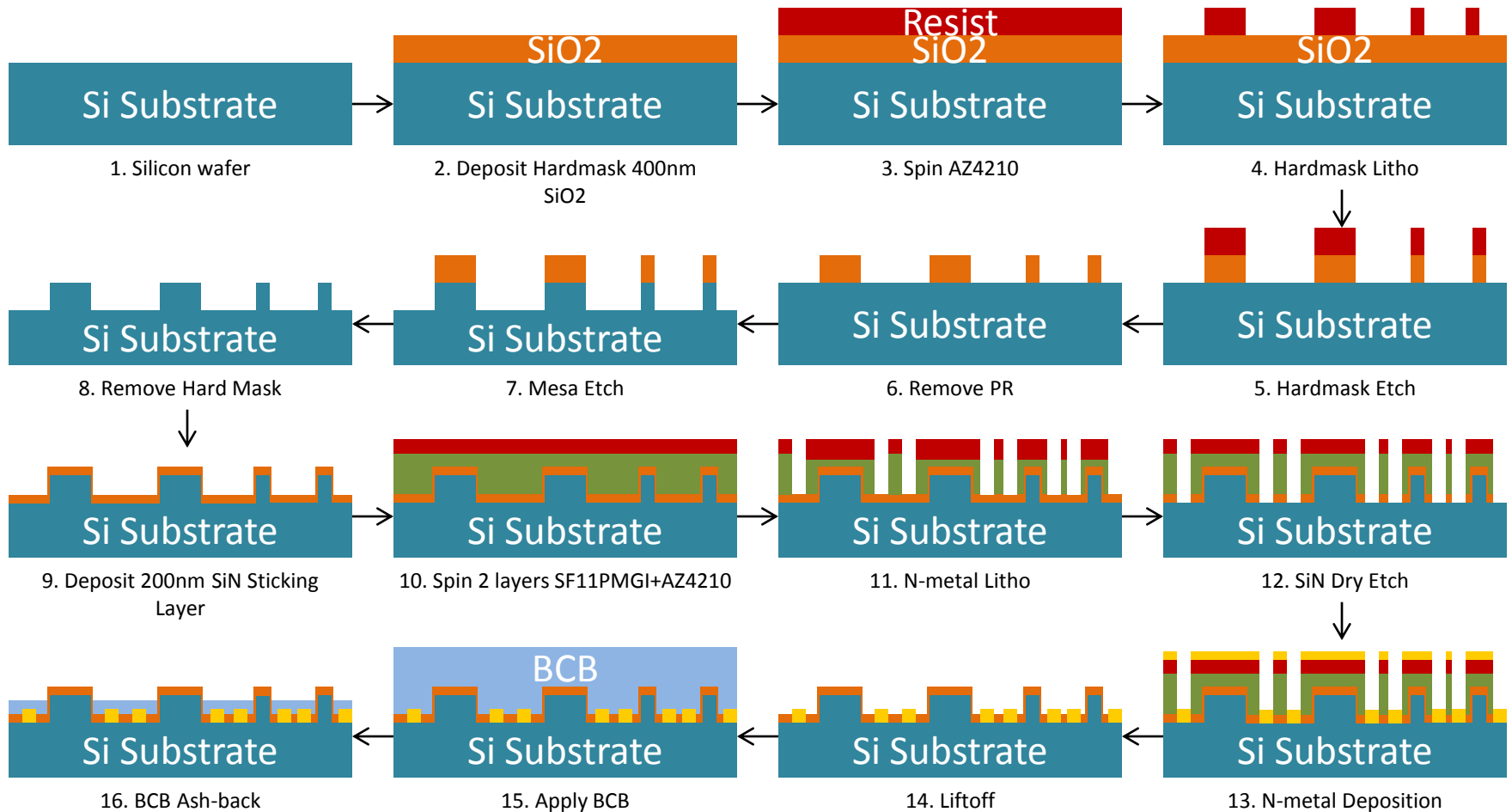


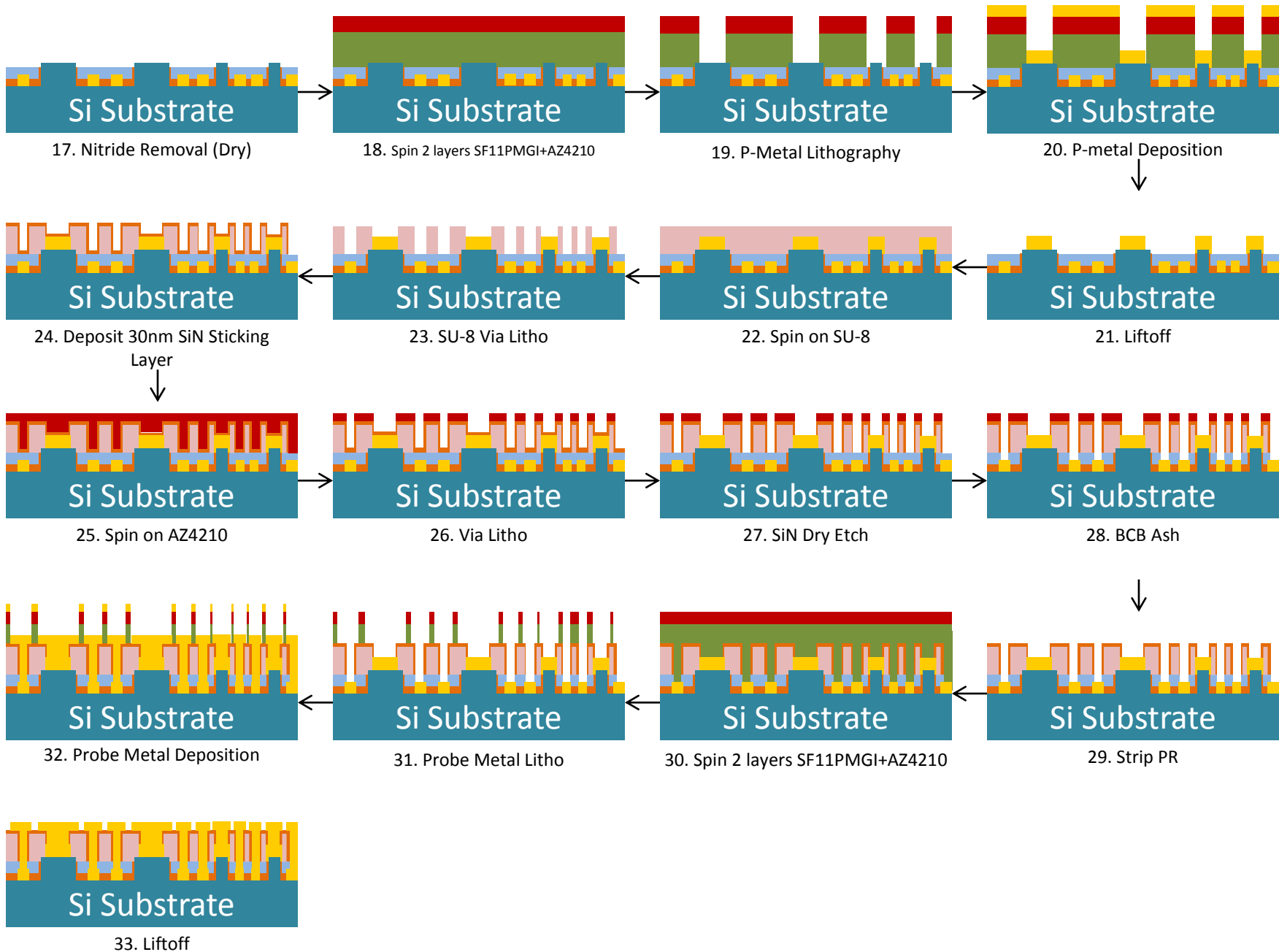
BCB Planarization Process Using EPHI SOA Masks

Jared Hulme

6/2/12

Process for BCB SOA Mask Run





Hard Mask Dep & Lithography

- Measure Si wafer thickness: = _____um
- Prepare an additional test piece to recharacterize Si etch rate (ICP1 - #157)

• Hard Mask Deposition

- Clean - ACE/ISO/DI
- Deposit Oxide
 - PlasmaTherm PECVD 5000A
- Measure Oxide Thickness in Ellipsometer: = _____ nm



Si Substrate

• P-Mesa Lithography

- Clean
 - ACE/ISO/DI
 - Dehydration bake: Hotplate **150C, 2-5min**
 - O2 Descum 30s, 300mT, 100W
- Spin HMDS (5000rpm, 30s) (let sit for 30s on chip before spinning)
- Spin AZ4210 (4000rpm, 30s)
- Pre-Exposure Bake (95C, 1min)
- Lithography
 - Use **P-Mesa Mask – EPHI-dev-2-1 – Quadrant I**
 - Put Quadrant I in the bottom right of the mask holder
 - Litho Tool: **Autostepper**
 - Program: **JAREDH\PROT**
 - Exposure: **1sec**
 - Focus Offset: 0
 - NO POST-EXPOSURE BAKE
 - Develop (AZ400K 1:4 diluted, 120sec)
 - DI Rinse
- Inspect in microscope
- Dektak PR height: = _____nm



SiO₂

Si Substrate



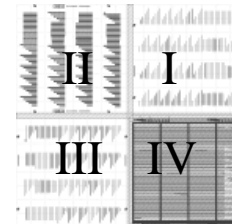
Resist
SiO₂

Si Substrate



SiO₂

Si Substrate



Hardmask Etch and Inspect

- **Hardmask Etch** - SiO₂ Etch target 500nm
 - Etch Tool: **ICP#2**
 - Clean: O₂ Clean, 5min
 - Season (Recipe, Time): Bowers **Sioxvert** etch # 101, **5min** (CHF₃ etch so check gases)
 - Etch(Recipe, Rate): (Bowers **Sioxvert** etch # 101, 250nm/min = 4.16nm/s) over etch by 20% => **Etch for 2'30"**
- Inspect in microscope
- Dektak height: = _____ nm

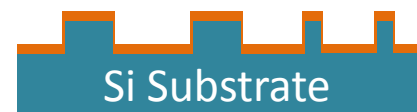
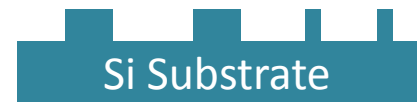


- **Strip PR**
 - ACE/ISO/DI Rinse
 - 1165 Soak at 80C in covered bath - 10min
 - ISO/DI Rinse
 - PEII - O₂ Descum (100W, 300mTorr, 60-120sec)
- Inspect in microscope
- Dektak height: = _____ nm



Mesa Etch and Inspect

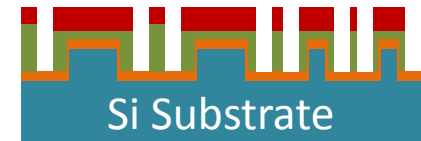
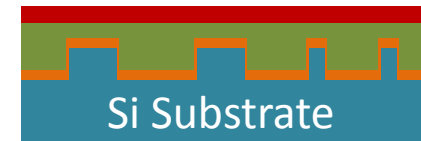
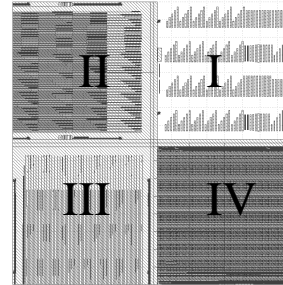
- **Si Etch target 2200nm**
 - Characterize etch rate:
 - Etch Tool: **ICP#2**
 - Switch gas CF4->SF6
 - Clean: O2 Clean, 5min (10' if last etch was Cl-based)
 - Season (Recipe, Time): Si etch # 124, 5' (~~400W, 50W RF, 30/10sccm SF6/O2, 1Pa~~)
 - Etch Test Piece 1: Si etch # 124, 6'30" at ~333nm/min
 - BHF dip (300nm/min): Dip for 2 min
 - Dektak measure etch depth _____ nm/min
 - Etch Sample: (Si etch # 124) 2200nm based on characterized etch rate
 - Switch gas SF6->CF4
 - Clean: O2 Clean, _____ min
 - Inspect in microscope
 - Dektak height: = _____ nm
- **Remove Oxide (~500nm)**
 - BHF dip (~300 nm/min) => Dip for 2 min
 - DI Rinse
- Inspect in microscope
- **Sticking Layer Deposition**
 - Clean - ACE/ISO/DI
 - Deposit SiN
 - **PlasmaTherm PECVD 200A**



N-metal Litho for Nitride

- **N-metal Lithography**

- Clean
 - ACE/ISO/DI
 - Dehydration bake: Hotplate 150C, 2-5min
 - O2 Descum 30s, 300mT, 100W
- Spin on resists
 - PMGI SF-11: 4000rpm/1 min
 - Bake 170C/1min
 - PMGI SF-11: 4000rpm/1min
 - Bake 170C/2min
 - AZ4210 Resist: 4000rpm/30sec
 - Pre-Exposure Bake (95C, 1min)
- Lithography
 - Use **N-Metal Mask – EPHI-dev-2-2 – Quadrant II**
 - Put Quadrant II in the bottom right of the mask holder
 - Litho Tool: **Autostepper**
 - Program: **JAREDH\PROT**
 - Align to center of P-Mesa Vernier (closest to the top left of the die)
 - » Vernier center is (1.264325, 317175) from top left
 - Exposure: **1sec**
 - Focus Offset: 0
 - **NO POST-EXPOSURE BAKE**
- Develop Resist
 - AZ400K 1:4 diluted, 120sec
 - DI Rinse
- DUV Expose SF-11: 300sec/1000W
 - Develop in SAL101 70sec
- DUV Expose SF-11: 300sec/1000W
 - Develop in SAL101 60sec
- DUV Expose SF-11: 300sec/1000W
 - Develop in SAL101 60sec
- Inspect in microscope
- Repeat DUV and develop as needed
- Dektak height: ____nm



Nitride Etch & N-Metal Deposition

- **Nitride Etch** - SiN Etch target 20nm
 - Etch Tool: **ICP#2**
 - Clean: O2 Clean, 5min
 - Season (Recipe, Time): Bowers **Sioxvert** etch # 101, **5min** (CHF3 etch so check gases)
 - Etch(Recipe, Rate): (Bowers **Sioxvert** etch # 101, 310nm/min = 5.16nm/s) => **Etch 10"**
- Inspect in microscope
- Dektak height: = _____nm



- Pre-metal clean
 - O2 Descum 30s, 300mT, 100W)
 - BHF dip
- **E-beam 3 metal deposition**
 - Ni: 50Å @ .2Å/sec
 - Ge: 300Å @ .5Å/sec
 - Au: 300Å @
 - Ni: 200Å @
 - Au: 1.5um @ 2/5 Å/sec for 200/remainder



- **Liftoff**
 - 1165 soak @ 80°C for 20min
 - Gently agitate with pipette
 - ISO/DI rinse
- Inspect in microscope
- Repeat liftoff steps as needed



BCB Application and Cure

• NOTES:

- There must not be any pauses from sample surface preparation to loading the spun sample w/ BCB into the Blue oven
- Any delays will allow increased surface oxide to regenerate on the semiconductor, increasing leakage currents
- Oxygen contaminates BCB and prolonged exposure will compromise the cure and ruin the sample
- If oven temperature is above room temperature, BCB will bubble during the cure
- Program sequence for HARD CURE (Total time in oven: ~7 hours)
 - (a) 5 min ramp to 50_C, 5 min soak
 - (b) 15 min ramp to 100_C, 15 min soak
 - (c) 15 min ramp to 150_C, 15 min soak
 - (d) 60 min ramp to 250_C, 60 min soak
 - (e) Natural cool down (NOTE TIME OF COOL DOWN: ~3.5 Hours)
 - (f) Oven off

• BCB application

- Prepare the 'Blue Oven'
 - Check that the oven is ~25C before beginning
 - Confirm program sequence is correct for Program 5
 - Place Aluminum Baking Table in 'Blue Oven'
 - Run N2 through chamber at 100%
 - Set alarm temperature to greater than 250C
- Clean
 - ACE/ISO/DI
 - Dehydration bake: Hotplate 150C, 2-5min
 - O2 Descum 30s, 300mT, 100W
- Apply BCB 3022-46 (Let sit on surface for 30 sec) – thickness ~3-4 μm
 - Spin (500 rpm, 100 rpm/s, 5 sec)
 - Spin (1500 rpm, 150 rpm/s, 30 sec)



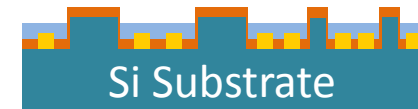
• BCB Cure

- Place sample on Aluminum Baking Table
- Reduce N2 flow to 60% after 3 min
- Load and run Program 5
- Wait for natural cool-down to 25C
- Remove sample and inspect under the microscope
- Turn off the 'Blue Oven'

P-Mesa Exposure

- **Wafer planarization ash back**

- Clean carrier wafer
 - ICP1 ash (Recipe 308: CF4/O2 50:200 sccm, 40 Pa, 1000W) **7 min**
- Load sample on carrier wafer
 - ICP1 ash(Recipe 308: CF4/O2 50:200 sccm, 40 Pa, 1000W) **2 min**
 - Ash rate ~ 400nm/min (it does take some time to heat up the sample before the full rate kicks in)
- Inspect sample in Microscope/Dektak/FEI SEM to see if both large and small mesas are exposed
- Repeat as needed
 - Carrier clean (7min), ash (1 min), inspection
 - Variation in BCB height should be under 200nm



- **Nitride Etch - SiN Etch target 20nm**

- Etch Tool: **ICP#2**
- Clean: O2 Clean, 5min
- Season (Recipe, Time): Bowers **Sioxvert** etch # 101, **5min** (CHF3 etch so check gases)
- Etch(Recipe, Rate): (Bowers **Sioxvert** etch # 101, 310nm/min = 4.16nm/s) => **Etch 10"**
- Inspect in microscope
- Dektak height: = _____nm



Sticking layer & P-Metal Lithography

- **P-metal Lithography**

- Clean

- ACE/ISO/DI
- Dehydration bake: Hotplate 150C, 2-5min
- O2 Descum 60s, 300mT, 100W)

- Spin on resists

- PMGI SF-11: 4000rpm/1min
 - Bake 170C/2min
- AZ4210 Resist: 4000rpm/30sec
- Bake 95C/1min

- Lithography

- **Use P-Metal Mask – EPHI-dev-2-2 – Quadrant III**
 - Put Quadrant III in the bottom right of the mask holder
- Litho Tool: **Autostepper**
 - Program: **JAREDH\PROT**
 - Align to P-Mesa Vernier (closest to the top left of the die)
 - » Vernier center is (1.264325,.317175) from top left
 - Exposure: **1sec**
 - Focus Offset: 0
- NO POST-EXPOSURE BAKE

- Develop Resist

- AZ400K 1:4 developer 120sec
- DI Rinse

- DUV Expose SF-11: 300sec/1000W

- Develop in SAL101 60sec

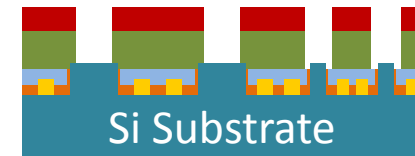
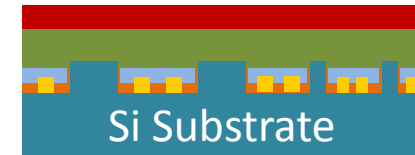
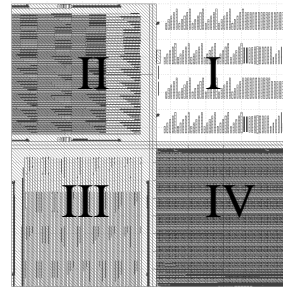
- DUV Expose SF-11: 300sec/1000W

- Develop in SAL101 60sec

- Inspect in microscope

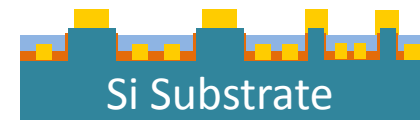
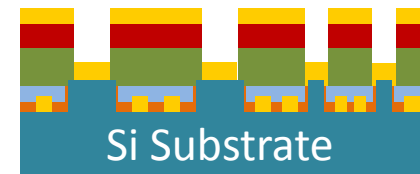
- Repeat DUV and develop as needed

- Dektak height: ____nm



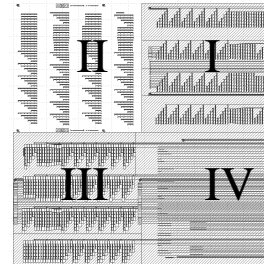
P-Metal Deposition & Anneal

- Pre-metal clean
 - O₂ Descum 60s, 300mT, 100W)
- **Remove Native Oxide**
 - Etch Tool: **ICP#2**
 - Clean: O₂ Clean, 5min
 - Season (Recipe, Time): Bowers **Sioxvert** etch # 101, **5min** (CHF₃ etch so check gases)
 - Etch(Recipe, Rate): (Bowers **Sioxvert** etch # 101, 250nm/min = 4.16nm/s) => **Etch 5 sec**
- **E-beam 3 metal deposition**
 - Pd: 30Å @ 1Å/sec
 - Ti: 170Å @ 1Å/sec
 - Pd: 170Å @ 1Å/sec
 - Au: 1000Å @ 2/5 Å/sec for 200/remainder
- **Liftoff**
 - 1165 soak @ 80°C for 20min
 - Gently agitate with pipette
 - ISO/DI rinse
- Inspect in microscope
- Repeat liftoff steps as needed
- **RTA (Rapid Thermal Anneal)**
 - 360°C / 30s
- Inspect in microscope



Apply SU-8

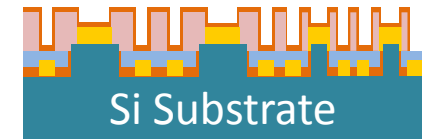
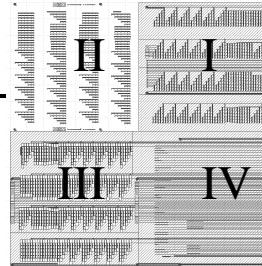
- Clean
 - ACE/ISO/DI (3 min each)
 - Dehydration bake: Hotplate 120C,3min
 - O2 Descum 30s, 300mT, 100W
- **Spin-coat SU-8 2002 (~2um)**
 - 10s@500rpm (ramp 100rpm/s)
 - 30s@3000rpm(ramp 500rpm/s)
 - Bake 95C 3min
- **SU-8 Lithography**
 - Litho Tool: **Autostepper**
 - **Use Via Mask(negative) – EPHI-dev-2-3 – Quadrant II**
 - Put Quadrant II in the bottom right of the mask holder
 - Program: **JAREDH\PROT**
 - Align to P-Mesa Vernier (closest to the top left of the die)
 - Vernier center is (1.264325,.317175) from top left
 - Exposure: **.4sec**
 - Focus Offset: -10
 - **Post-exposure bake:**
 - 65C, 1min
 - 95 C, 2min
 - **Develop (SU-8 Developer)**
 - 60s dip and shake + 15s pipette flush
 - ISO/DI rinse and N2 dry
 - Inspect vernier tips are open
 - Repeat using 30s dip and shake + 10s pipette flush until vernier tip open
 - Inspect via's are open over contacts
 - **Hard Bake (Hotplate)**
 - 95 C Starting point
 - Ramp to 150 C, hold 5 min
 - Ramp to 205 C, hold 5 min
 - Ramp to 260 C, hold 30 min
 - Ramp down 205 C, hold 5 min
 - Ramp down 150 C, hold 5 min
 - Ramp down 95 C, remove from hot plate
 - Color should be dark red



Via Lithography

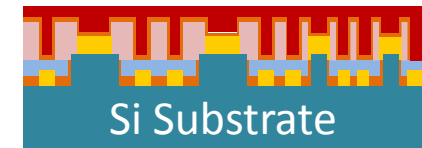
- **Sticking Layer Deposition**

- Clean - ACE/ISO/DI
- Deposit Oxide
 - PlasmaTherm PECVD 300A
- Oxide Thickness: = _____ nm



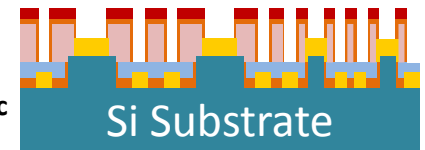
- **Via Lithography**

- Clean
 - ACE/ISO/DI
 - Dehydration bake: Hotplate **150C, 2-5min**
 - O2 Descum 30s, 300mT, 100W)
- Spin HMDS (5000rpm, 30s) (let sit for 30s on chip before spinning)
- Spin AZ4210 (4000rpm, 30s)
- Pre-Exposure Bake (95C, 1min)
- Litho Tool: **Autostepper**
 - **Use Via Mask (positive) – EPHI-dev-2-3 – Quadrant I**
 - Put Quadrant I in the bottom right of the mask holder
 - Program: **JAREDH\PROT**
 - Align to center of P-Mesa Vernier (closest to the top left of the die)
 - Vernier center is (1.264325,.317175) from top left
 - Exposure: **1sec**
 - Focus Offset: 0
 - Develop (AZ400K 1:4 diluted, 120sec)
 - DI Rinse
- Inspect in microscope
- Dektak height: = _____ nm

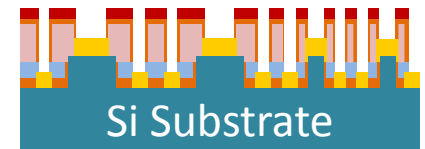


Via Etch

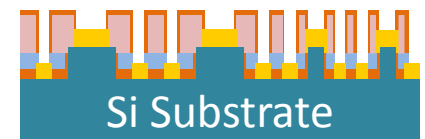
- **Sticking Layer Etch** - SiO₂ Etch target 30nm
 - Etch Tool: **ICP#2**
 - Clean: O₂ Clean, 5min
 - Season (Recipe, Time): Bowers **Sioxvert** etch # 101, **5min** (CHF₃ etch so check gases)
 - Etch(Recipe, Rate): (Bowers **Sioxvert** etch # 101, 250nm/min = 4.16nm/s) => **Etch for 20 sec**
- Inspect in microscope
- Dektak height: = _____ nm



- **BCB Ash** – target ~1000nm
 - **Clean carrier wafer** in Panasonic ICP #1 (Recipe 308: CF₄/O₂ 50:200 sccm, 40 Pa, 1000W) **7 min**
 - Load sample on carrier wafer
 - ICP ash (Recipe 308: CF₄/O₂ 50:200 sccm, 40 Pa, 1000W) **2 min**
 - Ash rate BCB ~ 400nm/min
 - Inspect sample in Microscope/Dektak to check that N-metal is exposed
 - Repeat as needed
 - Carrier clean (7min), sample ash (1 min), inspection



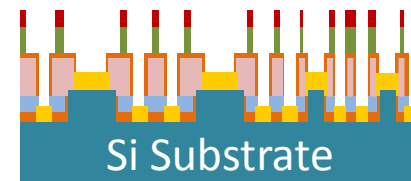
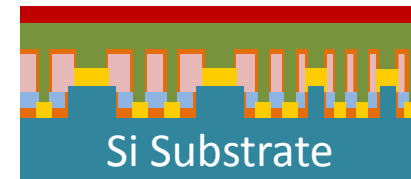
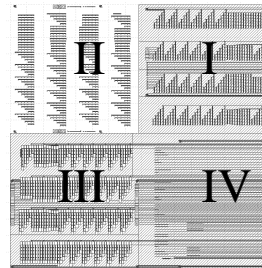
- **Strip PR**
 - 1165 soak @ 80°C for 20min
 - Gently agitate with pipette
 - ISO/DI rinse
- Inspect in microscope
- Repeat liftoff steps as needed



Probe Metal Litho

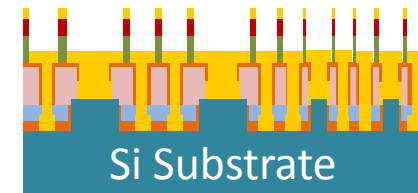
- **Probe-metal Lithography**

- Clean
 - ACE/ISO/DI
 - Dehydration bake: Hotplate 150C, 2-5min
 - O2 Descum 60s, 300mT, 100W)
- Spin on resists
 - PMGI SF-11: 4000rpm/1 min
 - Bake 170C/1min
 - PMGI SF-11: 4000rpm/1min
 - Bake 170C/2min
 - AZ4210 Resist: 4000rpm/30sec
 - Bake 95C/1min
- Lithography
 - **Use Probe-Metal Mask – EPHI-dev-2-3 – Quadrant III**
 - Put Quadrant III in the bottom right of the mask holder
 - Litho Tool: **Autostepper**
 - Program: **JAREDH\PROT**
 - Align to P-Mesa Vernier (closest to the top left of the die)
 - » Vernier center is (1.264325,.317175) from top left
 - Exposure: **1sec**
 - Focus Offset: 0
 - **NO POST-EXPOSURE BAKE**
- Develop Resist
 - AZ400K 1:4 developer 120sec
 - DI Rinse
- DUV Expose SF-11: 300sec/1000W
 - Develop in SAL101 70sec
- DUV Expose SF-11: 300sec/1000W
 - Develop in SAL101 60sec
- DUV Expose SF-11: 300sec/1000W
 - Develop in SAL101 60sec
- Inspect in microscope
- Repeat DUV and develop as needed
- Dektak height: ____nm

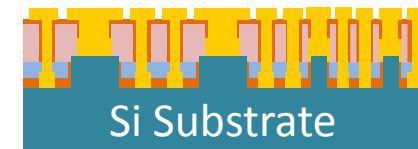


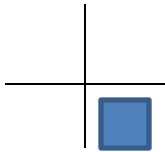
Probe-Metal Deposition

- Pre-metal clean
 - O₂ Descum 60s, 300mT, 100W)
 - **E-beam 4 metal deposition**
 - Ti: 50Å @ .2Å/sec
 - Pt: 200Å @ .5Å/sec
 - Au: 1.5um @ 2/5 Å/sec for 200/remainder
-



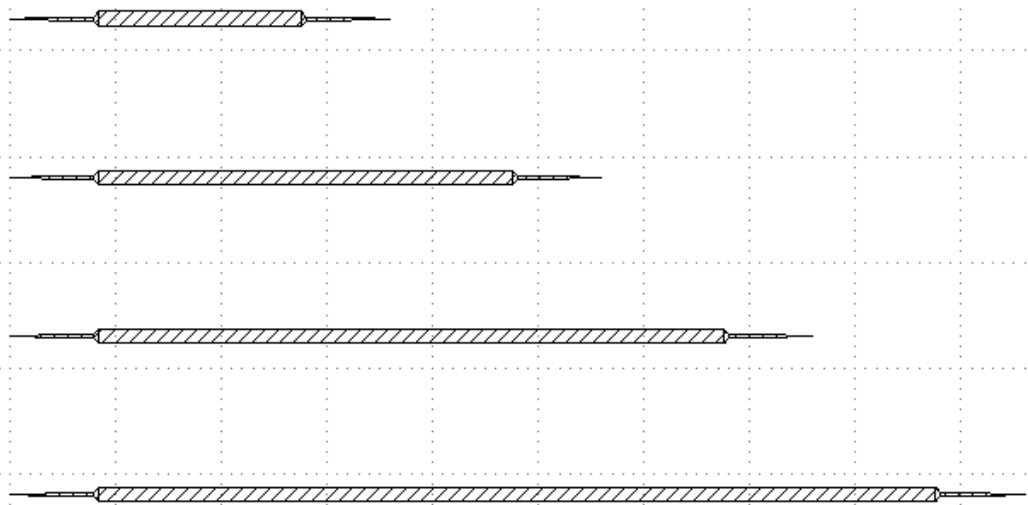
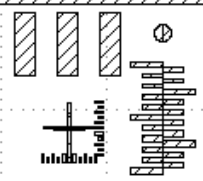
- **Liftoff**
 - 1165 soak @ 80°C for 20min
 - Gently agitate with pipette
 - ISO/DI rinse
 - Inspect in microscope
 - Repeat liftoff steps as needed
-



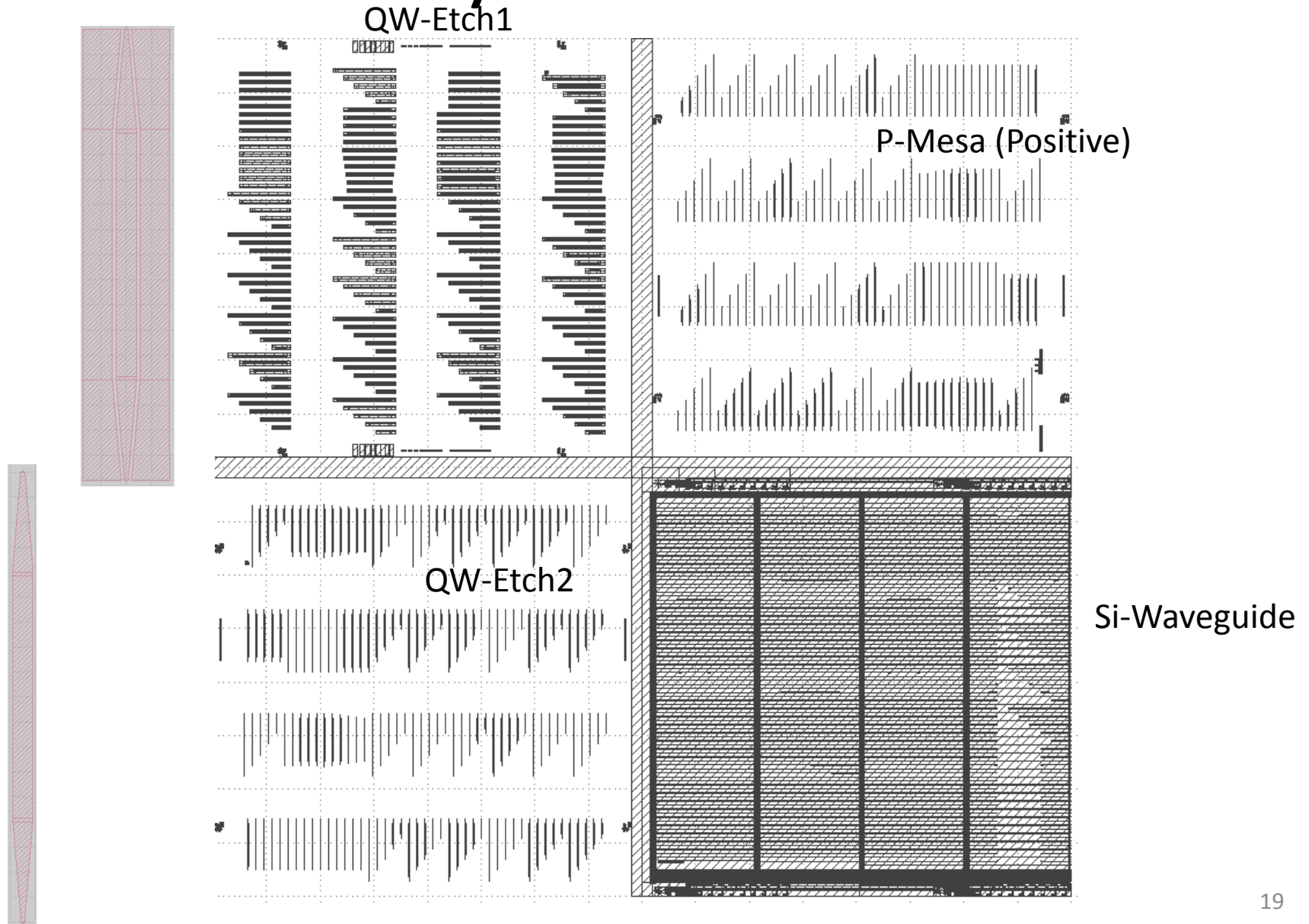


P-Mesa Vernier

(1264.325.,-317.175)
Vernier Center when
This mask quadrant is
in the lower right.

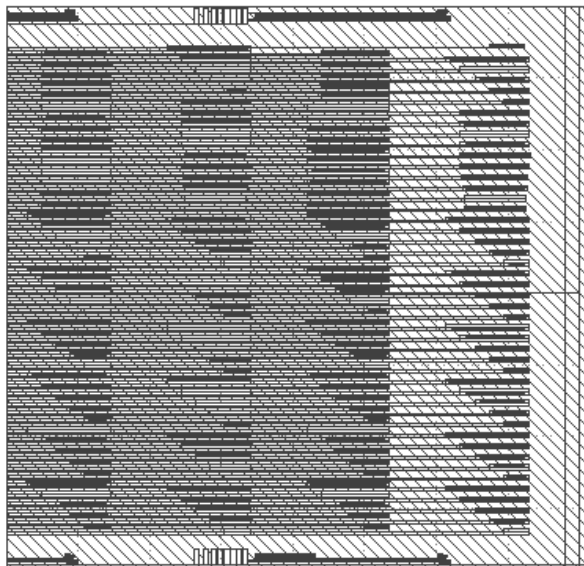


Mask Layout EPHI-dev-2-1

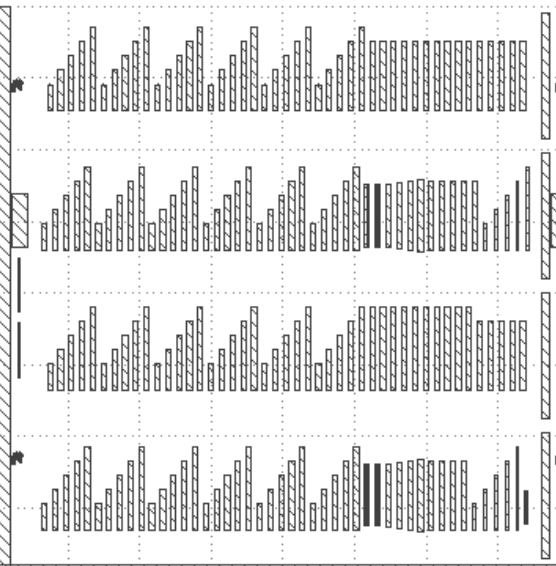


Mask Layout EPHI-dev-2-2

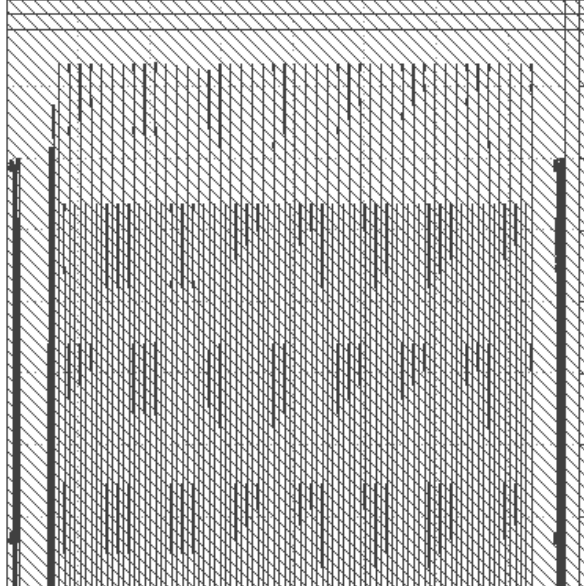
N-Metal
(Positive)



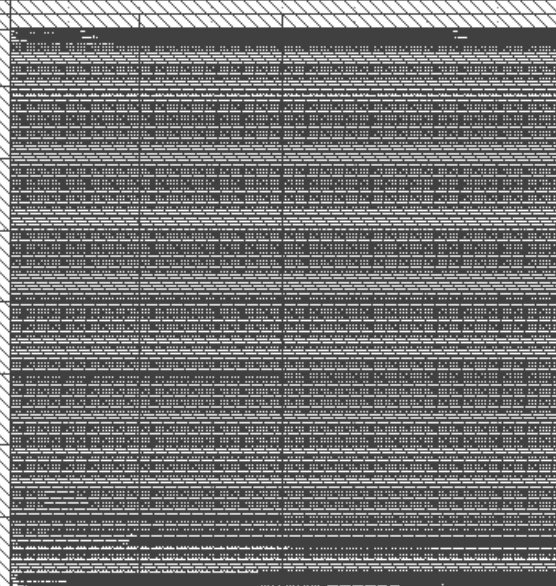
N-Substrate



P-Metal
(Positive)



VCs



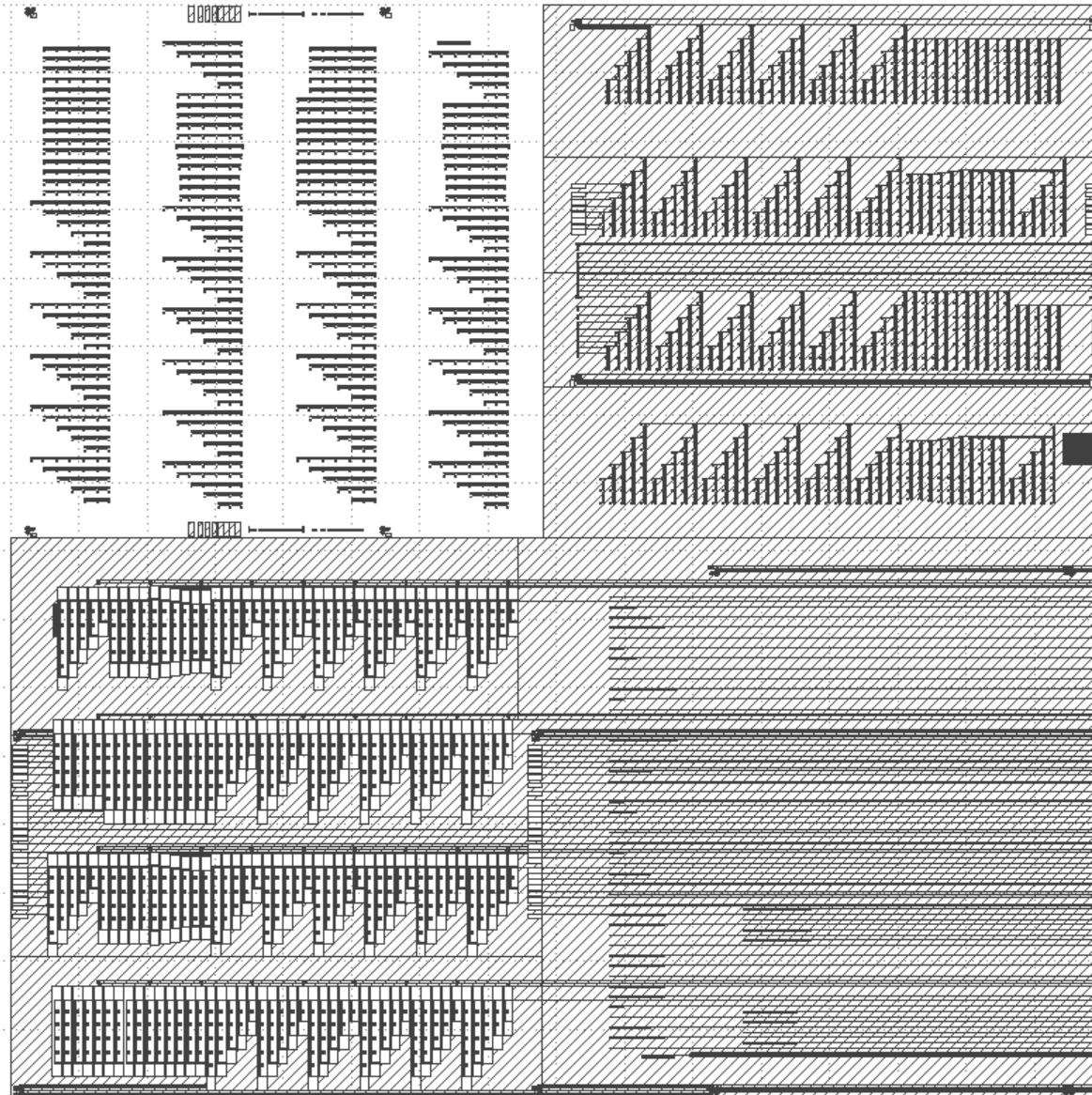
Mask Layout EPHI-dev-2-3

Via-Etch
Negative

Via-Etch
Positive

Probe-Metal
Positive

Implant



Questions

- Double check all metal stacks
- How long to develop AZ4210 (70s or 2min)
- Fix E-beam 4 dep rate info on slide 17
- Is this a good SU8 thickness?

Figure 1.a. SU-8 2000 Spin Speed vs. Thickness

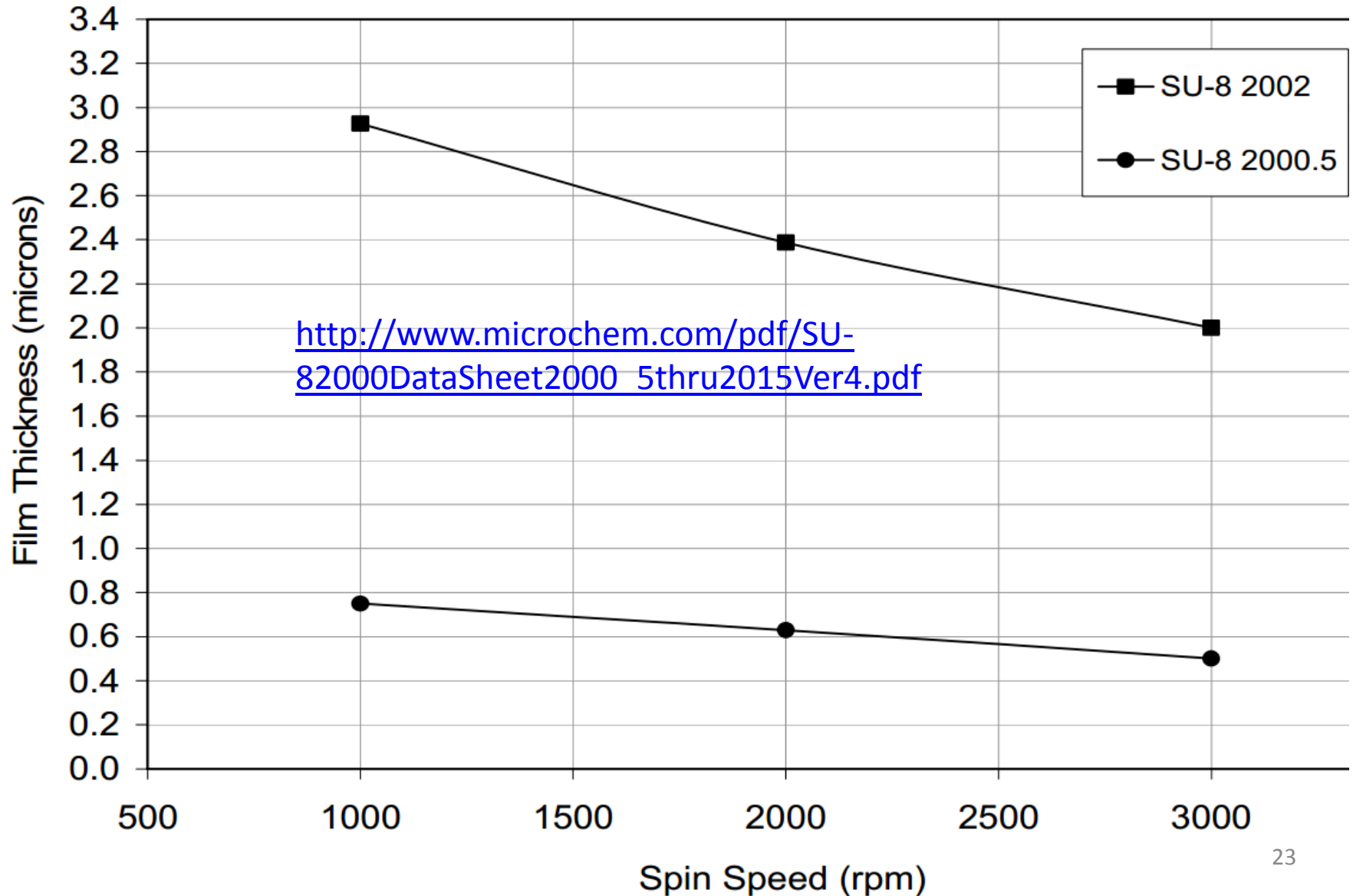


Figure 1.b. SU- 8 2000 Spin Speed vs. Thickness

