**STEP 1 - “Initial Oxidation”**

**Equipment:** Furnace N-2

**Procedure:** Load Wafers Boat, Back to Back, 1 space between fronts.

Turn off Nitrogen (usually on when no runs are in since N₂ is cheaper than O₂).

Slide boat into furnace with O₂ turned on. 5" push.

Run 5 min. with elephant (E) in place, O₂ on, and snorkel attached.

Then turn off O₂, turn on O+H+Cl, E in place and snorkel attached. - 40 min.

Then turn off O+H+Cl, turn on O₂ - 5 min.

Then remove snorkel and E, push end cap on tube and let wafers cool in E for 3 min before removing.

Turn on N₂, turn O₂ off after run is out of furnace.

Remove wafers from E and boat.

**Flows:**
- O₂ - 13 GPM (beads)
- N₂ - 5.5 GPM (stainless steel beads)
- O+H+Cl - 11.35 GPM

**Note:** The snorkel recirculates gases and prevents dangerous outgasing - particularly with the H+Cl.
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Then turn off O⁺⁺Cl, turn off O₂ - 5 min.

Then remove snorkel and E, push end cap on tube and load wafers boat in E for 3 min before removing.

Turn on N₂, turn O₂ off after run in end of furnace.

Remove wafers from E and boat.

**Flows:**
- O₂ - 13 g (bath)
- N₂ - 5.5 SS (stainless steel beads)
- O⁺⁺Cl - 11.35 SS

**Note:** The snorkel recirculates gases and prevents dangerous outgassing - particularly with the H Cl.
Step 1a - "Elliposeome tor Reading"

1. Place filter on pedestal and cover with lid.
2. Set P to "0" (left knob). Set A to "15" (right knob).
3. Increase P from 0 till small null occurs.
4. Increase A from 15 till major null occurs.
5. Tweak P & A till total null occurs.
6. Record P₁ and A₁.

Reset P to "0", A to "165"

1. Increase P from 0 till small null occurs
2. Decrease A from 165 till major null occurs
3. Tweak P and A till total null occurs.
4. Record P₂ and A₂.

Calculate Δ and Ψ where:

\[ \Delta = P₁ + P₂ \]
\[ \Psi = \left(180 - A₂\right) + A₂ \]

Go to chart and read off Ψ (index of refraction) and Δx.

Example:

\[ P₁ = 0, A₁ = 48 \]
\[ P₂ = 75, A₂ = 133 \]
\[ \Delta = 85, \Psi = \frac{47 + 48}{2} = 47.5 \]

From chart, \( \Delta x \approx 980 \)
Step 2 - "Implant" (Boron field)

Load wafers on carousel (not "0" position)

Load carousel

Pump down system
Open slits
Move to "0" position
Het tune-up

Set Magnet to value on perographs (for 35 keV Boron, this value on the magnet coarse wheel is 19.3). After having set fine control to ~ 3.0 it is about 19.

Beam on
Terminal Power on

Turn on High Voltage — slowly move to 35 keV after having verified an initial 3 to 7 keV plasma.

Turn on Quadrupoles

Turn current scale to 2 x 10^-5 m/s at the same time we are turning the quadrupoles and fine and coarse of magnet.

Once tuned, check focus, focus and probe (raise, lower) to verify that they are maximizing the current also.

*See Note*

Hard to close slits till we read ~ 1.5 mA on an FSA of 2 x 10^-6.

Dial in proper dose.

When pumpdown has reached ~ 5 x 10^-6, put in step on continuous mode as desired.

Verify proper carousel is being implemented. Use different height, keep time with MF holder.

When complete, record time, other data in log.

Unload system.

Reduce KEV and Magnet Current before shutting down.
Turn off High Voltage, Mogned, Beam, Terminal Power, Quadrupoles.

Remove carousel from chamber.

Pump down chamber with now-ofers just to seal against outside contaminants.

Note - For high energy implants (>120KeV):

The system is aligned for an optimised 60KeV implant which does give shifted centers of burn at higher energies. For higher KeV implants the following special tuning procedure is to be used:

Shift carousel to several dummy positions. Use stop mode and implant first position with slits open. Adjust quadrupoles and magneto while the implant is occurring so that all four lights on the scan & monitor are lit indicating sufficient overlap in all four directions. When this is done, the system will be somewhat detuned from a current maximisation standpoint but will begin to render an even burn. Once this is achieved no further tuning should be done except to reduce the slits.
Step 3 - "Wafer Clean A"

Make CAROS - 1500 ml Hydrogen Peroxide \( \text{H}_2\text{O}_2 \)
1500 ml Sulfuric Acid \( \text{H}_2\text{SO}_4 \)
Heat to ~130°C on Hot Plate
Usable one time only (can run two lots at once, however)

CAROS 2
Transfer dump wafers to white teflon boat. Attach gun holder to boat and immerse in CAROS.

Remain in CAROS for 15 min.

After 15 min in CAROS move wafers (in same boat) to N\(_2\)-DI H\(_2\)O rinse bath (nitrogen bubbles).
Rinse in N\(_2\)-DI H\(_2\)O for 5 min.
Then go to Super Q.

Super Q 2 - (Triple Cascade UP DI H\(_2\)O Rinse)
1st bath (leftmost) - 2 min.
2nd bath (center) - 5 min.
3rd bath (rightmost) - 5 min minimum (until >12mΩ water is reached).

Spin dry (automatic) - 2 1/2 min.
Then dump transfer back to normal blue carrier for next step.
STEP 4 - "PYRO - BORONIZATION"

First, run monitor to check on proper belt speed - thickness.

PROCEDURE:

Load wafers on susceptor after each wafer is blown off. Set speed to "190" (6-7 KHz). Turn switch on and avoid completion. Look for any problems such as severe streaking. When complete, remove wafers with vacuum pickup and check monitor (a) which should have been loaded with lead.

Checking the monitor:

While wafers are still hot, wet your finger in center of wafer. Etch wafer in straight HF till 50 deets. Rinse in water bath. Spray with TCE till wax comes off. Rinse in water, dry, to 1st scale.
Turn off High Voltage, Magnets, Beam, Terminal Power, Quadropoles.

Remove carousel from chamber.
Pump down chamber with now of gases just to seal against outside contaminants.

NOTE - For high energy implants (> 120 KeV):

The system is aligned for an optimized 60 KeV implant which does give shifted centers of burn at higher energies. For higher KeV implants the following special tuning procedure is to be used:

Shift carousel to several dummy positions. Use stop mode and implant first position with slits open. Adjust quadropoles and inject while the implant is occurring so that all four lights on the scan monitor are lit indicating sufficient overlap in all four directions. When this is done, the system will be somewhat damped from a current maximization standpoint but will still be rendering an even burn. Once this is achieved no further tuning should be done except to reduce the slits.
STEP 4a - DEKTAK

Put sample on chuck table (no vacuum needed).
Power on DEKTAK - turn on.

Turn on Chart Recorder (C.R.)
Turn on Deb. lamp.

Move Stylus down till contact is registered on C.R.
Using required range button, zero stylus on +0 ft line.
Also use "fine zero" to steady stylus.

Use Manual speed to get stylus near OP tape step.

When ready turn on Chart. Use Speed = 10 on C.R.
Then turn on Speed = .1 on DEKTAK and record step.

When step is complete, SHUT DOWN:

SHUT DOWN
Chart off
Speed Deb off
Lamp off
Spirit Stylus high
Run paper out of Chart and tear off.

Measure step height by calculating increment.
STEP 5 - “Wafer Clean B”
* SPIN SWAB - III

Put wafers together - all tops up in boat in blue carrier. Transfer boat to white teflon boat. Insert boat in load end (left end) of III. Hit Ready, Auto Load, Cycle Start. Load Receptacle Boat in Right end of III. Watch the three nozzles, to make sure we don’t run out of cleaning liquids.

The three nozzles contain:

- DI H₂O + FC93 (Wetting Agent) - 10 sec. scrub
- DI H₂O - 5 sec. rinse
- ISO-PROPYL ALCOHOL - 5 sec. rinse
- DRY - 5 sec. spin

* 50:1 Etch: Purpose - to remove any alcohol before entering a tube. This is a questionable step since in all probability the alcohol will not hurt the tube and secondly, it will still in all probability be removed in Super A.

Procedure: 10 sec. in 50:1, then 2 min. in Water Rinse.
Then to Super A.

* Super A: See Step 3.
STEP 6 - "Densify" - Furnace N-8

Load wafers in "Densify" & in same manner as at initial stage.
Put & on tube end.
Keep & in place.
Push wafers to work on rod (~10" push).
Put snorkel on & (Keep HCL from escaping).
Turn off N2
Turn on O2+HCL (950°C)
Set timer for 30 min.

After 30 min. Turn O2+HCL off, turn N2 on.
Wait 5 min with snorkel attached.
Remove wafers after disconnecting snorkel.

Purpose: The purpose of this step is to develop tighter structure within the oxide which allows better control during the etch step (slower etch rates).

STEPS 7, 8, 9 - Repeat of 4, 5, 6
STEP 10 - "FIRST PHOTO"

First clean syringe & parts in: acetone (A2), xylene (KTF).

TOOL SYRINGE

BAKE

For most photo projects, the first step is a pre-bake today on the surface for better photo resisted adherence.

This step is normally 30' @ 180°C.

COAT

Setting Spin Speed - Pull all 4 dummy wafers (one @ arrow) on spin chuck. Set strobe lights for 5000 RPM. Start spin and adjust speed for 3000 RPM. Note that if you see double arrow, we are really detecting a second harmonic.

We must see only one arrow.

Actual Coat - Load all 4 wafers. Turn on vacuum (check indicator). Feed about 1/4" of A2 on wafers. Hit start (black button). It will run for 30 seconds.

For this time and speed with the viscosity we are running, the final A2 thickness will be 10kÅ + 12kÅ. Deposit all coated wafers in a clean Teflon boat. Touch boat only @ gloved hands.

Bake for 30' @ ~100°C.

ALIGN - FIRST MASK

1.) Check intensity with detector.
2.) Invest plate with ring and vacuum on.
3.) Set exposure time for proper # of seconds.
4.) Run leader wafer (1st photo) - Align, Expose, Develop.
   Check for edge齐齐 and measure R.W. (c. 28).
5.) If OK, align all other wafers
   Depress "FIRST MASK" button
   Put wafer on chuck and while still depressing button, blow off and release.
   Continue and repeat.
6.) When complete @ 8 wafers, change masks.
7.) When all done, remove masks, pull wafer ring upside down, shut down.
ALIGN - Masks other than source-drain

1. Lift leaf, remove mask clamp
2. Blow off mask, insert mask - +5 up toward operator
3. PSD on clamp, fit vacuum, lower leaf
4. Push down wither, blow off, release button
5. With probes find cross alloys in each half. With G align halves.
6. With white button and with "scan", align rough on right hand control
7. Without white button, fine align
8. When properly aligned, hit red button, thereby taking wafer into contact
9. Check for proper alignment while in contact
10. If bad, hit red button, which separates mask on wafer
11. Once in contact and properly aligned, hit EXPOSE
12. While exposing, put new wafer on turntable chuck
13. When complete, release front button and wafer will exchange position
14. Put aligned and expose wafers in box

DEVELOP - Set timer for 5 min
Agitate wafers in develop for 45 sec. then put in bath for 1/4 min.
Spin dry and inspect

BAKE - 15 minutes @ 180°C oven in "A2" boat

ETCH - First Photo
Prebake as above
Put in buffered HF (HF + NH₄F) for 4 1/2 to 6 min.
Then rinse for 1 1/2 min. and dry
Then to stop rinse (CHF₃).
STEP 11 - "Strip Resist"
Put in "C" etch boat. Immense for 15' in CROCS as in Step 3.
Then Rinse as in Step 3.
Then ≤ 30 sec. in 50:1 as in Step 3.
Then Super Q as in Step 3.

STEP 12 - "Inspect" - Inspect particularly around the edges so as to verify that the resist is off at the points where it is thickest (edges).
(Spec. = 0.33 MAX)
Inside: .34, .35 (2 wafers) -.345 ave.
Outside: .385, .382

STEP 13 - "Silicon Etch" - 34°C
Place wafers (6 wafers each time + monitor)
Etch (Spec. = 1 3/4")
Etch 2 1/2 min. to attain deeper etch (2900 A).
Rinse - 5 min.
Measure monitor (actually measure scribe alley to field stop) on Deftab. Strip oxide in straight H2F and measure stop.
STEP 14 - "OXIDE ETCH"

In buffered HF, Etch W 30 sec, then rinse 5' and then Super Q, as in step 3.

**Note:** The value of this step is questionable and was eliminated on 3/25/75. It was included to reduce any possible step resulting from the silicon etch, undercutting the field. Thusly:

![Diagram](image)

**Purpose of oxide etch:**

To remove edge:

![Diagram](image)

**Probable result of etch (toograte, resulting in additional step to cover):**

![Diagram](image)

For this reason the etch was eliminated. It was, however, done on lot 019-H.