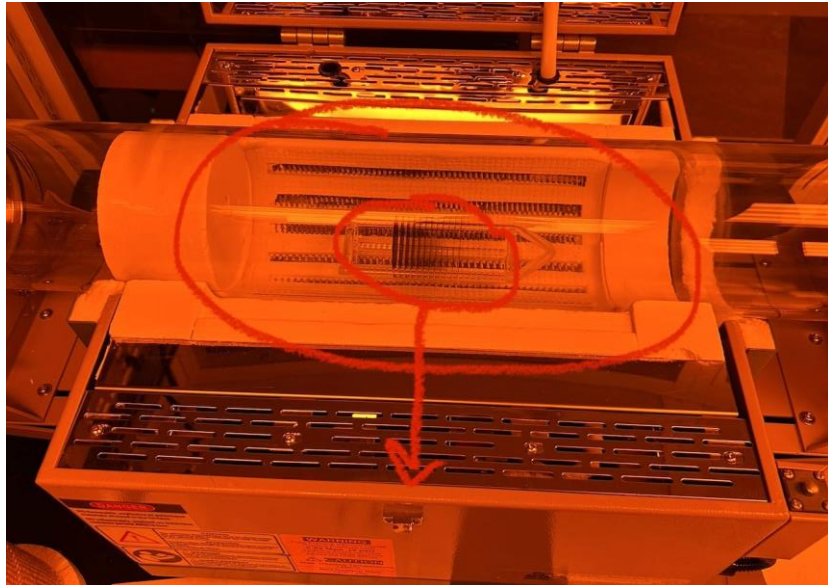


## Thermal Oxidation SOP

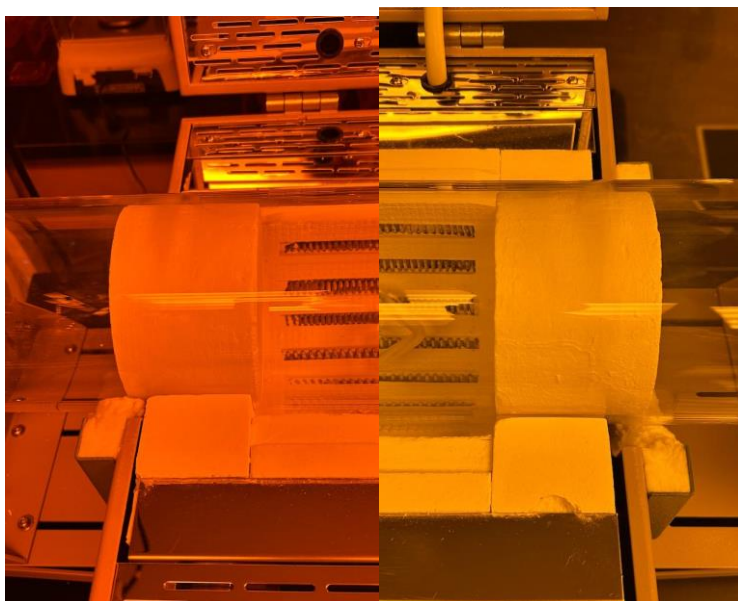
\*Needle valve is silver and butterfly valve is black

### Night Before Prep Gate OX (DRY OX):

1. Verify the UHP Oxygen and Nitrogen tanks are full enough for an oxidation run (> 700 psi)
2. Clean quartz boat with Acetone, Isopropyl, and Methanol, using cleanroom wipes
3. Clean tube furnace with Isopropyl and Methanol, using cleanroom wipes
4. Clean Thermocouple with Methanol, using cleanroom wipes
5. The back thermal block does not need to be moved.
6. Load the quartz boat with clean wafers. No matter the number of wafers, put them in the center of the boat so they are exposed to optimal and consistent heat. Make sure that the wafers are facing the shiny side away from the handle of the quartz boat. The shiny side is facing the gas input of the tube furnace. Two dummy wafers are used sandwiching the wafers on each end, also facing the same way (shiny side towards gas input).
7. Load the quartz boat into the center of the quartz tube so that the wafers line up with the door latch.




8. Line up the thermal blocks so that they line up with the inner insulation barrier of the furnace on each end.




9. Close the lid on the furnace SLOWLY- it can crush the tube. Close latch. Put the metal grid on top of the furnace in preparation for the thermocouple.
10. Put on metal lid and screw in on end of tube.
11. Program furnace controller:



Program	Input
c01	0
t01	20
c02	200
t02	20
c03	200
t03	40
c04	600
t04	20
c05	600
t05	50
c06	900
t06	55
c07	900
t07	70
c08	850
t08	20
c09	850
t09	120
c10	200
t10	-121
c11	185
t11	-121

- a. Turn the “Main Power” switch to ON position.

b. Press  , C01/current setting will be displayed

c. This button,  , will be used to go and see the next step of the heating curve.

d. When adjusting the times, these buttons are used to change values up and

down.  . To change certain values, use this button,  , to switch to different digits.


e. Day of Oxidation: after completed soaking time, change t06 from 55 to 1 by using the buttons shown in step d.


11. Place the Warning Furnace Sign on the Velcro door.


Day of Oxidation:

(**DRY RUN-Gate OX**) (Do not stand directly in front of furnace during process)

1. Go to the outside closet and open the UHP N<sub>2</sub> and O<sub>2</sub>. (You do not need to adjust the outlet valves.)
2. Back in the lab, turn the “Main Power” switch on, on the tube furnace. Double check the heating curve has been entered correctly following step 10 above. **Temperature C06 at 900°C for Dry oxidation. Time t06 at 55 min.**
3. Ensure that the Mass Flow Rates are set to 100 SCCM for N<sub>2</sub> and 20 SCCM for O<sub>2</sub>.

4. Twist the Nitrogen needle valve  , left at least three full rotations to open the nitrogen.

5. Turn the Nitrogen butterfly valve  to “ON” and nitrogen should now be flowing into the tube.




6. Press the  button for a couple seconds until the word “run” appears on the controller.
7. Press the green power button for two seconds until you hear a loud clicking sound and the red power light begins to blink. The blinking will not be consistent. The furnace is still on.
8. After 2.5 hours it is time to check if the furnace reached 900° C. Plug in the thermocouple hanging on the wall into the Omega Calibrator Thermometer.
9. Put on and wear the oven mitts.
10. Push the thermocouple through the metal lid and thermal block until the 2 scratches on the thermocouple are lined up with the end of the metal lid. Let the thermocouple sit for at least 3 minutes to ensure it reaches maximum temperature.
11. When you pull out the thermocouple it will be glowing red, place it on top of the metal grid on top of the furnace.

12. Twist the Oxygen needle valve at least three full rotations left to open the Oxygen.
13. Turn the DRY Oxygen butterfly valve to "ON" on the far right and Nitrogen butterfly valve to "OFF". Turn the Nitrogen needle valve right to close the Nitrogen.
14. Set a 25 minute timer for Dry oxidation. Once the desired oxidation time is done:
15. Reopen the Nitrogen needle valve. Turn the Nitrogen butterfly valve to "ON". Turn the DRY Oxygen butterfly valve to "OFF".
16. Close the Oxygen needle valve.
17. Go to the controller and program t06 from 55 min to 1 min. The cool down ramp should begin. Wait 1- 2 minutes to ensure temperature is actually going down on the controller.
18. Go to the outside closet and close the oxygen tank.
19. The furnace should take about 3-3.5 hours to cool down enough to be completely shut down. The furnace can be completely shut down once the temperature reaches 400°C or lower.
20. When the furnace has cooled off enough to be turned off, twist the Nitrogen butterfly valve to "OFF" and close the Nitrogen needle valve.
21. Switch the power switch on furnace controller to off and close the nitrogen tank in the outside closet.

### **Day of Oxidation: Dry-Wet-Dry (DWD)**

(DWD, 45-120-45, Field OX) (Do not stand directly in front of furnace during process)

- The bubbler takes about 1.5 hours to reach the optimal pressure of at least .085 MPa so it is important to time turning on the bubbler 1 hour and 45 minutes into the ramp up (which is a total of 2.5 hours).

1. Go to the outside closet and open the UHP N<sub>2</sub> and O<sub>2</sub>. (You do not need to adjust the outlet valves.)
2. Follow the same steps as “Night Before Prep”, change c06 to 1150, change t06 to 400
3. Unscrew the bubbler using the black wrench. Dump out remaining water and wipe it down with Kim wipes.
4. Fill the bubbler up 2/3 of the way, with 400 mL of DI water.
5. Put the bubbler back in the sleeve. Ensure all valves going into and out of the bubbler are closed.
6. Back in the lab, turn the “Main Power” switch on, on the tube furnace. **Double check the heating curve has been entered correctly following step 10 above.** Temperature C06 at 1150°C for DWD oxidation.
7. Ensure that the Mass Flow Rates are set to 20 SCCM for N<sub>2</sub> and 20 SCCM for O<sub>2</sub>.
8. Twist the Nitrogen needle valve , left at least two full rotations to open the nitrogen.
9. Turn the Nitrogen butterfly valve  to “ON” and nitrogen should now be flowing into the tube.
10. Press the  button for a couple seconds until the word “run” appears on the controller.
11. Press the green power button for two seconds until you hear a loud clicking sound and the red power light begins to blink. The blinking will not be consistent. The furnace is still on.
12. The bubbler takes about 1 hour and 30 minutes to heat up and reach the required pressure of at least .085 MPa. So, 1 hour and 45 minutes into the ramp up turn on the bubbler with the following steps:
  - a. Ensure the lid of the bubbler is tightly screwed on with wrench. Under the table is a small controller for the bubbler. Turn on the power switch.
  - b. The temperature should be set at 102°C. Press and hold the down arrow until the program says “run”. The bubbler is now heating up.
13. Once the furnace reaches 1150°C, twist the Oxygen needle valve at least two full rotations left to open the Oxygen.
14. Turn the DRY Oxygen butterfly valve to “ON” on the far right and Nitrogen butterfly valve to “OFF”. Turn the Nitrogen needle valve right to close the Nitrogen.
15. Set a timer for 45 minutes.
16. After 45 minutes, the bubbler should now be at .085 MPa or above, open the bypass valve fully on the bubbler
17. Open the outlet fully on the bubbler.
18. Open the butterfly wet ox valve to “ON” very slowly.
19. Close the dry butterfly valve to “OFF”
20. Close the bypass valve on the bubbler.
21. Open the inlet very slowly on the bubbler. (You will see water droplets enter the furnace, this is normal).
22. Set a timer for 120 minutes.

23. After 120 minutes of wet oxidation, close the outlet to the bubbler.
24. Close the inlet to the bubbler.
25. Open the Dry ox butterfly valve slowly to "ON"
26. Close the wet butterfly valve to off
27. Turn off the bubbler by flipping the power switch off on the bubbler controller under the table.
28. Set a time for 45 minutes. Verify the Oxygen is flowing at 20 SCCM.
29. After 45 minutes change the time t06 to one minute. The cool down begins.
30. It takes about 3.5 hours for the furnace to turn off. Can turn off the furnace when it is < 400 degrees Celsius.