CyMOS process
Spring 2016
Iowa State University

Start Date ________________________________

Starting Material

Orientation: ______________

Dopant: ______________

Resistivity: ______________ Ω•cm

Doping Concentration: ______________ cm^{-3}

Diameter: ______________ inch

Thickness: ______________ μm

Lot Identification: ______________

Wafer Count

Device wafers: ______________

Test wafers: ______________

TW1	TW2	TW3	TW4	CMOS

1. Field Oxide Date ______________ Name____________________

Oxidize all device wafers and all test wafers.

Standard Clean *Use plastic tweezers after cleaning wafers*

- ☐ SC-1: 15 minutes at 80°C
  2500 ml DI H_2O + 500 ml NH_4OH + 500 ml H_2O_2
- ☐ Cascade rinse: 3 minutes
- ☐ HF dip: 15 seconds in 50:1 HF
- ☐ Cascade rinse: 1 minute
- ☐ SC-2: 15 minutes at 80°C
  3000 ml DI H_2O + 500 ml HCl + 500 ml H_2O_2
- ☐ Cascade rinse: 3 minutes
- ☐ Spin rinse/dry

Wet Oxidation *Use plastic tweezers*

☐ Push:	Ambient:	1 slpm dry N_2
	Temperature:	800°C
	Rate:	1 inch every 12 seconds
☐ Ramp up:	Ambient:	1 slpm dry N_2
	Final temperature:	__________°C
	Elapsed time:	__________
☐ Bubbler on:	Temperature:	__________°C
	Bubbler N_2:	200 sccm—switch to vent
☐ Oxidation:	Ambient:	200 sccm bubbler N_2 — switch to tube
Temperature:	__________°C	
	Time:	__________
☐ Bubbler off:	Power:	off
	Bubbler N_2:	off — switch to vent
☐ Ramp down:	Ambient:	1 slpm dry N_2
	Final temperature:	800°C
	Elapsed time:	__________
☐ Pull:	Ambient:	1 slpm dry N_2
	Temperature:	800°C
	Rate:	1 inch every 12 seconds

Measure oxide thickness TW1 ____________________ TW2 ____________________.

TW3 ____________________ TW4 ____________________.

2. pattern for p-well Date ____________ Name____________________

Use CMOS mask level 1

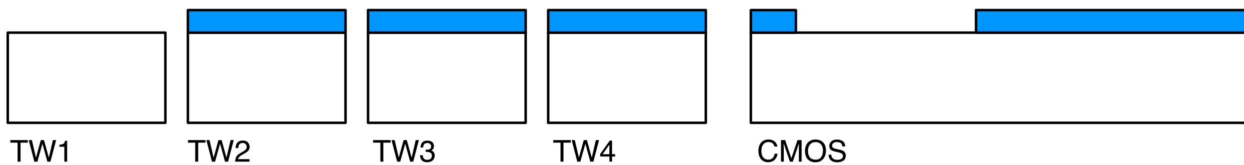
Pattern and etch all device wafers. Do not do any lithography on the test wafers. Use TW1 *only* for etch rate calibration. Do not etch any of the other test wafers.

Pattern Photoresist *Use metal tweezers*

- ☐ Spin HMDS: 4000 rpm for 25 seconds
- ☐ Spin photoresist: _____________ photoresist: __________rpm for __________seconds
- ☐ Prebake: __________°C for ____________minutes
- ☐ Expose: __________seconds
- ☐ Develop: MIF-300 developer for __________seconds
- ☐ Cascade rinse: 3 minutes
- ☐ Dry:
- ☐ Inspect:
- ☐ Postbake: __________°C for ____________minutes

SiO_2 Etch & Photoresist Strip *Use metal tweezers*

- ☐ BOE: __________ minutes
- ☐ Cascade rinse: 2 minutes
- ☐ Acetone #1: 3 minutes
- ☐ Acetone #2: 1 minutes
- ☐ Methanol: 1 minute
- ☐ Cascade rinse: 2 minutes
- ☐ Spin rinse/dry:



3. Boron deposition for pwell   Date __________ Name _____________

Deposit boron on all device wafers and on TW1. Do the standard clean on the other test wafers, but do not put them into the furnace.

Standard Clean *Use plastic tweezers after cleaning wafers*

☐	SC-1:	15 minutes at 80°C 2500 ml DI H_2O + 500 ml NH_4OH + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	HF dip:	15 seconds in 50:1 HF
☐	Cascade rinse:	1 minute
☐	SC-2:	15 minutes at 80°C 3000 ml DI H_2O + 500 ml HCl + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	Spin rinse/dry	

Boron Deposition *Use plastic tweezers*

☐	Push	Ambient:	2 slpm dry N_2
		Temperature:	850°C
		Rate:	1 inch every 12 seconds
☐	Recovery	Ambient:	1 lpm N_2 + 1 lpm O_2
		Temperature:	850°C
		Time:	20 minutes
☐	Source	Ambient:	1 lpm N_2 + 1 lpm O_2 + 40 sccm H_2
		Temperature:	850°C
		Time:	2 minutes
☐	Soak	Ambient:	2 lpm N_2
		Temperature:	__________°C
		Time:	__________
☐	Pull	Ambient:	2 lpm N_2
		Temperature:	850°C
		Rate:	1 inch every 12 seconds

Deglaze

☐	BOE:	30 seconds
☐	Cascade rinse:	3 minutes
☐	Spin rinse/dry	

4. p-well drive

Date ______________ Name___________________

Perform the drive on all device wafers and all test wafers.
(The standard clean can be omitted if going directly from deposition to drive.)

Standard Clean *Use plastic tweezers after cleaning wafers*

	Step	Details
☐	SC-1:	15 minutes at 80°C 2500 ml DI H_2O + 500 ml NH_4OH + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	HF dip:	15 seconds in 50:1 HF
☐	Cascade rinse:	1 minute
☐	SC-2:	15 minutes at 80°C 3000 ml DI H_2O + 500 ml HCl + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	Spin rinse/dry	

P-Well Low-Temperature Oxidation (LTO) and Boron Drive *Use plastic tweezers*

	Step	Parameter	Value
☐	Bubbler on:	Temperature:	98°C
		Bubbler N_2:	200 sccm—switch to vent
☐	Push:	Ambient:	1 slpm dry N_2
		Temperature:	800°C
		Rate:	1 inch every 12 seconds
☐	LTO:	Ambient:	200 sccm bubbler N_2 Bubbler switch to tube
		Temperature:	800°C
		Time:	30 minutes
☐	Bubbler off:	Power:	off
	(if not used further)	Bubbler N_2:	off — switch to vent
☐	Pull:	Ambient:	1 slpm dry N_2
		Temperature:	800°C
		Rate:	1 inch every 12 seconds
☐	Deglaze: BOE	30 seconds	
☐	Cascade rinse:	3 minutes	
☐	Spin rinse/dry		
☐	Push:	Ambient:	1 slpm dry N_2
		Temperature:	800°C

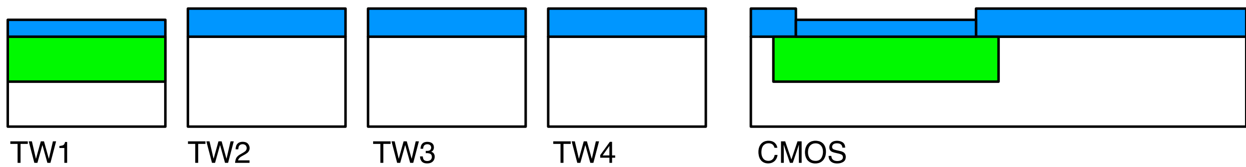
☐ Ramp up:	Ambient:	1 slpm dry N_2
	Final temperature:	__________°C
	Elapsed time:	__________
☐ Oxidation:	Ambient:	__________
	Temperature:	__________°C
	Time:	__________
☐ Drive:	Ambient:	__________
	Temperature:	__________°C
	Time:	__________
☐ Ramp down:	Ambient:	1 slpm dry N_2
	Final temperature:	800°C
	Elapsed time:	__________
☐ Pull:	Ambient:	1 slpm dry N_2
	Temperature:	800°C
	Rate:	1 inch every 12 seconds

Measure oxide thickness TW1 ____________________________________.

TW2 ____________________________________.

TW3 ____________________________________.

TW4 ____________________________________.



5. Pattern for PMOS source/drain Date ___________ Name_______________

Use CMOS mask level 2

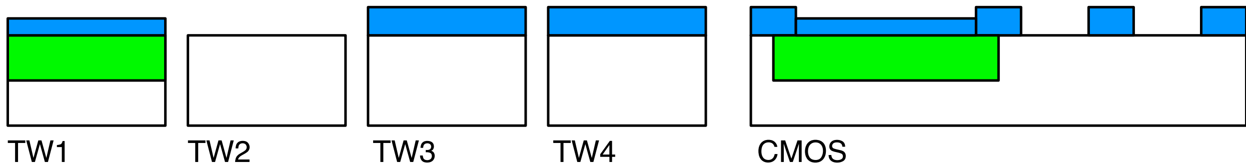
Pattern and etch all device wafers. Do not do any lithography on the test wafers. Use TW2 *only* for etch rate calibration. Do not etch TW1 or TW3

Pattern Photoresist *Use metal tweezers*

- ☐ Spin HMDS: 4000 rpm for 25 seconds
- ☐ Spin photoresist: ____________ photoresist: _________rpm for _________seconds
- ☐ Prebake: _________°C for ___________minutes
- ☐ Expose: _________seconds
- ☐ Develop: MIF-300 developer for _________seconds
- ☐ Cascade rinse: 3 minutes
- ☐ Dry:
- ☐ Inspect:
- ☐ Postbake: _________°C for ___________minutes

SiO_2 Etch & Photoresist Strip *Use metal tweezers*

- ☐ BOE: _________ minutes
- ☐ Cascade rinse: 2 minutes
- ☐ Acetone #1: 3 minutes
- ☐ Acetone #2: 1 minutes
- ☐ Methanol: 1 minute
- ☐ Cascade rinse: 2 minutes
- ☐ Spin rinse/dry:



6. Boron dep. for PMOS source/drain Date __________ Name _____________

Deposit boron on all device wafers and on TW2. Do the standard clean on the other test wafers, but do not put them into the furnace.

Standard Clean *Use plastic tweezers after cleaning wafers*

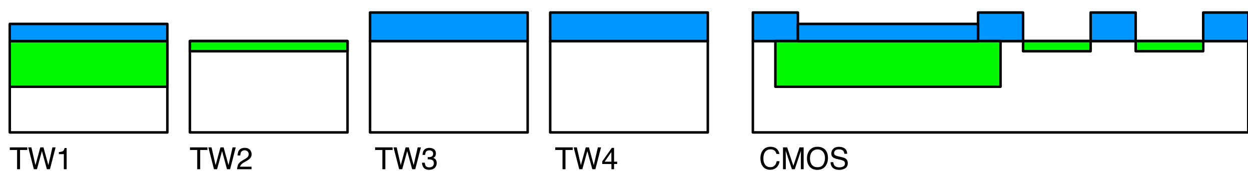
☐ SC-1:	15 minutes at 80°C 2500 ml DI H_2O + 500 ml NH_4OH + 500 ml H_2O_2
☐ Cascade rinse:	3 minutes
☐ HF dip:	15 seconds in 50:1 HF
☐ Cascade rinse:	1 minute
☐ SC-2:	15 minutes at 80°C 3000 ml DI H_2O + 500 ml HCl + 500 ml H_2O_2
☐ Cascade rinse:	3 minutes
☐ Spin rinse/dry	

Boron Deposition *Use plastic tweezers*

☐ Push	Ambient:	2 slpm dry N_2
	Temperature:	850°C
	Rate:	1 inch every 12 seconds
☐ Recovery	Ambient:	1 lpm N_2 + 1 lpm O_2
	Temperature:	850°C
	Time:	20 minutes
☐ Source	Ambient:	1 lpm N_2 + 1 lpm O_2 + 40 sccm H_2
	Temperature:	850°C
	Time:	2 minutes
☐ Soak	Ambient:	2 lpm N_2
	Temperature:	__________°C
	Time:	__________
☐ Pull	Ambient:	2 lpm N_2
	Temperature:	850°C
	Rate:	1 inch every 12 seconds

Deglaze

☐ BOE:	30 seconds
☐ Cascade rinse:	3 minutes
☐ Spin rinse/dry	



7. Boron drive

Date ______________ Name____________________

Perform the boron on all device wafers and all test wafers.
(The standard clean can be omitted if going directly from deposition to drive.)

Standard Clean *Use plastic tweezers after cleaning wafers*

- ☐ SC-1: 15 minutes at 80°C
  2500 ml DI H_2O + 500 ml NH_4OH + 500 ml H_2O_2
- ☐ Cascade rinse: 3 minutes
- ☐ HF dip: 15 seconds in 50:1 HF
- ☐ Cascade rinse: 1 minute
- ☐ SC-2: 15 minutes at 80°C
  3000 ml DI H_2O + 500 ml HCl + 500 ml H_2O_2
- ☐ Cascade rinse: 3 minutes
- ☐ Spin rinse/dry

P-Well Low-Temperature Oxidation (LTO) and Boron Drive *Use plastic tweezers*

Step	Parameter	Value
☐ Bubbler on:	Temperature:	98°C
	Bubbler N_2:	200 sccm—switch to vent
☐ Push:	Ambient:	0.3 slpm dry N_2
	Temperature:	800°C
	Rate:	1 inch every 12 seconds
☐ LTO:	Ambient:	200 sccm bubbler N_2 Bubbler switch to tube
	Temperature:	800°C
	Time:	30 minutes
☐ Bubbler off:	Power:	off
(if not used further)	Bubbler N_2:	off — switch to vent
☐ Pull:	Ambient:	0.3 slpm dry N_2
	Temperature:	800°C
	Rate:	1 inch every 12 seconds
☐ Deglaze: BOE	30 seconds	
☐ Cascade rinse:	3 minutes	
☐ Spin rinse/dry		
☐ Push:	Ambient:	1 slpm dry N_2
	Temperature:	800°C
	Rate:	1 inch every 12 seconds

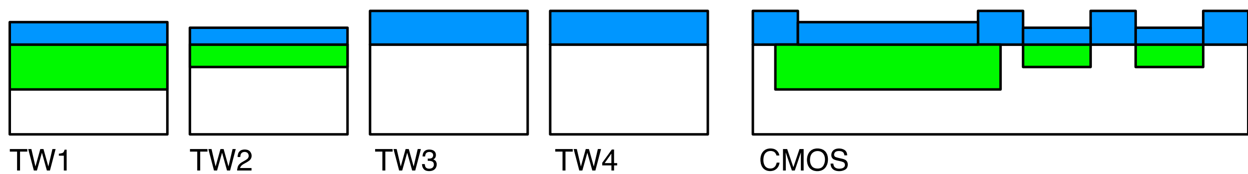
☐ Ramp up:	Ambient:	1 slpm dry N_2
	Final temperature:	___________°C
	Elapsed time:	___________
☐ Oxidation:	Ambient	___________
	Temperature:	___________°C
	Time:	___________
☐ Drive:	Ambient:	___________
	Temperature:	___________°C
	Time:	___________
☐ Ramp down:	Ambient:	1 slpm dry N_2
	Final temperature:	800°C
	Elapsed time:	___________
☐ Pull:	Ambient:	1 slpm dry N_2
	Temperature:	800°C
	Rate:	1 inch every 12 seconds

Measure oxide thickness TW1 ____.

TW2 ____.

TW3 ____.

TW4 ____.



8. pattern for NMOS source/drain Date ____________ Name________________

Use CMOS mask level 3
Pattern and etch all device wafers. Do not do any lithography on the test wafers. Use TW3 for for etch rate calibration. Also etch TW1. Do not etch TW2 or TW4. (Although TW1 has the same oxide thickness as the NMOS source and drain regions, it is also necessary to etch the body contact regions for the PMOS transistors. Therefore, TW3 is the correct calibration wafer.)

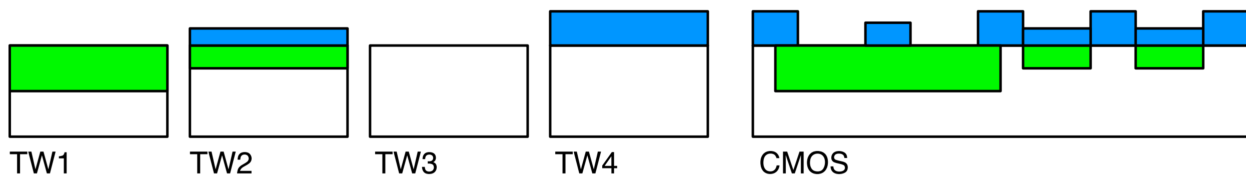
Pattern Photoresist *Use metal tweezers*

- ☐ Spin HMDS: 4000 rpm for 25 seconds
- ☐ Spin photoresist: _____________ photoresist: __________rpm for __________seconds
- ☐ Prebake: __________°C for ____________minutes
- ☐ Expose: __________seconds
- ☐ Develop: MIF-300 developer for __________seconds
- ☐ Cascade rinse: 3 minutes
- ☐ Dry:
- ☐ Inspect:
- ☐ Postbake: __________°C for ____________minutes

SiO_2 Etch & Photoresist Strip *Use metal tweezers*

- ☐ BOE: __________ minutes
- ☐ Cascade rinse: 2 minutes
- ☐ Acetone #1: 3 minutes
- ☐ Acetone #2: 1 minutes
- ☐ Methanol: 1 minute
- ☐ Cascade rinse: 2 minutes
- ☐ Spin rinse/dry:

Measure sheet resistance: TW1 ____________________________________.



Note: TW3 can be retired after this step.

9. Phosphorus deposition   Date ___________ Name____________________

Deposit phosphorus glass on all device wafers and TW1. The other test wafers, but do not include them in the deposition. TW3 is no longer needed and has been retired.

Standard Clean *Use plastic tweezers after cleaning wafers*

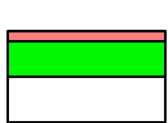
☐	SC-1:	15 minutes at 80°C 2500 ml DI H_2O + 500 ml NH_4OH + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	HF dip:	15 seconds in 50:1 HF
☐	Cascade rinse:	1 minute
☐	SC-2:	15 minutes at 80°C 3000 ml DI H_2O + 500 ml HCl + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	Spin rinse/dry	

Phosphorus Deposition *Use plastic tweezers*

☐	Push:	Ambient:	1 lpm N_2
		Temperature:	900°C
		Rate:	1 inch every 12 second
☐	Source:	Ambient:	1 lpm N_2
		Temperature:	900°C
		Time:	__________ minutes
☐	Pull:	Ambient:	1 lpm N_2
		Temperature:	900°C
		Rate:	1 inch every 12 seconds

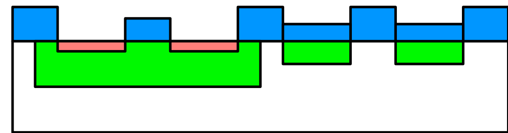
Deglaze

☐	BOE:	30 seconds
☐	Cascade rinse:	3 minutes
☐	Spin rinse/dry:	


TW1

TW2

TW4


CMOS

10. Phosphorus drive Date ___________ Name____________________

Include all device and test wafers in the drive.
(The standard clean can be omitted if going directly from deposition to drive.)

Standard Clean *Use plastic tweezers after cleaning wafers*

☐	SC-1:	15 minutes at 80°C 2500 ml DI H_2O + 500 ml NH_4OH + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	HF dip:	15 seconds in 50:1 HF
☐	Cascade rinse:	1 minute
☐	SC-2:	15 minutes at 80°C 3000 ml DI H_2O + 500 ml HCl + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	Spin rinse/dry	

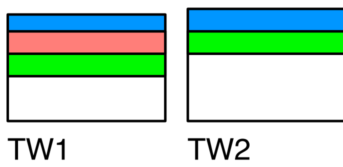
Phosphorus Drive *Use plastic tweezers*

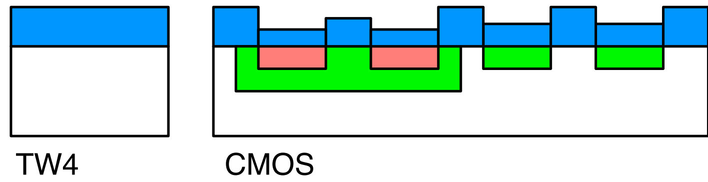
☐	Bubbler on:	Temperature:	98°C
	(if used)	Bubbler N_2:	200 sccm—switch to vent
☐	Push:	Ambient:	1 slpm dry N_2
		Temperature:	800°C
		Rate:	1 inch every 12 seconds
☐	Ramp up:	Ambient:	___________
		Final temperature:	___________°C
		Elapsed time:	___________
☐	Oxidation:	Ambient	___________
		Temperature	___________°C
		Time	___________
☐	Drive:	Ambient:	___________
		Temperature:	___________°C
		Time:	___________
☐	Ramp down:	Ambient:	1 slpm dry N_2
		Final temperature:	800°C
		Elapsed time:	___________
☐	Pull:	Ambient:	1 slpm dry N_2
		Temperature:	800°C
		Rate:	1 inch every 12 seconds

Measure oxide thickness TW1 ______________________________.

TW2 ______________________________.

TW4 ______________________________.





11. Pattern for gate oxide   Date ____________   Name____________________

Use CMOS mask 4.

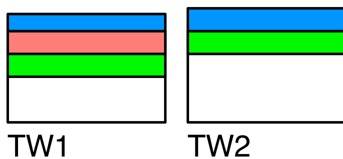
Pattern and etch all device wafers. Do not do not any lithograph on the test wafers. Use TW4 *only* for etch rate calibration. Do not etch TW1 or TW2.

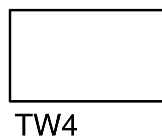
Pattern Photoresist *Use metal tweezers*

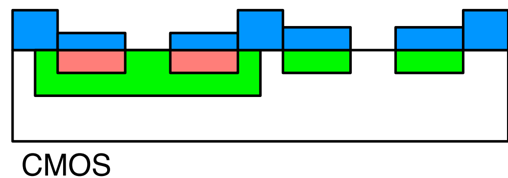
- ☐ Spin HMDS: 4000 rpm for 25 seconds
- ☐ Spin photoresist: _____________ photoresist: __________rpm for __________seconds
- ☐ Prebake: __________°C for ____________minutes
- ☐ Expose: __________seconds
- ☐ Develop: MIF-300 developer for __________seconds
- ☐ Cascade rinse: 3 minutes
- ☐ Dry:
- ☐ Inspect:
- ☐ Postbake: __________°C for ____________minutes

SiO_2 Etch & Photoresist Strip *Use metal tweezers*

- ☐ BOE: __________ minutes
- ☐ Cascade rinse: 2 minutes
- ☐ Acetone #1: 3 minutes
- ☐ Acetone #2: 1 minutes
- ☐ Methanol: 1 minute
- ☐ Cascade rinse: 2 minutes
- ☐ Spin rinse/dry:







12. Gate oxide
Date ____________ Name____________________

Oxidize all device wafers and all test wafers.

Standard Clean *Use plastic tweezers after cleaning wafers*

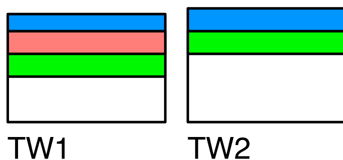
☐	SC-1:	15 minutes at 80°C 2500 ml DI H_2O + 500 ml NH_4OH + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	HF dip:	15 seconds in 50:1 HF
☐	Cascade rinse:	1 minute
☐	SC-2:	15 minutes at 80°C 3000 ml DI H_2O + 500 ml HCl + 500 ml H_2O_2
☐	Cascade rinse:	3 minutes
☐	Spin rinse/dry	

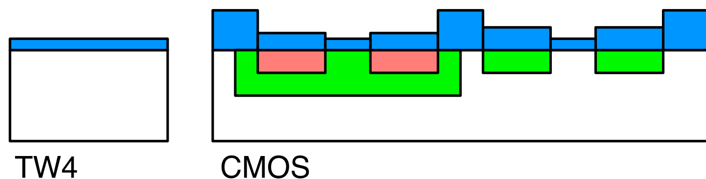
Dry Oxidation *Use plastic tweezers*

☐	Push:	Ambient:	1 slpm dry N_2
		Temperature:	800°C
		Rate:	1 inch every 12 seconds
☐	Ramp up:	Ambient:	1 slpm dry N_2
		Final temperature:	__________°C
		Elapsed time:	__________
☐	Drive:	Ambient:	1 slpm O_2
		Temperature:	__________°C
		Time:	__________
☐	Ramp down:	Ambient:	1 slpm dry N_2
		Final temperature:	800°C
		Elapsed time:	__________
☐	Pull:	Ambient:	1 slpm dry N_2
		Temperature:	800°C
		Rate:	1 inch every 12 seconds

Measure oxide thickness

TW1 ______________________________.
TW2 ______________________________.
TW4 ______________________________.





Note: TW4 can be retired after this step.

13. Pattern for contact vias Date ___________ Name___________________

CMOS mask 5.

Pattern and etch all device wafers. Do not do any lithography on the test wafers. Use TW2 *only* for etch rate calibration. Also, etch TW1. TW4 was retired after the previous step.

Pattern Photoresist *Use metal tweezers*

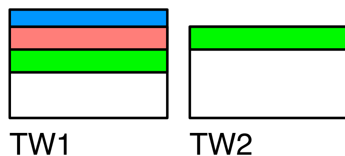
- ☐ Spin HMDS: 4000 rpm for 25 seconds
- ☐ Spin photoresist: _____________ photoresist: __________rpm for __________seconds
- ☐ Prebake: __________°C for ____________minutes
- ☐ Expose: __________seconds
- ☐ Develop: MIF-300 developer for __________seconds
- ☐ Cascade rinse: 3 minutes
- ☐ Dry:
- ☐ Inspect:
- ☐ Postbake: __________°C for ____________minutes

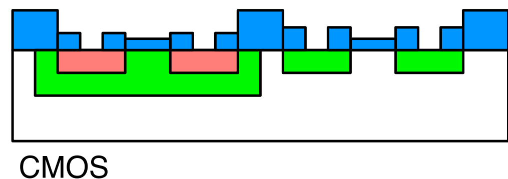
SiO_2 Etch & Photoresist Strip *Use metal tweezers*

- ☐ BOE: __________ minutes
- ☐ Cascade rinse: 2 minutes
- ☐ Acetone #1: 3 minutes
- ☐ Acetone #2: 1 minutes
- ☐ Methanol: 1 minute
- ☐ Cascade rinse: 2 minutes
- ☐ Spin rinse/dry:

Measure sheet resistance: TW2 ____________________________________.

Also, etch all oxide off TW1.
Measure sheet resistance.: TW1_____________________________.





Note: TW1 and TW2 can be retired after this step and sent off for profiling, if desired.

14. Contact Metallization Date ____________ Name___________________

Deposit metal on all device wafers.

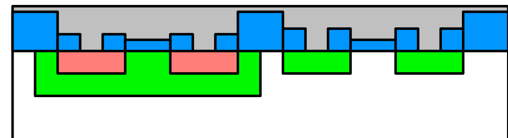
Metal can be deposited with no prior treatment. However, a 15-second dip in the dilute HF bath (part of the standard clean process) can be included to remove any residual oxides that may be in the contact areas.

Metallization *Use metal tweezers*

- ☐ system used: ____________________
- ☐ metal deposited: aluminum
- ☐ total thickness: ____________________

Metal sheet resistance ________________________________.

Measured metal thickness _____________________________.



15. Metal contact pattern Date ___________ Name ___________________

CMOS mask 6.

Pattern and etch metal on all device wafers.

Pattern Photoresist *Use metal tweezers*

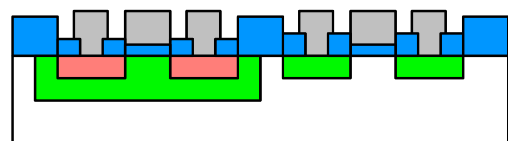
- ☐ Spin HMDS: 4000 rpm for 25 seconds
- ☐ Spin photoresist: ____________ photoresist: __________rpm for __________seconds
- ☐ Prebake: __________°C for ____________minutes
- ☐ Expose: __________seconds
- ☐ Develop: MIF-300 developer for __________seconds
- ☐ Cascade rinse: 3 minutes
- ☐ Dry:
- ☐ Inspect:
- ☐ Postbake: __________°C for ____________minutes

Aluminum etch & Photoresist Strip *Use metal tweezers*

- ☐ PAN etch: 80 ml H_3PO_4 + 80 ml CH_3COOH + 20 ml HNO_3 + 20 ml H_2O room temperature
- ☐ etch time __________ minutes
- ☐ Cascade rinse: 2 minutes
- ☐ Acetone #1: 3 minutes
- ☐ Acetone #2: 1 minutes
- ☐ Methanol: 1 minute
- ☐ Cascade rinse: 2 minutes
- ☐ Spin rinse/dry:

Sintering *Use metal tweezers*

☐ Push:	Ambient:	1 lpm dry N_2
	Temperature:	____________
	Rate:	1 inch per second
☐ Sinter:	Ambient:	1 lpm dry N_2
	Temperature:	____________
	Elapsed time:	____________
☐ Pull:	Ambient:	1 lpm dry N_2
	Temperature:	____________
	Rate:	1 inch per second



CMOS