STEP 1 - "Initial Oxidation"

Equipt.: Furnace N-2

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

Turn off Nitrogen (normally on when no runs are in since N_2 is cheaper than O_2).

Slide boat into furnace with O_2 turned on. (5" push)

Run 5 min. with elephant (E) in place, O_2 on, and snorkel attached.

Then turn off O_2, turn on O+HCl, E in place and snorkel attached. - 40 min.

Then turn off O+HCl, turn on O_2 - 5 min.

Then remove snorkel and E, put endcap on tube and let wafers cool in E for ~3 min before removing.

Turn on N_2, turn O_2 off after run is out of furnace

Remove wafers from E and boat.

Flows: O_2 - 13 Glass (beads)
N_2 - 5.5 SS (stainless steel beads)
O+HCl - 11.35 SS

Note: The snorkel recirculates gases and prevents dangerous outgasing - particularly with the HCl.

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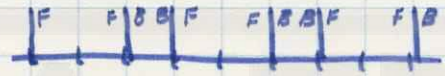

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Step 1a - "Ellipseometer tox Reading"

Put wafer on pedestal and cover with lid.

Set P to "0" (left knob). Set A to "15" (right knob).

Increase P from 0 till small null occurs.

Increase A from 15 till major null occurs.

Tweak P & A till total null occurs.

Record P_1 and A_1.

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

Increase P from 0 till small null occurs

<u>Decrease</u> A from 165 till major null occurs

Tweak P and A till total null occurs.

Record P_2 and A_2.

Calculate Δ and ψ where: $\Delta = P_1 + P_2$

$$\psi = \frac{(180 - A_2) + A_1}{2}$$

Go to chart and read off η (index of refraction) and t_{ox}.

Example: $P_1 = 0$, $A_1 = 48$
$P_2 = 85$, $A_2 = 133$
$\Delta = 85$ $\psi = \frac{47+48}{2} = 47.5$
From chart, $t_{ox} \approx 980 Å$

Step 2 - "Dumplant" (Boron field)

Load wafers on carousel (not "0" position)
Vent system
Load Carousel
Pump Down System
Open slits
Preset to "0" position
Hit tune-up.
Set Magnet to value per graphs (for 35 KeV Boron, this value on the Magnet Course wheel [after having set fine control to ~3.0] is about "9").
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 Quadrapoles.
Turn current scale to 2×10^{-5} or so at the same time we are tuning the quadrapoles and fine and coarse of magnet.

Once tuned, check lens, focus and probe (raise, lower) to verify that they are maximizing the current also.
*See NOTE
Start to close slits till we read ~1.5 μA on an FSA of 2×10^{-6}.
Dial in proper dose.
When pumpdown has reached $< 5 \times 10^{-6}$, put in step or continuous mode as desired.
Verify proper carousel is being implanted.
Hit Start, keep time with stopwatch.
When complete, record time, other data in log.
Vent system.

Reduce KEV and Magnet Current before shutting down.

Turn off High Voltage, Mognet, Beam, Terminal Power, Quadrapoles.

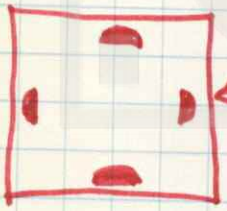
Remove carousel from chamber.

Pump down chamber with no wafers just to seal against outside contaminants.

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

The system is aligned for an optimized 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 step mode and implant first position with slits open. Adjust quadrapoles and magnet <u>while the implant is occurring</u> so that all four lights on the scan monitor are lit indicating sufficient overscan in all four directions. When this is done, the system will be somewhat detuned from a current maximization standpoint but will at least be rendering 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 H_2O_2
1500 ml Sulfuric Acid H_2SO_4
Heat to ~130°C on Hot Plate
Usable one time only (can run two lots at once, however)

CAROS:

Transfer dump wafers to white teflon boat. Attach gem 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_2O rinse bath (nitrogen bubbles)

Rinse in N_2-DI H_2O for 5 min.

Then go to Super Q.

SUPER Q: -(Triple Cascade UP DI H_2O Rinse)

1st bath (leftmost) - 2 min.

2nd bath (center) - 5 min.

3rd bath (rightmost) - 5 min minimum (or till > 12 MΩ water is reached).

Spin dry (automatic) - 2½ min.

Then dump transfer back to normal blue carrier for next step.

STEP 4 - "PYRO - ~~PHOSPHORUS~~"

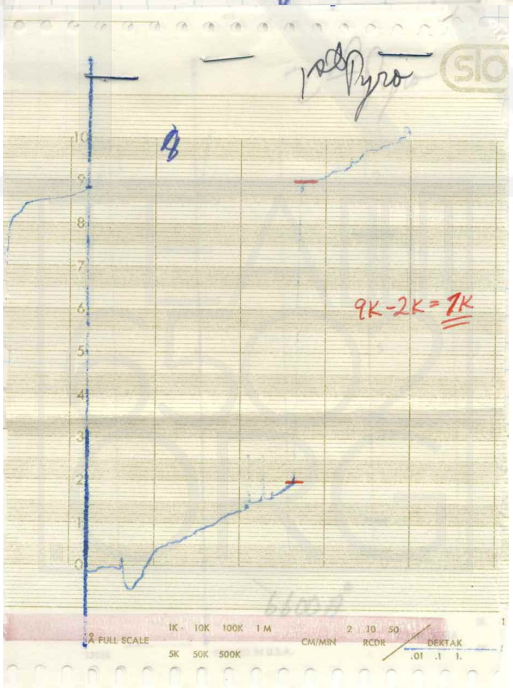
First, run monitor to check on proper belt speed - thickness.

PROCEDURE:

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

Checking the monitor:

While wafer is still hot, melt wax in center of wafer.
Etch wafer in straight HF till it dewets.
Rinse in water bath. Spray with TCE till wax comes off.
Rinse in water, dry, to Def tak.



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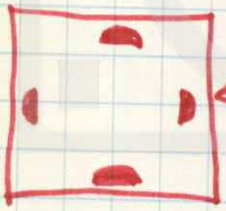


STEP 4a

DEKTAK -

Put sample on chuck table (no vacuum needed).

Power on Dektak - turn on.

Turn on Chart Recorder (C.R.)

Turn on Dek. lamp.

Move Stylus down till contact is registered on C.R.

Using required range buttons, zero stylus on ~0 Å line.
Also use "fine zero" to steady stylus

Use Manual speed to get stylus near oxide 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 Dek off
Lamp Off
Spin 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 load to white teflon boat.
Insert boat in load end (left end) of III.
Hit Reset, 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 H_2O + FC93 (Wetting Agent)	-	10 sec. scrub
DI H_2O	-	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, in all probability be removed in Super Q.

Procedure: 10 sec. in 50:1, then 2 min in Water Rinse.

Then to Super Q.

* Super Q : See Step 3.

STEP 6 - "Densify" - Furnace N-8

Load wafers in "Densify" ξ in same manner as at initial oxide.
Put ξ on tube end.
Keep ξ in place.
Push wafers to mark on rod (~10" push).
Put snorkel on ξ (Keep HCl from escaping).
Turn off N_2
Turn on O_2+HCl (950°C)
Set timer for 30 min.

After 30 min. Turn O_2+HCl off, turn N_2 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 (AZ), xylene (KTFR). Load Syringe.

BAKE

For most photo operations, the first step is a pre-bake to dry on the surface for better photo resist adherence. This step is normally 30' @ 180°C.

COAT

Setting Spin Speed - Put all 4 dummy wafers (one w/ arrow) on spin chuck. Set strobe light for 3000 RPM. Start spin and adjust speed for 3000 RPM. Note that if we 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). Put about 1½" of AZ on wafers. Hit start (black button). It will run for 30 sec. For this time and speed and with the viscosity we are running, the final AZ thickness will be 10KÅ to 12KÅ. Deposit all coated wafers in a clean teflon boat. Touch boat only w/ glove hands.

Bake for 30' @ ~100°C.

ALIGN - FIRST MASK

1.) Check intensity with detector.
2.) Insert 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 acuity and measure R.W. (<.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 w/ 8 wafers, change masks.
7.) When all done, remove mask, put wafer ring upside down, shut down.

Step 10a

ALIGN - Masks other than source-drain

1.) Lift head, Remove Mask Clamp
2.) Blow off mask, Insert mask - #'s up toward operator
3.) Put on clamp, hit vacuum, lower head.
4.) Put on wafer, blow off, release button
5.) With knobs find cross alleys in each half. With θ, align halves.
6.) With white button on right hand control and with "SCAN", align rough.
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 wafers will exchange position.
14.) Put aligned and exposed wafers in box.

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

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

ETCH - First Photo
Prebake as above
Put in buffered HF ($HF + NH_4F$) for 4 1/2 to 6 min. (till dewet).
Then rinse for ~5 min. and dry.
Then to Strip Resist (CARO5).

STEP 11 - "Strip Resist"

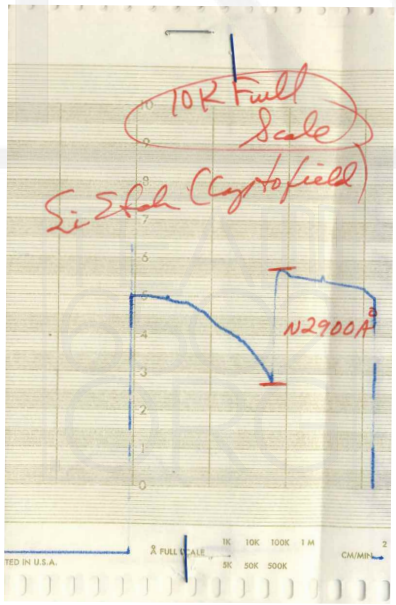
Put in "C" teflon boat
Immerse for 15' in CAROS as in Step 3.
Then Rinse as in step 3.
Then ≤ 30 sec. in 50:1 as in step 3
Then Super Q as in Step 3.

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. = .33 MAX)
Inside: .34, .35 (2 wafers) - .345 ave.
Outside: .385, .382

STEP 13 - "SILICON ETCH" - 34°C

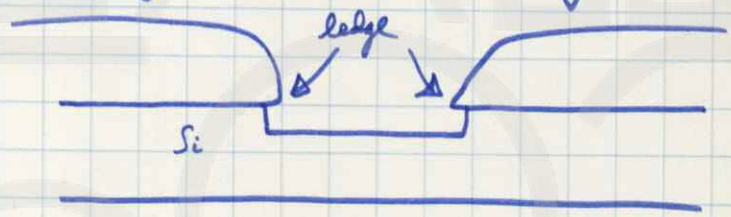
Place wafers (6 max each time + monitor)
Etch (spec = 1 3/4')
& etch 2 1/2 min. to attain deeper etch (2900Å).
Rinse ~ 5 min
Measure monitor (actually measure scribe alley to field step) on Dektak. Strip oxide in straight HF and measure step.



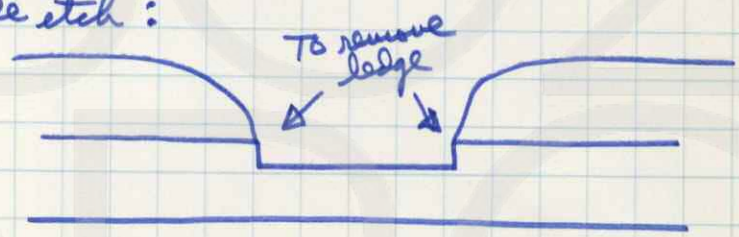
STEP 14 - "OXIDE ETCH"

In buffered HF, Etch ~ 30 sec, then rinse 5' and then SuperQ, as in step 3.

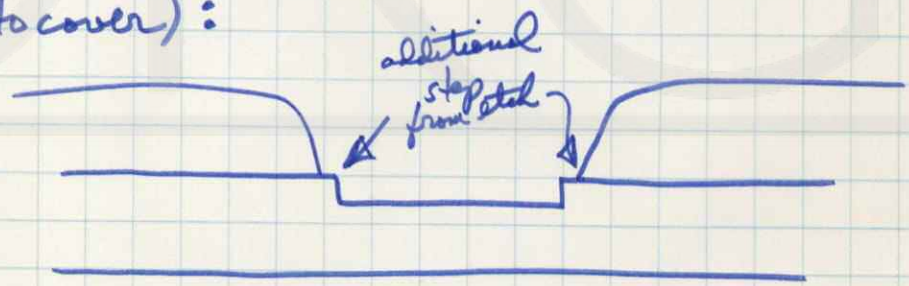
NOTE: The value of this step is questionable and was eliminated on 3/25/75. It was included to reduce any possible step resulting from the silicon etch undercutting the field thinly:



Purpose of oxide etch:



Probable result of etch (too great, resulting in additional step to cover):



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