4	1

	#22	#23	#24	#25
0.1000 ~ 0.1200	0	3	1	0
0.1200 ~ 0.1400	0	1	3	0
0.1800 ~ 0.2000	0	2	0	1
0.2000 ~ 0.2200	0	0	1	1

[그림1-2]

**측정 결론** : 2차에 걸쳐서 측정한 결과 1차에서는 65nm급 Particle 수준도 만족하는

수준이 었으나, 2차에서는 180nm정도에서 소량씩 발견되는 점으로 미루어

아직은 Partilce Spec을 0.2um 개런티 범위로 잡아야하며, 왕왕 그중에

좋은 Particle Spec이 나올 수 있을 것으로 사료

## 7. ZingSemi Thermal Oxidation Process결과

**공정명** : SiO<sub>2</sub> 3,000A by Wet Thermal Oxidation

**공정 조건** : H<sub>2</sub>O 1,050도에서 Bubbling

**공정 시간** : 약 8hr

**Uniformity (두께 균일도)** : 0.57% 매우 좋은 수준

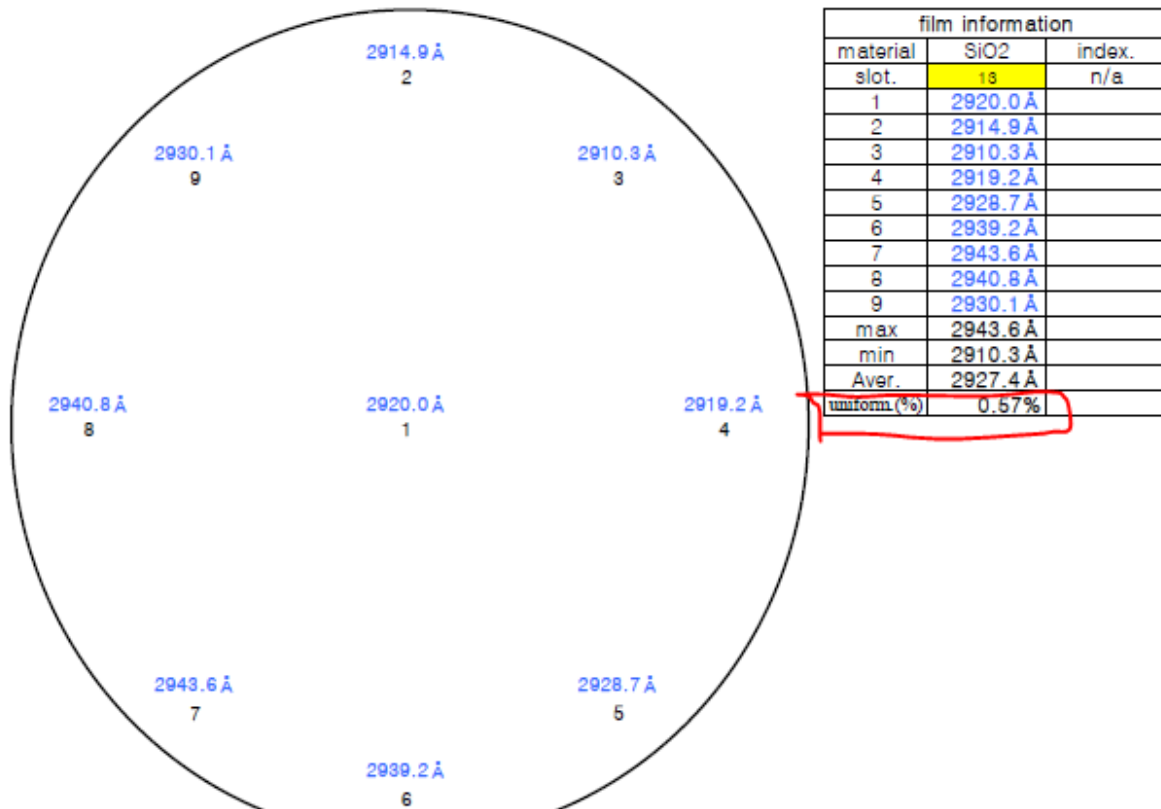
**공정 후 결론** : 고온 공정에서 작업하면 Polishing 테크닉에 따라 어떤 웨이퍼에서는

산소 Swirl이라는 회오리 모양이 보일때도 있으나, Zingsemi 웨이퍼는 그런 것이 없었으며,

Uniformity도 실트론 웨이퍼 수준으로 나옴. 반도체에서는 Edge 5mm안에서 Uniformity 5% 허용 범위로 간주

## inspection report

wafer specification		Process order		measurement system
maker	ZING SEMI	Process	Wet oxidation	Nano-spec
diameter	299.8 - 300.2 mm	lot no.	702300F6321	Inspection date
thickness	750 - 800 um	type.	Double polished	2017-11-29
orientation	P - 100 (Boron)	material	SiO <sub>2</sub> on Si	
resistivity	0.5 - 100 Ωcm	edge exclusion	±5mm	



	operator	inspector	approval	remark
signature	박민재	황의경		

㈜ 바이세미

[그림 2-1 , Zingsemi wafer thermal Oxidation Uniformity 결과].

## 8. ZingSemi DC Sputtering Process 결과

공정명 : Ti 250A / Al+1%Si 1um Depo by DC Sputtering Process

공정 조건 : 아래 그림 참조 1um로 두꺼워서 5,000A씩 2번 증착

Name / Step	1
Step Name	1
Gun.Select	Gun1
MFC.Ar	85
Process.Time	0
Move.Count	10
Pre.SP.Time	5
Power	2750
Temp	0
APC.Value(0=Open)	3
DelayTime	10

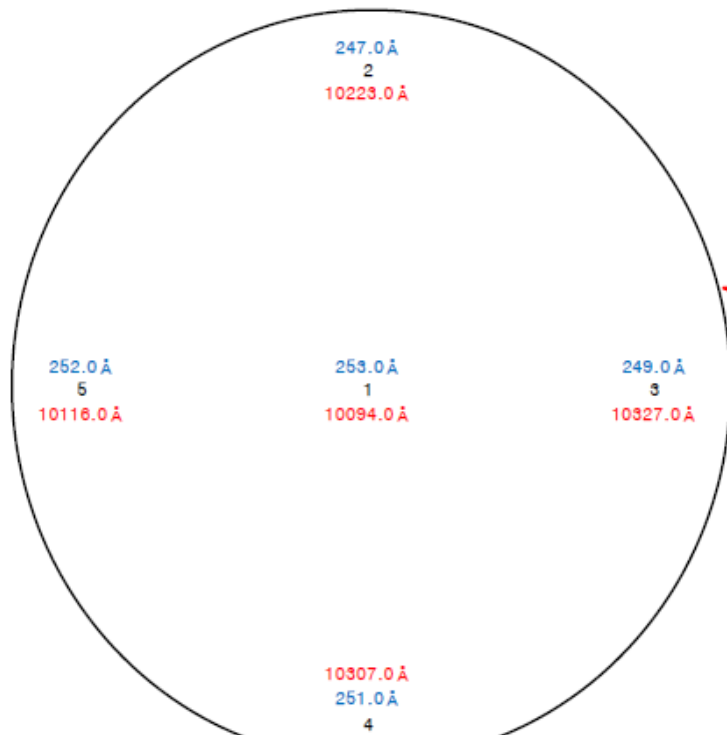
Uniformity (두께 균일도) : 1.2%이내 매우 좋은 수준

공정 후 결론 : 메탈 증착후 Si의 경우 웨이퍼 표면이 안 좋거나하면 Al<sub>2</sub>O<sub>3</sub>로 변화는 산화 경향이 있으나, Zingsemi wafer는 그런 것이 없이 깨끗함, Ti와의 Adhesion Layer 역할도 충분히 함

Uniformity도 실트론 웨이퍼 수준으로 나옴. 반도체에서는 Edge 5mm안에서 Uniformity 5% 허용 범위로간주

# inspection report

wafer specification		Process order		measurement system
maker	ZINGSEMI	Process	Ti/Al Deposition	Alpha step
diameter	299.8 – 300.2 mm	Lot no.	71129001308	Inspection Date
thickness	750 – 800 um	type	Double Polished	2017-12-17
orientation	P – 100 (Boron)	material	Ti/Al on Si	
resistivity	1 – 100 $\Omega$ .cm	edge exclusion	$\pm$ 5mm	



film information		
material	Ti on Si	index.
slot.	Sample	n/a
T	247.0 Å	
B	251.0 Å	
C	253.0 Å	
L	252.0 Å	
R	249.0 Å	
max	253.0 Å	
min	247.0 Å	
Aver.	250.4 Å	
	1.20%	

film information		
material	Al on Ti/Si	index.
slot.	sample	n/a
T	10223.0 Å	
B	10307.0 Å	
C	10094.0 Å	
L	10116.0 Å	
R	10327.0 Å	

max	10327.0 Å
min	10094.0 Å
Aver.	10213.4 Å
	1.14%

	operator	inspector	approval	remark
signature	박민재	황의경		

## 9. ZingSemi surface Roughness / Thickness / Resistivity

### 측정 결과



의뢰 기관 : 한국 나노기술원 ( <http://www.kanc.re.kr> )

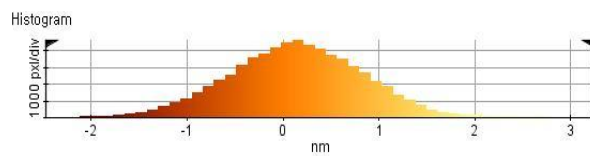
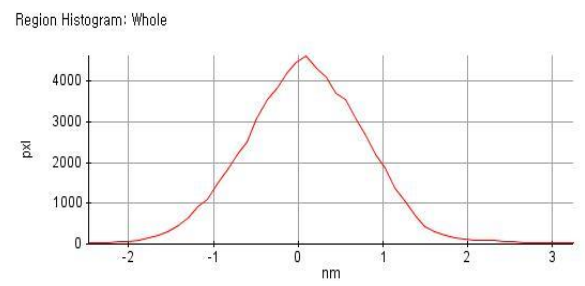
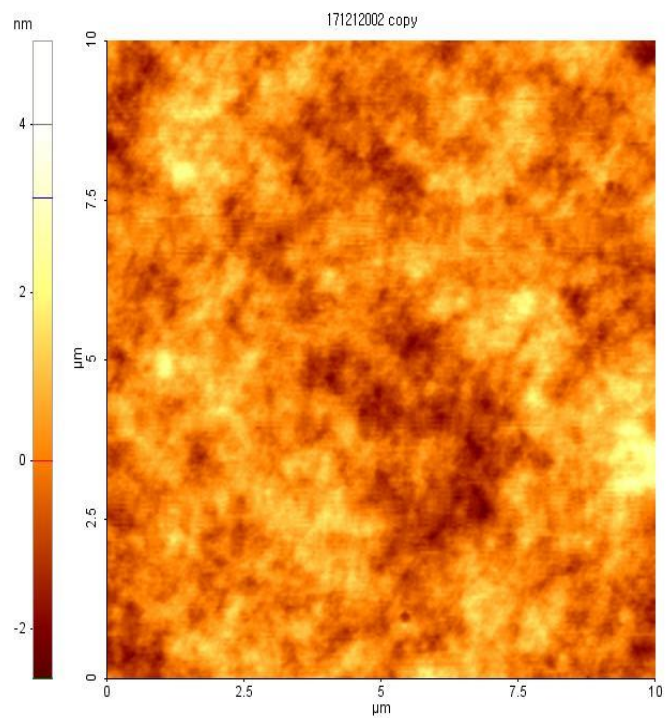
#### 9-1 Roughness Data

측정 장비 : AFM

측정 결과 : -> 100mm\*100mm 로 잘라서 9 point 측정했습니다.

Ra 값을 보시면 됩니다. ave 값으로 약 0.5~0.6nm 나왔습니다

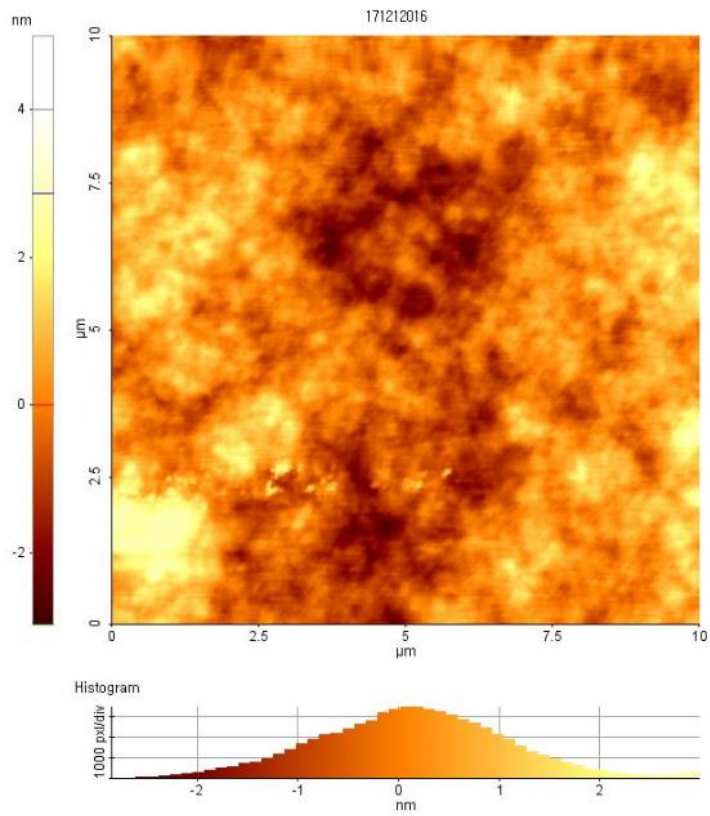




Statistics

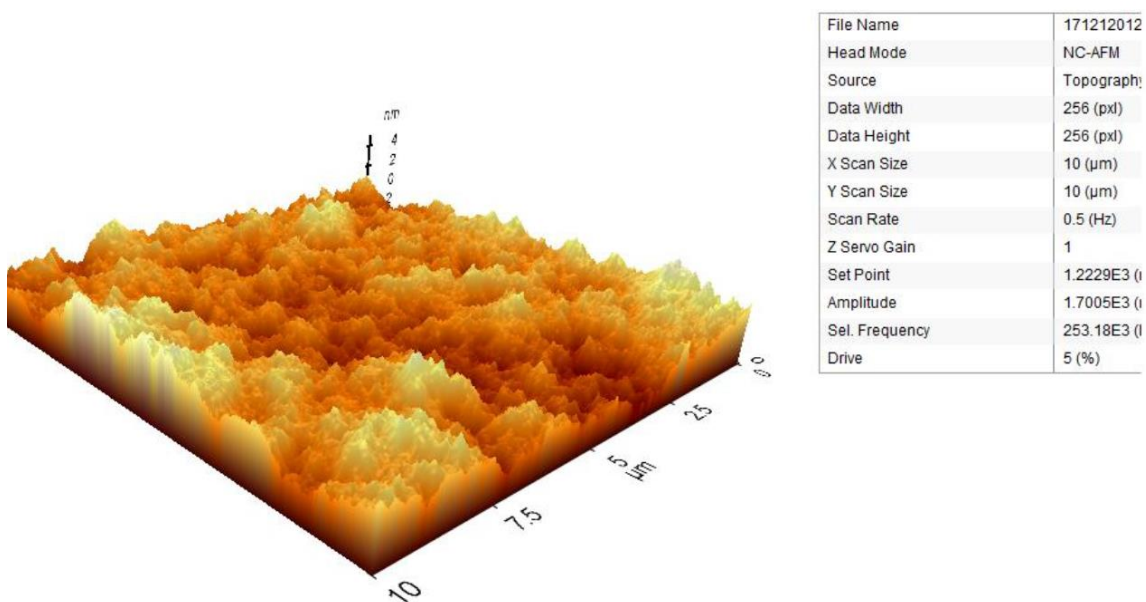
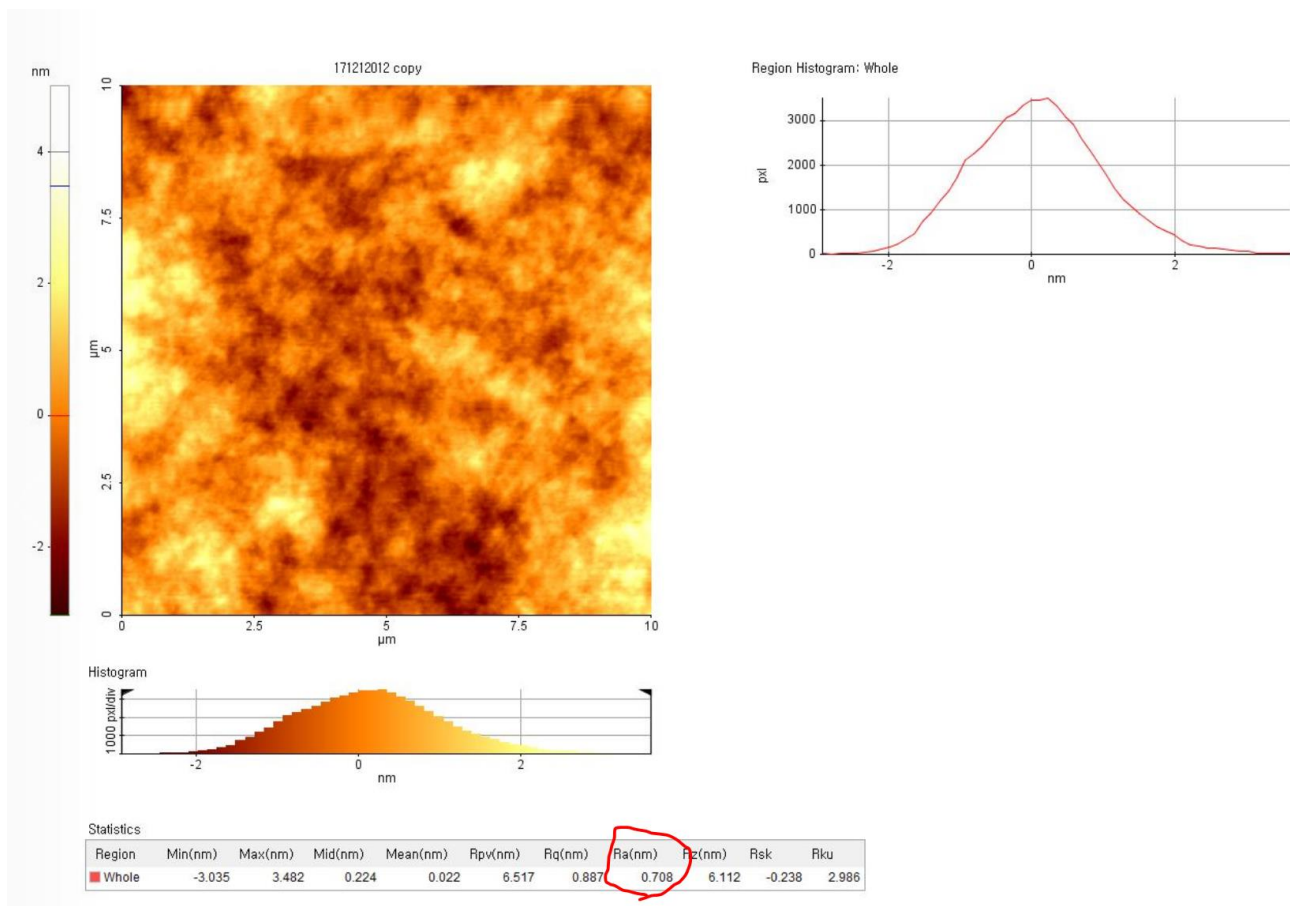
Region	Min(nm)	Max(nm)	Mid(nm)	Mean(nm)	Rpv(nm)	Rq(nm)	Ra(nm)	Rz(nm)	Rsk	Rku
Whole	-2.590	3.125	0.268	0.024	5.715	0.698	0.553	5.319	-0.054	3.200

[그림3-1AFM측정결과]



File Name	171212016
Head Mode	NC-AFM
Source	Topography
Data Width	256 (pxl)
Data Height	256 (pxl)
X Scan Size	10 (μm)
Y Scan Size	10 (μm)
Scan Rate	0.5 (Hz)
Z Servo Gain	1
Set Point	1.2229E3 (nm)
Amplitude	1.7005E3 (nm)
Set. Frequency	253.18E3 (Hz)
Drive	5 (%)

[그림3-1AFM측정결과]

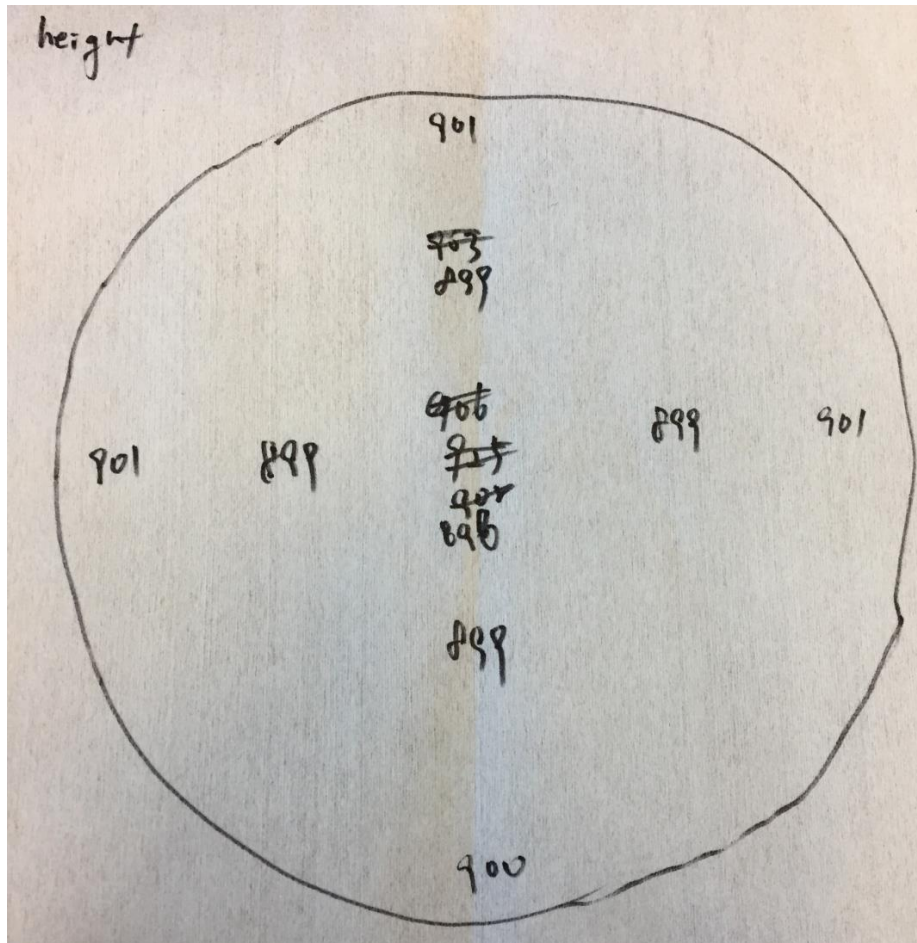


### 9-2 Thickness Data

측정 장비 : Height Gauge

측정 결과 :

300mm full wafet 에서 9 point 측정했습니다. ave 값으로 약 900um 정도 나왔습니다



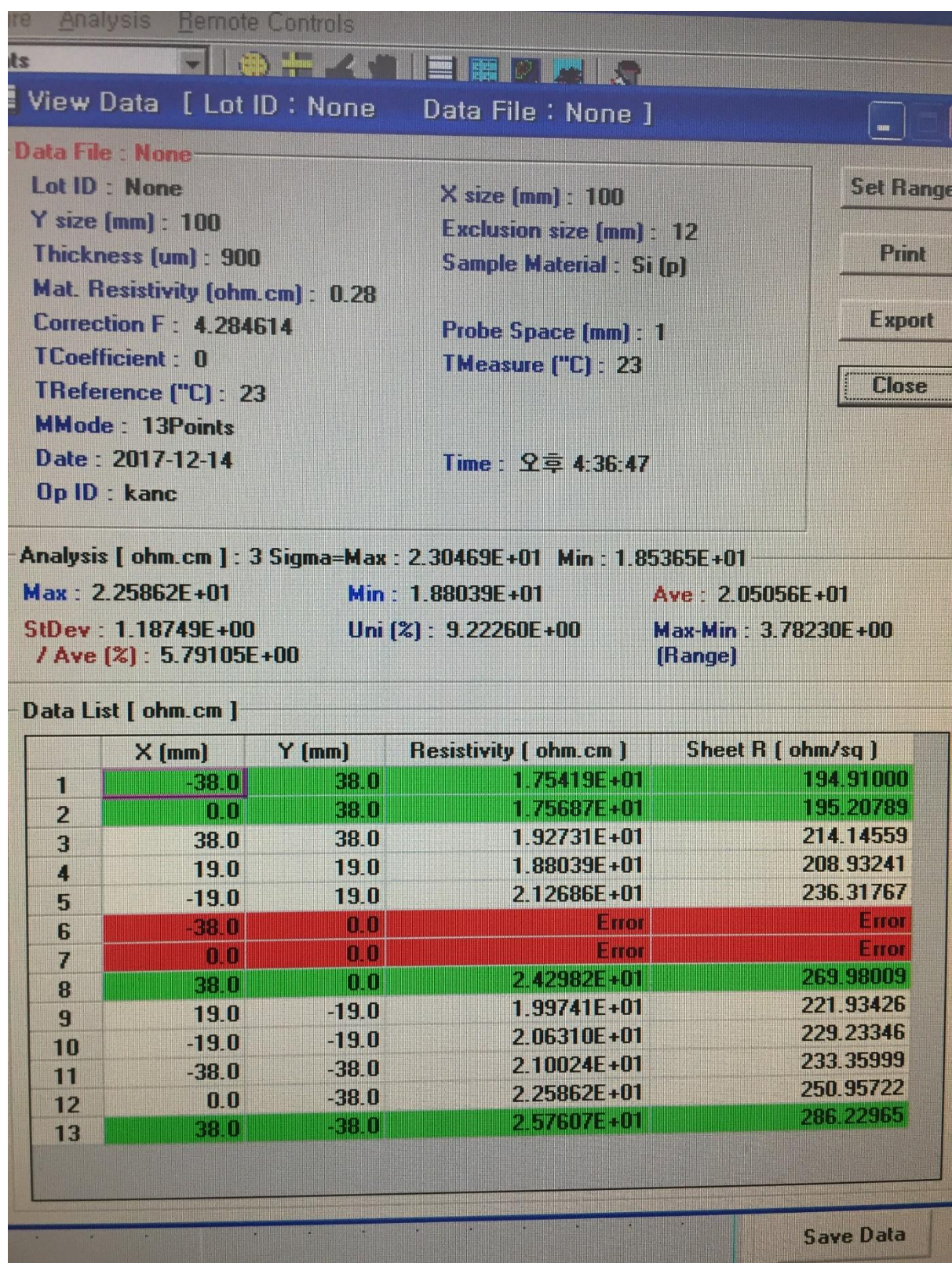
### 9-3 Resistivity Data

측정 장비 : 4point probe

측정 결과 : 100mm\*100mm 로 잘라서 13 point 측정했습니다.

ave 값으로 약 20 ohm.cm 정도 나왔습니다





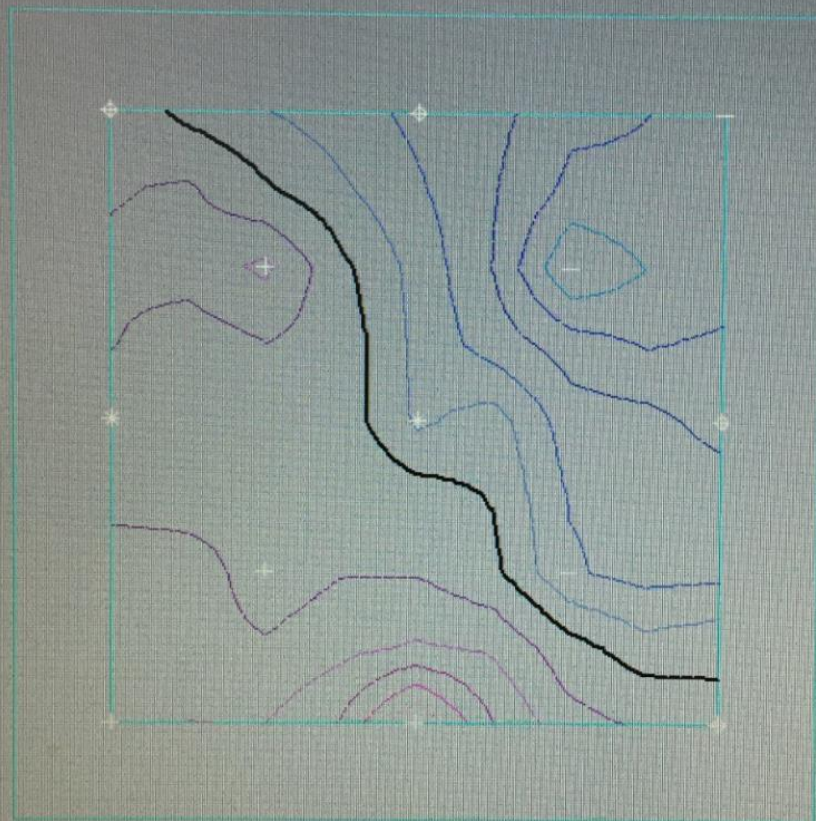


e [ Sample Type: None ] Size (mm) - X: 100 Y: 100 Exclusion: 12 Thickness (um): 900

Recine Extend Measure Analysis Remote Controls

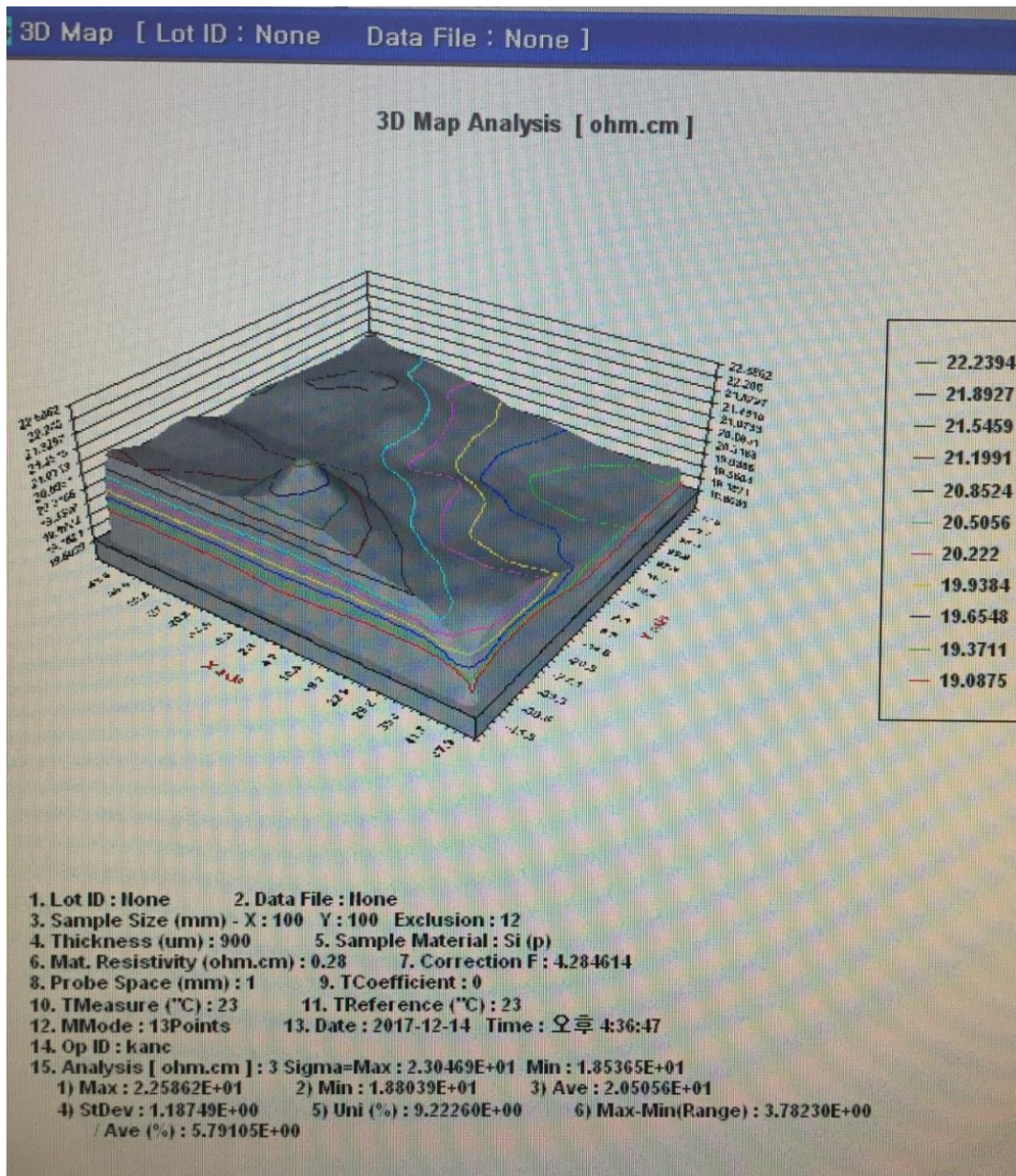
Contour Map [ Lot ID : None Data File : None ]

Contour Map Analysis [ ohm.cm ]



2.22394E+01  
2.18927E+01  
2.15459E+01  
2.11991E+01  
2.08524E+01  
2.05056E+01  
2.02220E+01  
1.99384E+01  
1.96548E+01  
1.93711E+01  
1.90875E+01

1. Lot ID : None  
2. Data File : None  
3. Sample Size (mm) - X: 100 Y: 100 Exclusion : 12  
4. Thickness (um) : 900  
5. Sample Material : Si (p)

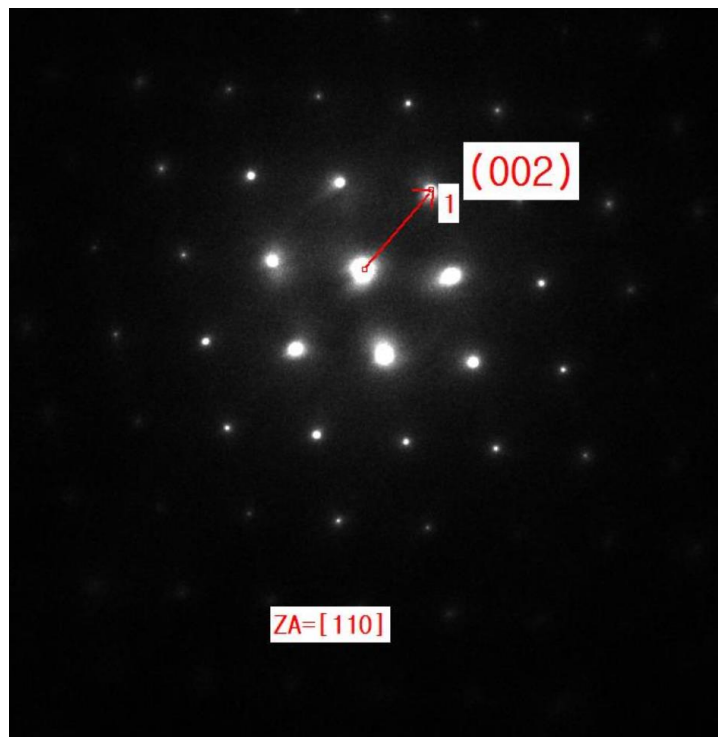
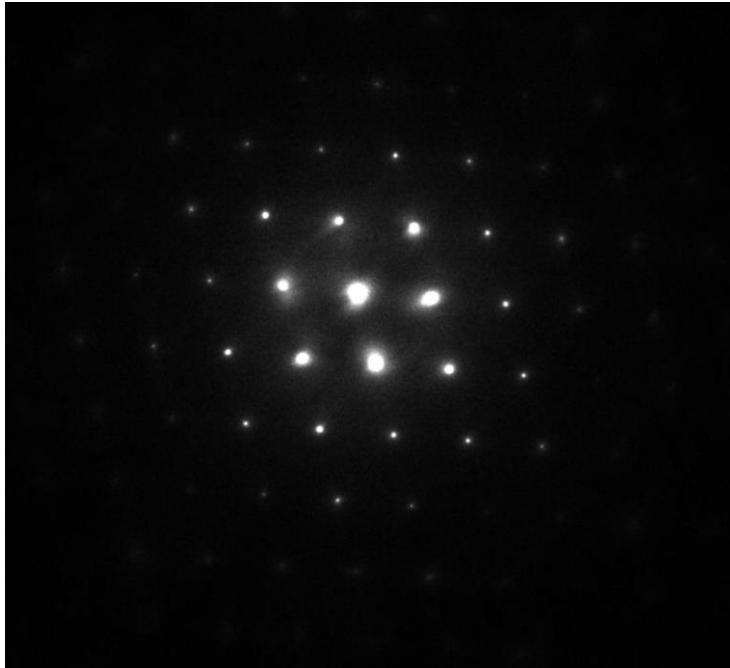


#### 9-4 Orientation Data

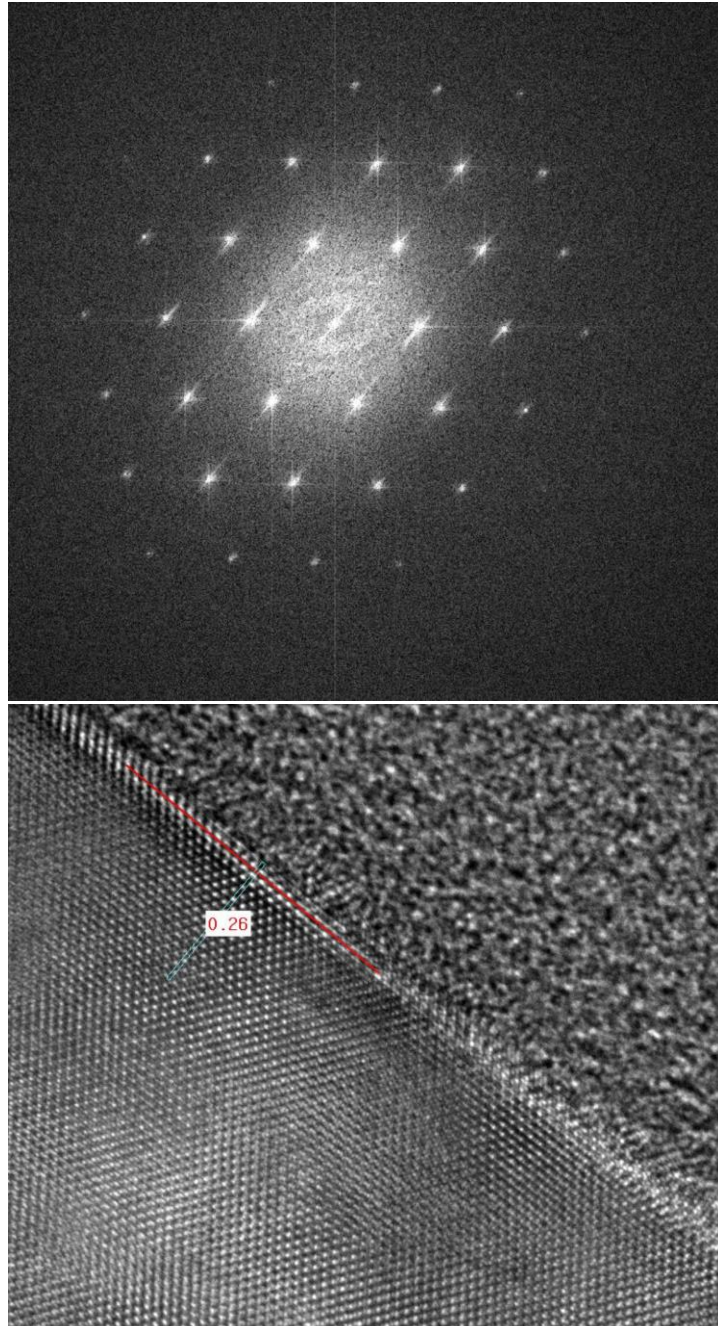
측정 장비 : TEM

측정 결과 : <100> 일치







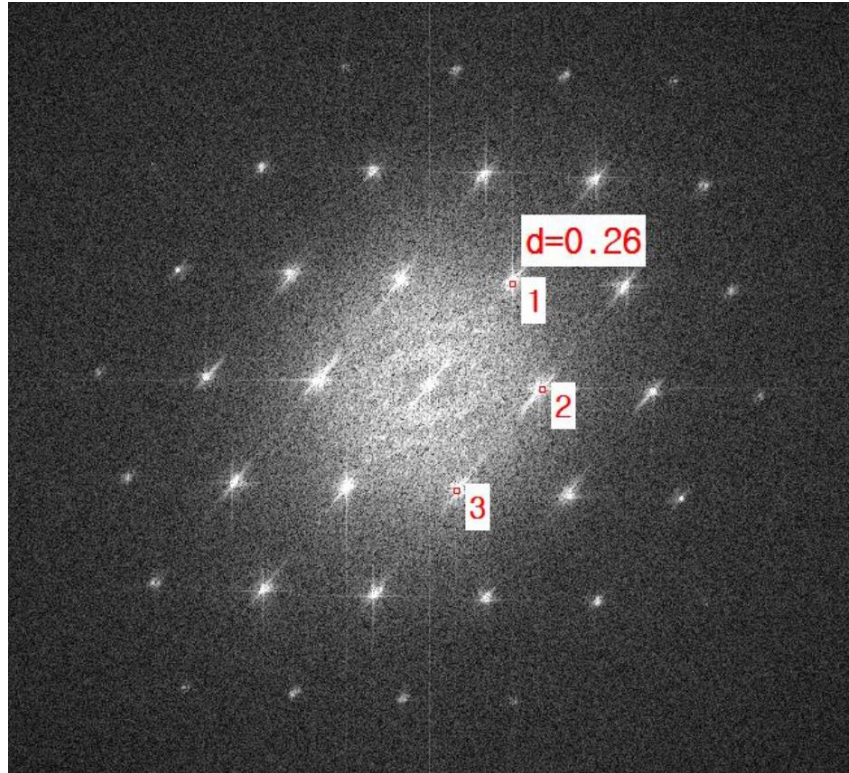


### [분석 추가 설명]

흰점이 실리콘 원자를 나타내는 것 초록색 길이가 원자 10 개가 배열된 길이를 잴 것이 그것을 10 으로 나뉘서 , 원자 한 개의 길이를 잴 것임

즉, 0.26nm 라는 얘기인데 그 정도 크기의 원자 크기가 <100> 일때의 값입니다

<111>의 경우 0.31 정도 나옴



## [ 결 론 ]

웨이퍼의 Particle 은 [0.2um@Max20ea](#) 이하로 스펙 관리되면 종종 Particle 이 좋은 웨이퍼가 나올 수도 있음

측정 결과 TEM 분석을 통해 <100>이 맞고, 두께는 900um 정도 나오며, 이정도 두께면 차후 Reclaim 이나 Coinroll wafer 로도 충분히 사용 가능함

저항 값은 20ohm.cm 가 나오고 표면 Roughness 는 5~6A 정도로 좋게 나옴

차후 타입은 측정을 더 해야함.

공정상에서는 고온 공정에서 표면의 변화 (산소 Swirl 이 나타나지 않음 ) 면의 변화가 없어서 Uniformity 도 잘 나오는 것으로 판단

Al 의 산화나 Haze 가 나오지 않음

더 필요한 측정 내용 : Type , TTV , Bow , Warpage

2017 년 12 월 21 일

(주) BUYSEMI 대표이사 김 원일





# 별첨 . 65nm Particle Spec 성적서

## CERTIFICATE OF QUALITY CONFORMANCE

Part Number :

Delivery Number : S201709260002

LOT STATISTICAL SUMMARY						
Lot Number :	70233075313					
Parameter	UOM	Customer Spec	Average	Standard Deviation	Minimum	Maximum
Crystal Orientation Tolerance	degrees	-1 to 1	0.0984	0.0284	0.0810	0.1430
Notch Orientation Tolerance	degrees	-2 to 2	-0.0390	0.0132	-0.0470	-0.0183
Diameter	mm	299.8 to 300.2	299.9992	0.0025	299.9949	300.0028
Thickness	um	765 to 785	773.0973	1.7275	769.5390	775.0930
Resistivity	Ohm-cm	8 to 22	11.0276	0.4582	10.4800	11.7900
Radial Resistivity Variation (RRG)	%	0 to 10	1.7328	1.5161	0.4300	3.7300
Oxygen Concentration	old ppma	Monitor	25.8865	1.7307	23.9913	27.6425
Carbon Concentration	ppma	0 to 0.5	0.0000	0.0000	0.0000	0.0000
TTV	um	0 to 2	0.2348	0.0713	0.1259	0.3858
Warp	um	0 to 35	8.7356	3.2444	4.9061	16.4063
Bow	um	0 to 15	2.7949	2.7471	0.0525	8.6704
LLS @ 65nm	ea/wafer	0 to 50	13.4400	9.0281	2	41
Surface Metal Al	E10at/cm2	0 to 1	0.1312	0.0382	0.0822	0.1817
Surface Metal Na	E10at/cm2	0 to 1	0.0317	0.0229	0.0116	0.0850
Surface Metal Ca	E10at/cm2	0 to 1	0.0220	0.0197	0.0067	0.0618
Surface Metal Zn	E10at/cm2	0 to 1	0.0074	0.0078	0.0025	0.0320
Surface Metal Cu	E10at/cm2	0 to 1	0.0523	0.0525	0.0226	0.2135
Surface Metal Fe	E10at/cm2	0 to 1	0.0500	0.0834	0.0011	0.4420
Surface Metal Ni	E10at/cm2	0 to 1	0.0103	0.0097	0.0016	0.0252
Surface Metal Cr	E10at/cm2	0 to 1	0.0038	0.0000	0.0038	0.0038
Surface Metal K	E10at/cm2	0 to 1	0.0243	0.0224	0.0113	0.0730

LOT STATISTICAL SUMMARY						
Lot Number :	70234075307					
Parameter	UOM	Customer Spec	Average	Standard Deviation	Minimum	Maximum
Crystal Orientation Tolerance	degrees	-1 to 1	0.1207	0.0304	0.0810	0.1430
Notch Orientation Tolerance	degrees	-2 to 2	-0.0286	0.0141	-0.0470	-0.0183
Diameter	mm	299.8 to 300.2	299.9982	0.0033	299.9927	300.0012
Thickness	um	765 to 785	775.0875	0.4203	774.0690	775.5690
Resistivity	Ohm-cm	8 to 22	11.2688	0.4520	10.4800	11.7900
Radial Resistivity Variation (RRG)	%	0 to 10	1.1064	1.2454	0.4300	3.7300
Oxygen Concentration	old ppma	Monitor	25.9759	1.5683	23.9913	27.6425
Carbon Concentration	ppma	0 to 0.5	0.0000	0.0000	0.0000	0.0000
TTV	um	0 to 2	0.2378	0.0840	0.0876	0.3775
Warp	um	0 to 35	10.6882	3.4854	5.6832	19.1532
Bow	um	0 to 15	4.3161	2.8944	0.0584	11.0465
LLS @ 65nm	ea/wafer	0 to 50	14.9600	7.8660	5	36
Surface Metal Al	E10at/cm2	0 to 1	0.1288	0.0218	0.1193	0.1778
Surface Metal Na	E10at/cm2	0 to 1	0.0528	0.0176	0.0241	0.0653
Surface Metal Ca	E10at/cm2	0 to 1	0.0463	0.0211	0.0161	0.0618
Surface Metal Zn	E10at/cm2	0 to 1	0.0134	0.0082	0.0023	0.0194
Surface Metal Cu	E10at/cm2	0 to 1	0.0969	0.0521	0.0252	0.1351
Surface Metal Fe	E10at/cm2	0 to 1	0.0402	0.0076	0.0260	0.0449
Surface Metal Ni	E10at/cm2	0 to 1	0.0043	0.0016	0.0032	0.0074
Surface Metal Cr	E10at/cm2	0 to 1	0.0045	0.0015	0.0038	0.0075
Surface Metal K	E10at/cm2	0 to 1	0.0500	0.0313	0.0074	0.0730