

CyMOS process
Spring 2013
Iowa State University

Start Date _____

Starting Material

Orientation: _____
Dopant: _____
Resistivity: _____ $\Omega\cdot\text{cm}$
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 H₂O + 500 ml NH₄OH + 500 ml H₂O₂
- 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 H₂O + 500 ml HCl + 500 ml H₂O₂
- Cascade rinse: 3 minutes
- Spin rinse/dry

Wet Oxidation *Use plastic tweezers*

- Push: Ambient: 1 slpm dry N₂
Temperature: 800°C
Rate: 1 inch every 12 seconds
- Ramp up: Ambient: 1 slpm dry N₂
Final temperature: _____ °C
Elapsed time: _____
- Bubbler on: Temperature: _____ °C
Bubbler N₂: 200 sccm—switch to vent
- Oxidation: Ambient: 200 sccm bubbler N₂ — switch to tube
Temperature: _____ °C
Time: _____
- Bubbler off: Power: off
Bubbler N₂: off — switch to vent
- Ramp down: Ambient: 1 slpm dry N₂
Final temperature: 800°C
Elapsed time: _____
- Pull: Ambient: 1 slpm dry N₂
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

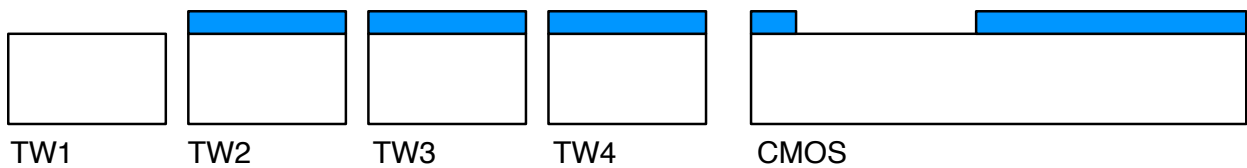
Pattern and etch all device wafers. Do not do any lithography on the test wafers. Use TW1 *only* for etch rate calibration. Do not etch any of the other test wafers.

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

SiO₂ 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 H₂O + 500 ml NH₄OH + 500 ml H₂O₂
- 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 H₂O + 500 ml HCl + 500 ml H₂O₂
- Cascade rinse: 3 minutes
- Spin rinse/dry

Boron Deposition *Use plastic tweezers*

- Push Ambient: 2 slpm dry N₂
Temperature: 850°C
Rate: 1 inch every 12 seconds
- Recovery Ambient: 1 lpm N₂ + 1 lpm O₂
Temperature: 850°C
Time: 20 minutes
- Source Ambient: 1 lpm N₂ + 1 lpm O₂ + 40 sccm H₂
Temperature: 850°C
Time: 2 minutes
- Soak Ambient: 2 lpm N₂
Temperature: _____°C
Time: _____
- Pull Ambient: 2 lpm N₂
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*

- SC-1: 15 minutes at 80°C
2500 ml DI H₂O + 500 ml NH₄OH + 500 ml H₂O₂
- 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 H₂O + 500 ml HCl + 500 ml H₂O₂
- Cascade rinse: 3 minutes
- Spin rinse/dry

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

- Bubbler on: Temperature: 98°C
Bubbler N₂: 200 sccm—switch to vent
- Push: Ambient: 1 slpm dry N₂
Temperature: 800°C
Rate: 1 inch every 12 seconds
- LTO: Ambient: 200 sccm bubbler N₂ Bubbler switch to tube
Temperature: 800°C
Time: 30 minutes
- Bubbler off: Power: off
(if not used further) Bubbler N₂: off — switch to vent
- Pull: Ambient: 1 slpm dry N₂
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 N₂
Temperature: 800°C

NSF Laboratory - CyMOS process traveler

- Ramp up: Ambient: 1 slpm dry N₂
 Final temperature: _____°C
 Elapsed time: _____

- Oxidation: Ambient: _____
 Temperature: _____°C
 Time: _____

- Drive: Ambient: _____
 Temperature: _____°C
 Time: _____

- Ramp down: Ambient: 1 slpm dry N₂
 Final temperature: 800°C
 Elapsed time: _____

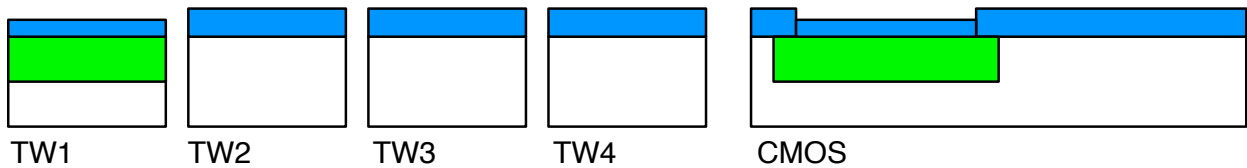
- Pull: Ambient: 1 slpm dry N₂
 Temperature: 800°C
 Rate: 1 inch every 12 seconds

Measure oxide thickness TW1 _____.

 TW2 _____.

 TW3 _____.

 TW4 _____.



5. Pattern for PMOS source/drain Date _____ Name _____

Use CMOS mask level 2

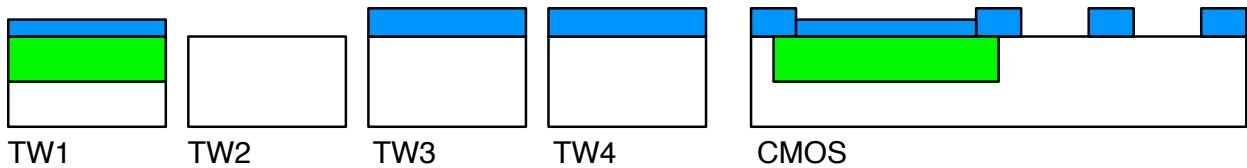
Pattern and etch all device wafers. Do not do any lithography on the test wafers. Use TW2 *only* for etch rate calibration. Do not etch TW1 or TW3

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

SiO₂ 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 H₂O + 500 ml NH₄OH + 500 ml H₂O₂
- 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 H₂O + 500 ml HCl + 500 ml H₂O₂
- Cascade rinse: 3 minutes
- Spin rinse/dry

Boron Deposition *Use plastic tweezers*

- Push Ambient: 2 slpm dry N₂
Temperature: 850°C
Rate: 1 inch every 12 seconds
- Recovery Ambient: 1 lpm N₂ + 1 lpm O₂
Temperature: 850°C
Time: 20 minutes
- Source Ambient: 1 lpm N₂ + 1 lpm O₂ + 40 sccm H₂
Temperature: 850°C
Time: 2 minutes
- Soak Ambient: 2 lpm N₂
Temperature: _____°C
Time: _____
- Pull Ambient: 2 lpm N₂
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 H₂O + 500 ml NH₄OH + 500 ml H₂O₂
- 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 H₂O + 500 ml HCl + 500 ml H₂O₂
- Cascade rinse: 3 minutes
- Spin rinse/dry

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

- Bubbler on: Temperature: 98°C
Bubbler N₂: 200 sccm—switch to vent

- Push: Ambient: 0.3 slpm dry N₂
Temperature: 800°C
Rate: 1 inch every 12 seconds

- LTO: Ambient: 200 sccm bubbler N₂ Bubbler switch to tube
Temperature: 800°C
Time: 30 minutes

- Bubbler off: Power: off
(if not used further) Bubbler N₂: off — switch to vent

- Pull: Ambient: 0.3 slpm dry N₂
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 N₂
Temperature: 800°C
Rate: 1 inch every 12 seconds

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 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.)

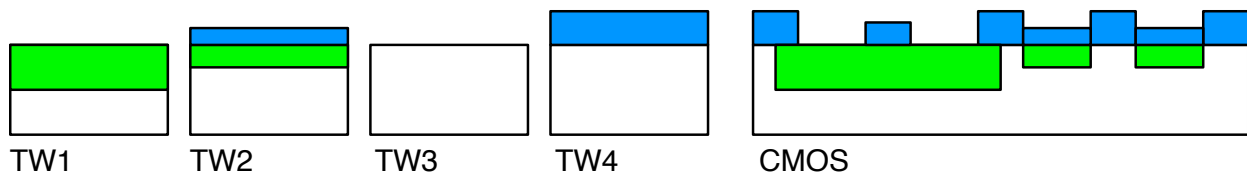
Pattern Photoresist *Use metal tweezers*

- 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

SiO₂ 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*

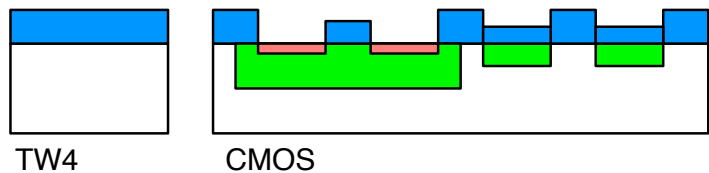
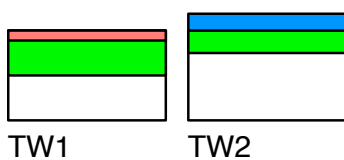
- SC-1: 15 minutes at 80°C
2500 ml DI H₂O + 500 ml NH₄OH + 500 ml H₂O₂
- Cascade rinse: 3 minutes
- HF dip: 15 seconds in 50:1 HF
- Cascade rinse: 1 minute
- SC-2: 15 minutes at 80°C
3000 ml DI H₂O + 500 ml HCl + 500 ml H₂O₂
- Cascade rinse: 3 minutes
- Spin rinse/dry

Phosphorus Deposition *Use plastic tweezers*

- Push: Ambient: 1 lpm N₂
Temperature: 900°C
Rate: 1 inch every 12 second
- Source: Ambient: 1 lpm N₂
Temperature: 900°C
Time: _____ minutes
- Pull: Ambient: 1 lpm N₂
Temperature: 900°C
Rate: 1 inch every 12 seconds

Deglaze

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



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 H₂O + 500 ml NH₄OH + 500 ml H₂O₂
- 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 H₂O + 500 ml HCl + 500 ml H₂O₂
- Cascade rinse: 3 minutes
- Spin rinse/dry

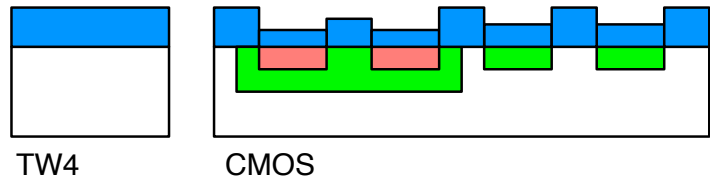
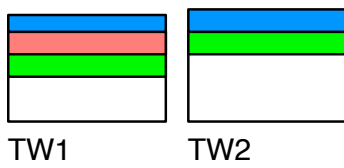
Phosphorus Drive Use plastic tweezers

- Bubbler on: Temperature: 98°C
(if used) Bubbler N₂: 200 sccm—switch to vent
- Push: Ambient: 1 slpm dry N₂
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 N₂
Final temperature: 800°C
Elapsed time: _____
- Pull: Ambient: 1 slpm dry N₂
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.

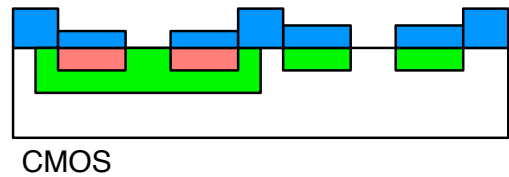
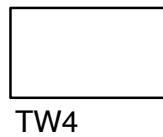
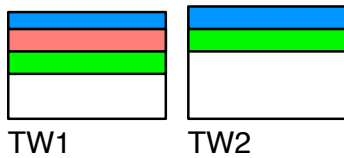
Pattern and etch all device wafers. Do not do any lithograph on the test wafers. Use TW4 *only* for etch rate calibration. Do not etch TW1 or TW2.

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

SiO₂ 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.

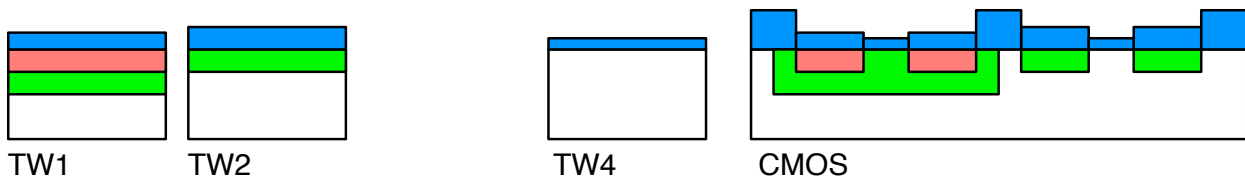
Standard Clean *Use plastic tweezers after cleaning wafers*

- SC-1: 15 minutes at 80°C
2500 ml DI H₂O + 500 ml NH₄OH + 500 ml H₂O₂
- 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 H₂O + 500 ml HCl + 500 ml H₂O₂
- Cascade rinse: 3 minutes
- Spin rinse/dry

Dry Oxidation *Use plastic tweezers*

- Push: Ambient: 1 slpm dry N₂
Temperature: 800°C
Rate: 1 inch every 12 seconds
- Ramp up: Ambient: 1 slpm dry N₂
Final temperature: _____ °C
Elapsed time: _____
- Drive: Ambient: 1 slpm O₂
Temperature: _____ °C
Time: _____
- Ramp down: Ambient: 1 slpm dry N₂
Final temperature: 800°C
Elapsed time: _____
- Pull: Ambient: 1 slpm dry N₂
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

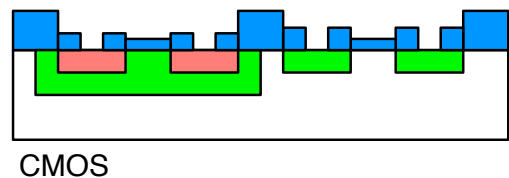
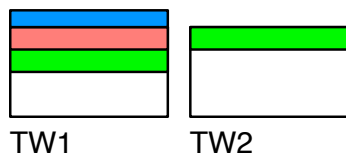
SiO₂ Etch & Photoresist Strip *Use metal tweezers*

- 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.

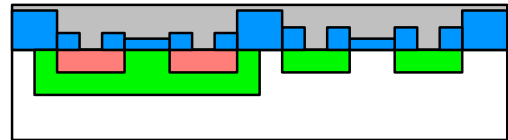
Metal can be deposited with no prior treatment. However, a 15-second dip in the dilute HF bath (part of the standard clean process) can be included to remove any residual oxides that may be in the contact areas.

Metallization *Use metal tweezers*

- system used: _____
- metal deposited: aluminum
- total thickness: _____

Metal sheet resistance _____.

Measured metal thickness _____.



CMOS

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 H₃PO₄ + 80 ml CH₃COOH + 20 ml HNO₃ + 20 ml H₂O
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 N₂
Temperature: _____
Rate: 1 inch per second
- Sinter: Ambient: 1 lpm dry N₂
Temperature: _____
Elapsed time: _____
- Pull: Ambient: 1 lpm dry N₂
Temperature: _____
Rate: 1 inch per second

