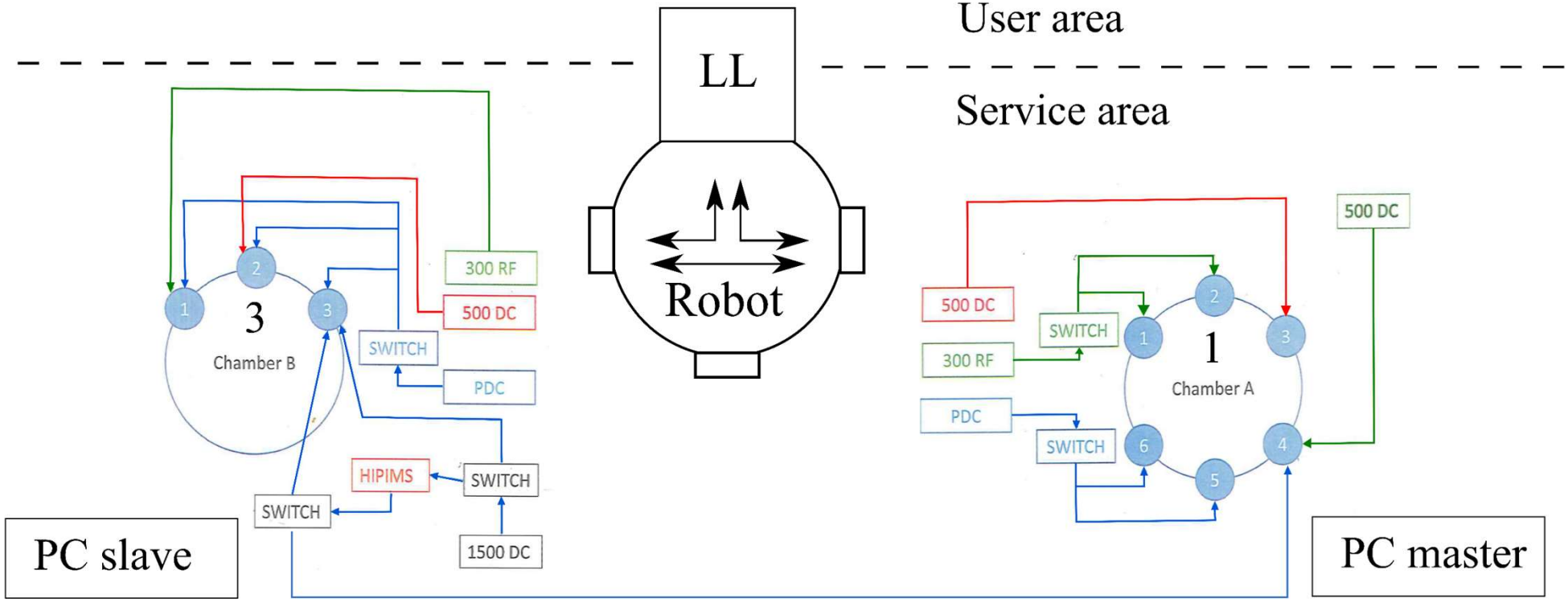
Cluster-based multi-chamber high vacuum sputtering deposition system

Acceptance test. DTU Nanolab, 13-24 January 2020


User area
LL
Service area
Robot
3
Chamber B
1
2
3
300 RF
500 DC
SWITCH
PDC
HIPIMS
SWITCH
SWITCH
1500 DC
1
Chamber A
1
2
3
4
5
6
500 DC
SWITCH
300 RF
PDC
SWITCH
500 DC
PC slave
PC master

13 January Monday

- Al DC manual deposition PC1
- Al DC recipe run PC1
- Al DC cassette recipe 6 wafers PC1 (overnight)

14 January Tuesday

- Al recipe run PC3
- AlN reactive p-DC PC3 with RF bias on substrate **XPS**
- Al DC cassette recipe 6 wafers PC3 (overnight)
- RF clean PC1
- RF clean PC3
- ITO RF failed unstable bias
- Heat courve PC1 failed (overnight)

15 January Wednesday

- AlN reactive p-DC PC3 with RF bias on substrate (uniform) **XPS**
- AlN rective p-DC PC3 without RF bias on substrate (nonuniform) **XPS**
- ITO p-DC manual PC1
- ITO p-DC cassette recipe 6 wafers PC1 (overnight) **XPS (3'rd wafer)**
- SiO2 RF cassette recipe 2 wafers PC1 (overnight) src1-not uniform, src2-uniform **XPS, SE**
- Heat courve PC3 failed (overnight)

16 January Thursday

- Ni DC PC1
- ITO p-DC after substrate holder adjustement (unsufficient uniformity of ITO cassette run from 15.01.2020)
- SiO2 RF cassette recipe. Src1 failed. Unstable bias. Src2 failed. Miscommunication with HIPIMS from PC3 (no deposition)
- Cu HiPIMS PC3 src3 recipe run
- Ni DC cassette recipe PC1 (noticed no rotation –accidental cancel), (overnight)
- Cu DC cassette recipe PC1 (overnight)
- Heat courve PC3 failed (overnight, software issue)

17 January Friday

- Heat courve test up to 100C
- RF test. Change of dark space shield in PC1 and test on 4'' Al in PC3.
- AlN p-DC reactive in PC3. 900W triple the power, reduced 3 times dep. time. 15 N2 MFC2 **XPS**
- SiO2 RF PC1 src1. Cassette recipe **SE**
- SiO2 RF PC1 src2. Cassette recipe **SE**
- Ni DC PC1. Cassette recipe

18-19 January Weekend

- 24 hours pump test
- Heat courve in PC1&PC3
- ITO batch PC1

20 January Monday

- Cu DC in PC3
- Manual HiPIMS Cu in PC1
- SiO2 RF src2 **SE**
- AlN batch without bias in PC3 p-DC Reactive. Cassette recipe (overnight). Came out with bad uniformity. **XPS**

21 January Tuesday

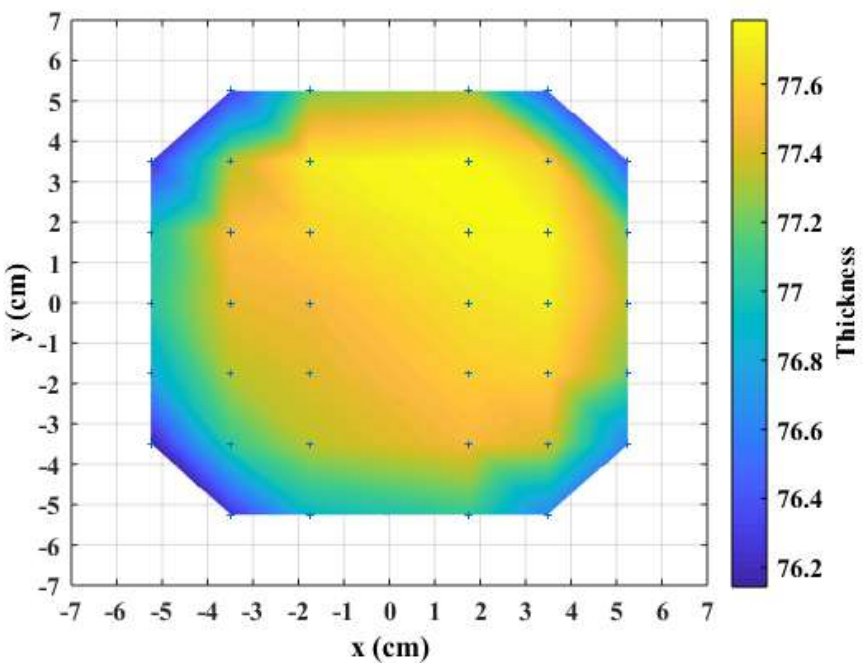
- HiPIMS Cu on Si trench PC1 (recipe)
- HiPIMS Cu on Si trench PC3 (recipe) **XPS**
- AlN quick test to improve deposition
- AlN batch (overnight)

22-24 January Wednesday-Friday

- AlN testing. Adjusting the position for AlN target to get uniformity from 6-8% down to 3%
- Co deposition tests in PC3 and PC1
- HiPIMS tests in PC1 and PC3 in manual and automatic mode and with co-deposition
- Residual gas analysis in PC3

SiO2 RF deposition 15 01 2020

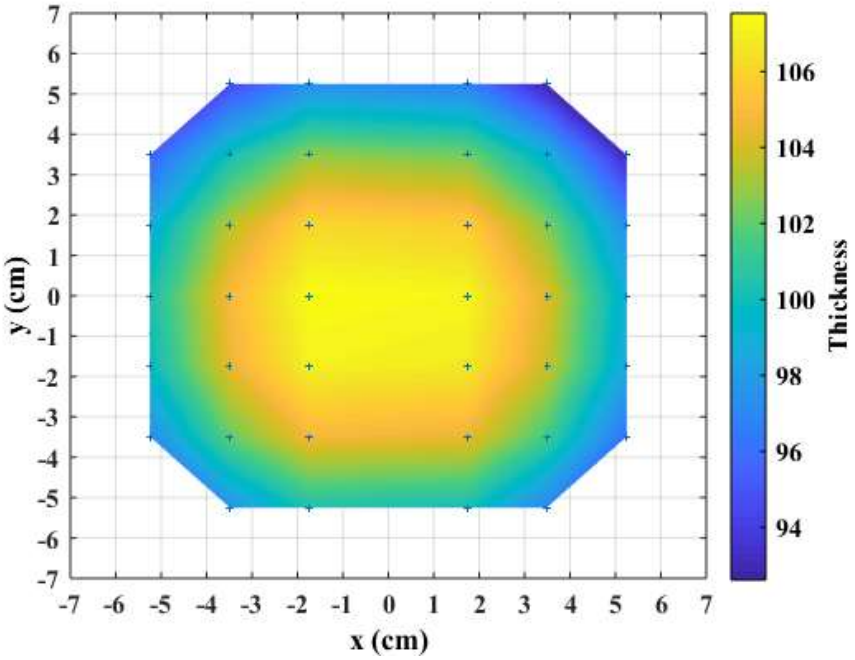
procent deviation of the thickness: 1.0636 %
mean value of thickness: 77.1778 nm
standart deviation: 0.49334



Src 1 PC1

We observed unstable RF bias!

procent deviation of the thickness: 7.4015 %
mean value of thickness: 100.8372 nm
standart deviation: 4.1588



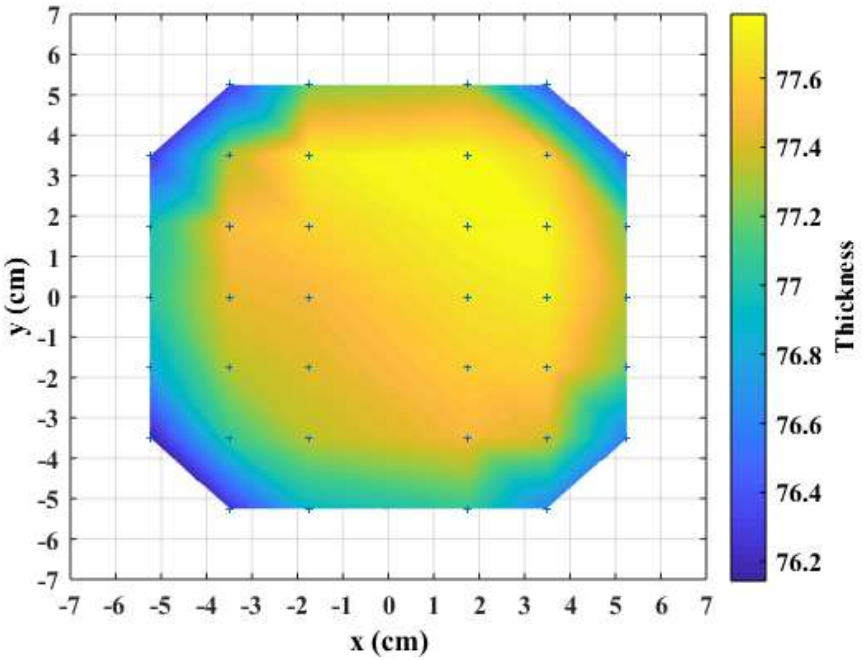
Src 2 PC1

SiO2 RF deposition 17 01 2020

scr1

RF bias issues fixed

scr2



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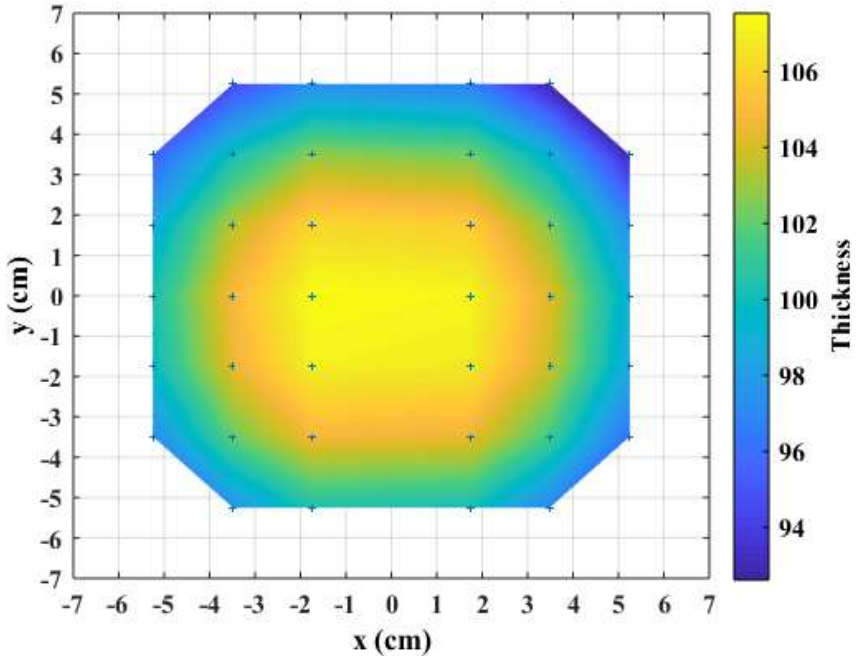

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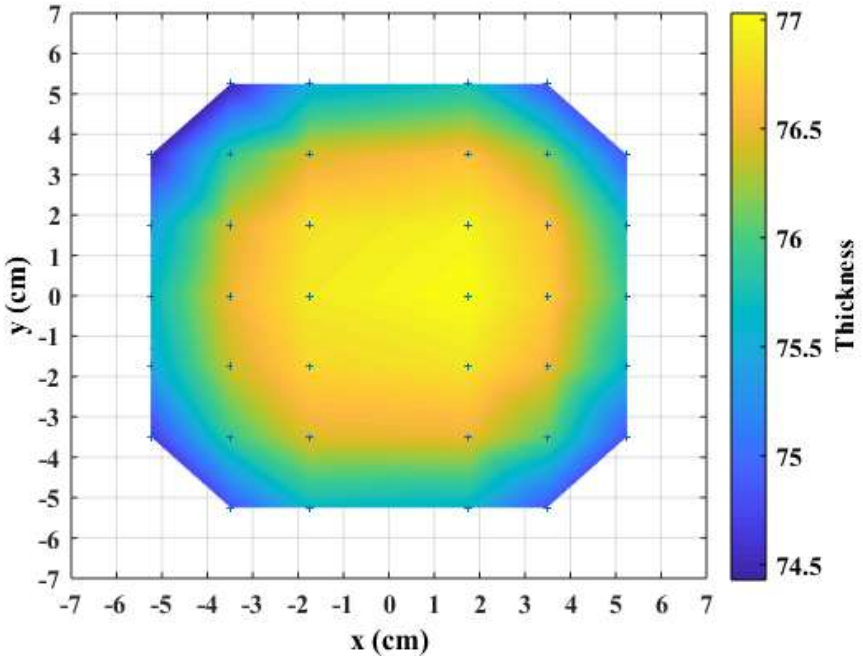
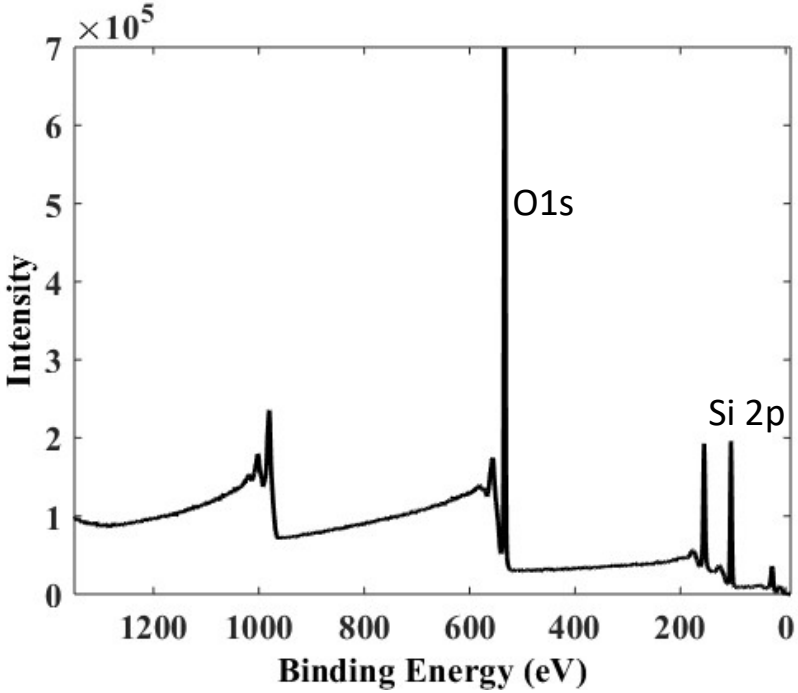
SiO2 RF deposition 20 01 2020

PC1 src2 position adjusted

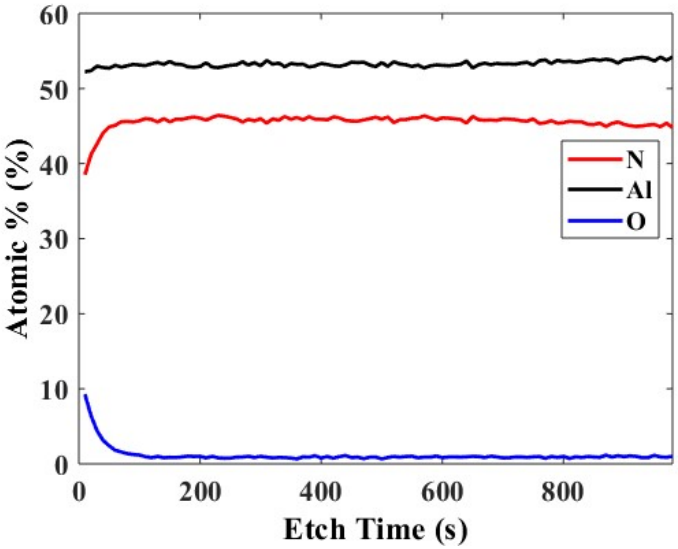


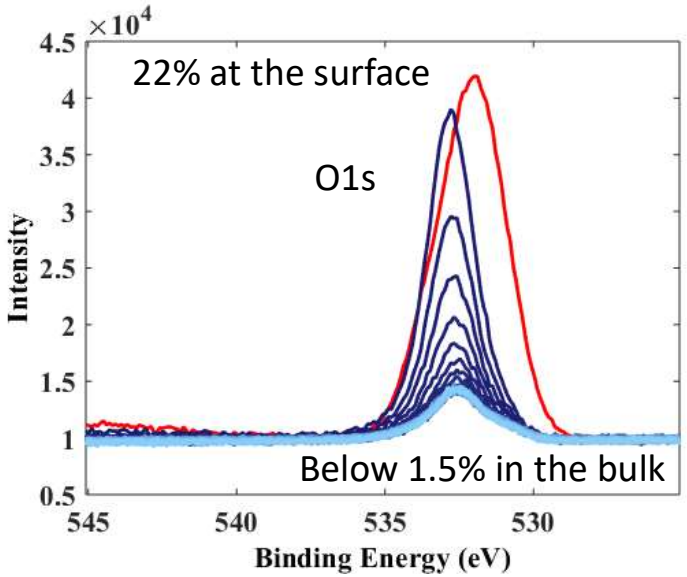


procent deviation of the thickness: 1.7125 %
mean value of thickness: 75.909 nm
standart deviation: 0.78878

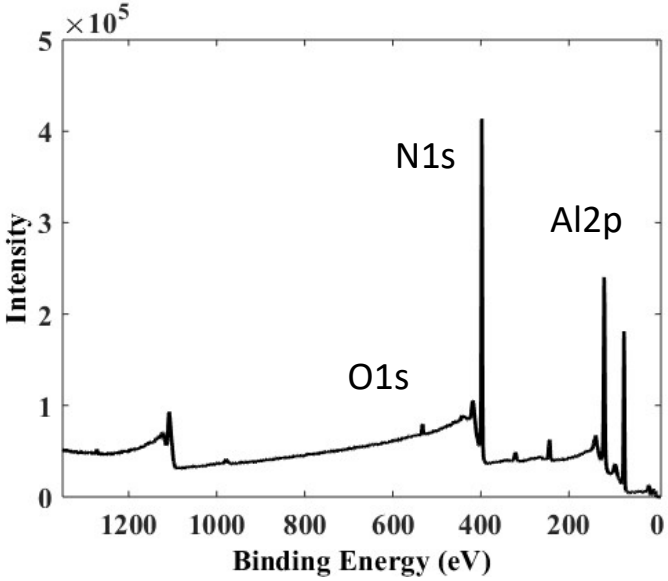
XPS results 15.01.2020

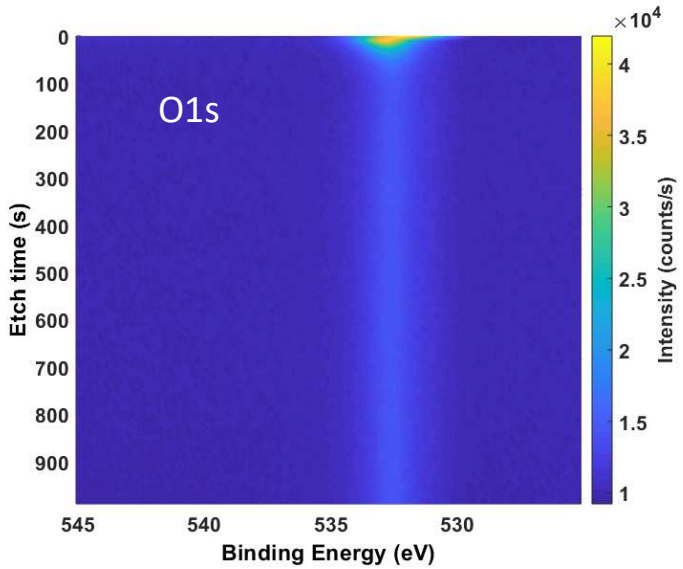
sample	AL	N	O	In	Sn	Si
AlN reactive p-DC PC3 with RF bias on substrate 14.01.2020 center/edge	48.38/49.83	37.22/42.04	14.40/8.13			
AlN reactive p-DC PC3 with RF bias on substrate 15.01.2020	47.91	35.50	16.59			
AlN rective p-DC PC3 without RF bias on substrate 15.01.2020 center/edge	46.96/46.87	30.51/32.38	22.53/20.75			
ITO p-DC cassette recipe (3rd wafer) 15.01.2020 PC1			58.41	38.59	2.99	
SiO2 RF cassette recipe PC1 15.01.2020 src1/src2			63.87/64.51		! (surface signal in src2)	35.44/35.49

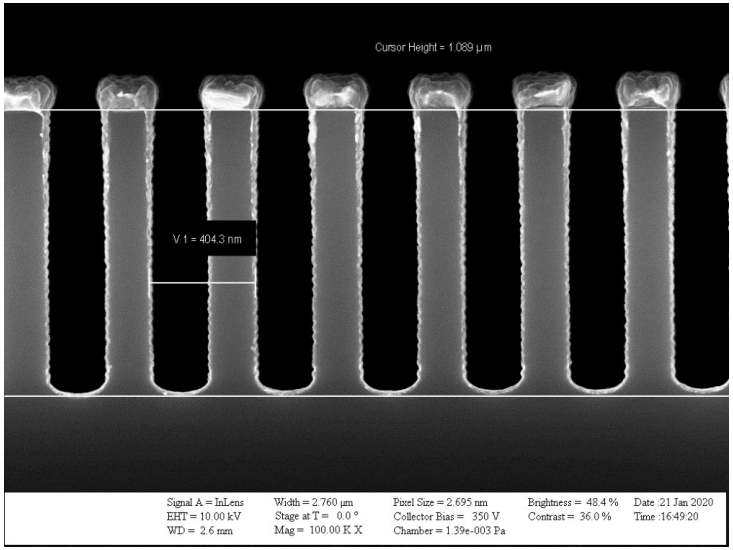


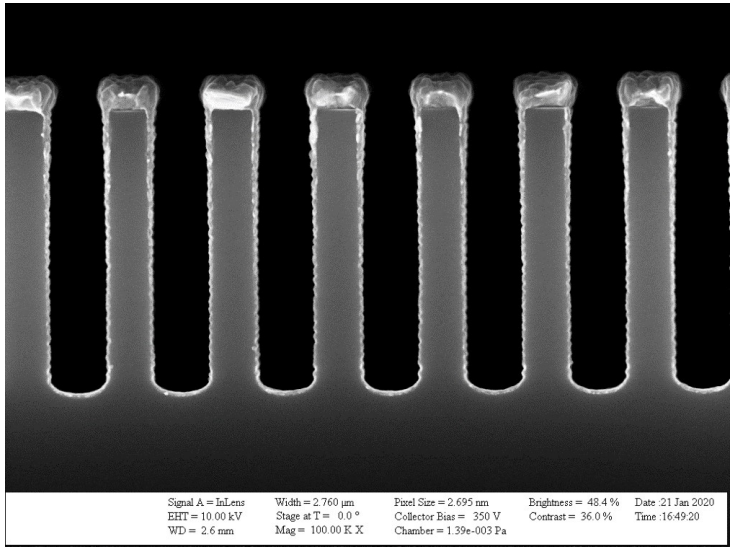


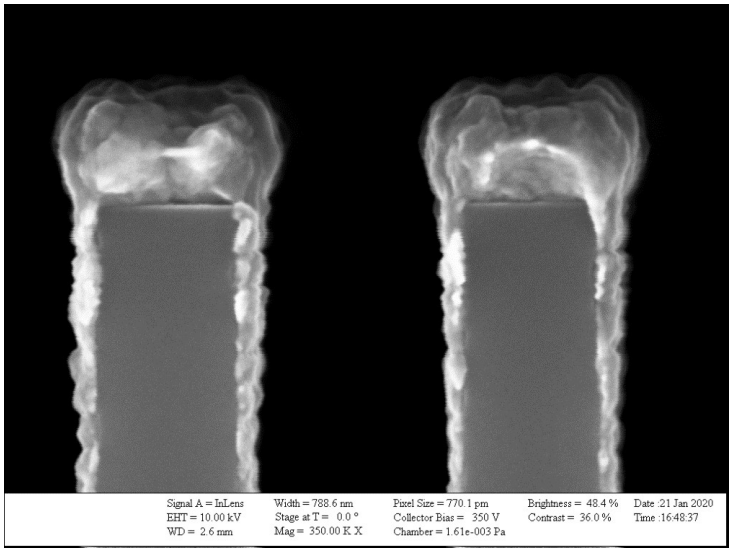
XPS analysis of AlN
Deposited 17 01 2020

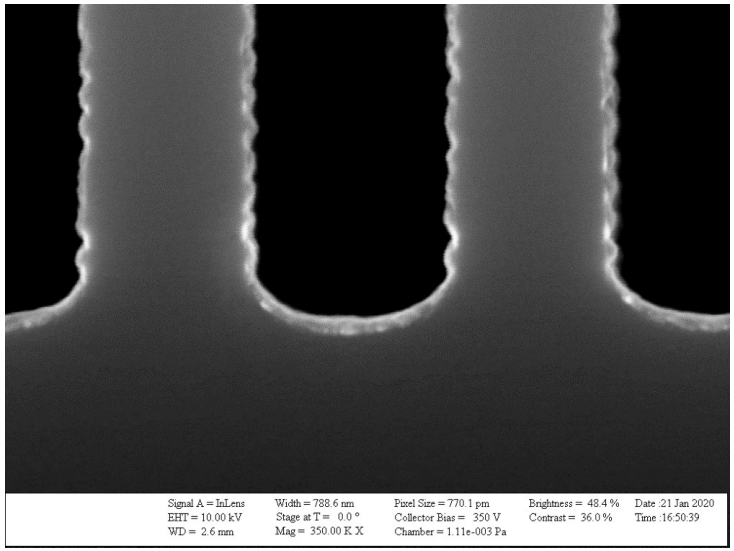






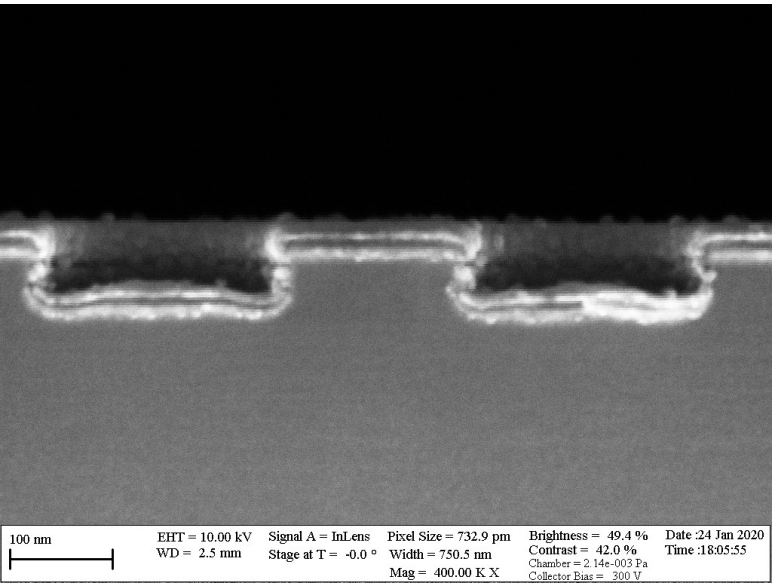


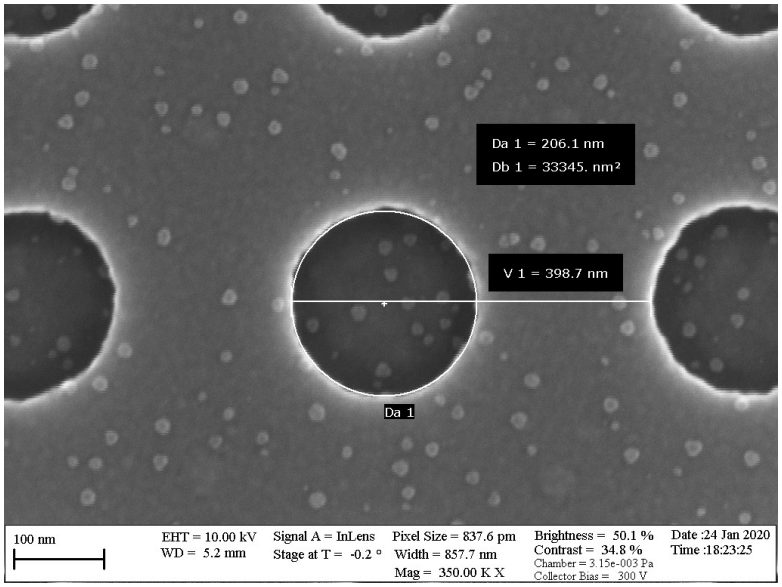


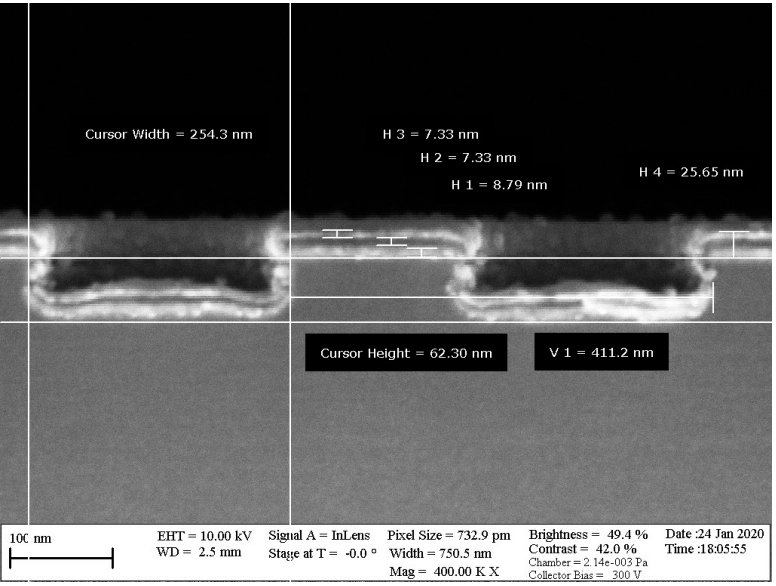


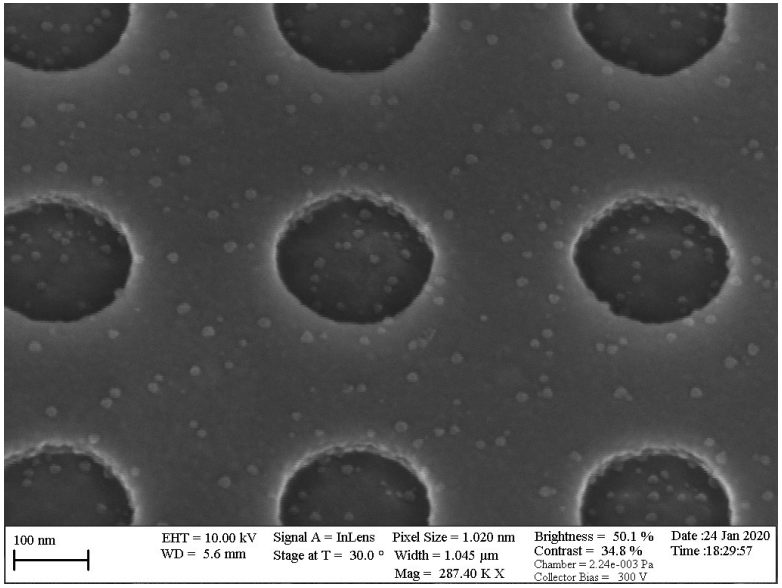
Cu HiPIMS on Si trench

Depth of trench: 1 µm
Period: 400 nm









CuAl/SiO2/CuAl coating on shallow holes etched in Si.
Cu HiPIMS co-deposited with Al DC

Source/recipe name	Material	Pressure(mTorr)	Power (W)	Voltage(V)	Deposition time (Sec)	Thickness (nm) at the center	Unifomity (%)	Comments
1/MD PC1 Src1 RF Upstream	SiO2	3	140(RF)	590	900	35,62	0,5	
2/MD PC1 Src2 RF Upstream	SiO2	3	140(RF)	588	900	40,77	3	
3/MD PC1 Src3 DC Upstream	Ni	3	500(DC)	420	900	350	2,5	
4/MD PC1 Src4 DC Upstream	Cu	3	500(DC)	463	900	783	2,2	
5/MD PC1 Src5 DC	Al	3	200(DC)	373	300	40	-	
5/MD PC1 Src5 Pulse DC Downstream with Reactive O2 gas	Al	3	500(PDC) Frequency: 100Hz Revers time: 2µs	283	900	25	-	n=1,66
6/MD PC1 Src6 Pulse DC Upstream	ITO	3	140(PDC) Frequency: 100Hz Revers time: 2µs	354	900	175	4,5	