

Lindberg/Blue 3-Zone Thermal Oxidation/Anneal Furnace (Model STF55366)

Operating Instructions

This tool is to be used by authorized personnel only. For training & consultation contact: Manager, **Omid Mahdavi**, (520) 621-9849, omidm@email.arizona.edu

Enter all necessary information in the Log Book for each use

1. Check the logsheet and inside the furnace tube to make sure the furnace tube is empty.
2. **ENABLE** Oxidation Furnace on CORAL.
3. Note the appropriate process information on the logsheet.

Furnace Temperature Controller Setup (Yokogawa Model UP150)

1. Locate controllers on the side panel outside in the chase area (**Figure 1**)



Figure 1 – Lindberg Temperature Controller Setup

2. Press and hold the **RESET** key on each of the 3 controllers (LEFT, CENTER, RIGHT) until the breaker goes off. Each controller corresponds to the zone inside the tube.
3. Press and hold the **SET/ENT** the key on the LEFT controller until PRG shows up:
4. Press **RUN** (arrow down) key to get **PRG -1** (negative one) to display.

NOTE: Press **RESET** to get to **PRG 1** on the LEFT controller as it is the newest version (vs. RUN to get to PRG -1 on the CENTER and RIGHT controllers).

5. Press **SET/ENT** multiple times until **SP1** is displayed.
6. Use the arrow keys to set **SP1** (SetPoint 1) temperature. This could be the temperature at which you would like to load your samples. It could also be the process temperature if you are loading samples at ambient temperature. Please refer to **Table 1** & **Figure 2** for desired temperature and final oxide growth if performing Si oxidation.
7. Press **SET/ENT** to save this setting.
8. Press **SET/ENT** again to set SP1 ramp-up time, **tM1**.
9. Set **tM1** to >90 minutes if the temp difference between current furnace temperature and the **SP1** is greater than 400C. This is the ramp time to SP1 from the current furnace temperature, typically ambient.
10. Press **SET/ENT** again to save this setting.
11. Press **SET/ENT** to set **SP2** (SetPoint 2) temperature same as SP1. This could be the temperature at which you would like to load your samples. It could also be the process temperature if you are loading samples at ambient. Please refer to **Table 1** & **Figure 2** for desired temperature and final oxide growth if performing Si oxidation.
12. Press **SET/ENT** to set SP2 soak time, **tM2**. This could be the anticipated amount of time required for loading your substrates at a temperature lower than that of the process. This could also be the required process time at temperature **SP2**. Please refer to **Table 1** & **Figure 2** for desired temperature and final oxide growth if performing Si oxidation.

NOTE: It is recommended that the actual process time be controlled by the user with a stop watch. The user should record the exact time the samples are placed in the furnace at temperature **SP2** and use a stop watch to extract the sample after the desired time has elapsed. It is recommended that 45-60min be added to the required process time (**tM2**) to allow for loading/unloading of wafers, etc.

13. Press **SET/ENT** again to save this setting.
14. Press **SET/ENT** to set **SP3** temperature. This could be the ramp-down temperature setpoint or any other desired temperature setting, typically ambient.
15. Press **SET/ENT** to save this setting.
16. Press **SET/ENT** again to set SP3 time, **tM3**. This is ramp-down time, typically >90minutes.
17. Press **SET/ENT** again to set SP4 time, tM4, to **OFF**.
18. Press and hold **SET/ENT** until the current temperature is displayed.
19. Repeat previous steps starting at Step 3 for the CENTER and RIGHT controllers.
20. Starting with the LEFT controller press and hold the **RUN** button until the light comes on for each controller. When the 3rd controller is activated the breaker will switch on.
21. To turn off the furnace after your processing has been completed and your substrates have been removed from the furnace simply **DISABLE** the tool on CORAL.

DI Water Bubbler Setup for Wet Oxidation

1. Remove clamp holding the fill tube cap.
2. Remove the fill tube cap and place on a clean surface.
3. Refer to **Figure 3**. Fill the bubbler with fresh DI water using a clean beaker, and if needed a clean funnel, from the lithography area inside the Class 100 cleanroom.
NOTE: NEVER RE-FILL BUBBLER WHILE IT'S HOT AND NEVER LET IT RUN DRY.

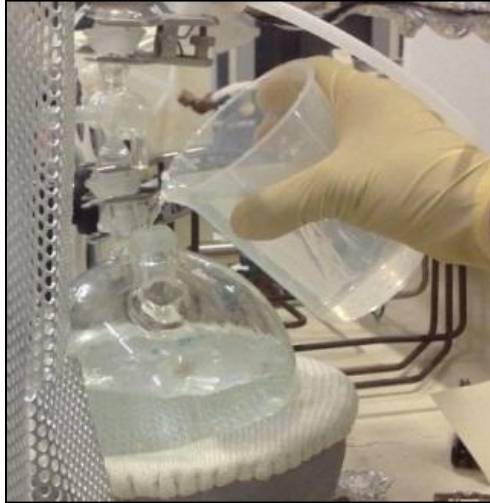


Figure 3 – Filling DI Water Bubbler for Wet Oxidation

4. Fill the bubbler no higher than the designated mark on the bubbler.
NOTE: It is recommended that the DI water in the funnel be replaced entirely if the last oxidation run was performed more than 48 hours prior.
5. Place the fill tube cap back on the fill tube and clamp it. Do not over tighten the clamp.
6. Turn on the Variac (bubbler heater) and set knob to 80 (which means 80% of 110 V)
7. Make sure that the bubbler vent valve is venting to the atmosphere by positioning the valve as shown in **Figure 4**.

Substrate Preparation and Loading/Unloading

1. Prepare and clean your Si substrate by using an appropriate cleaning method such as HF cleaning or an RCA clean procedure.
2. Load the Si substrate on a clean quartz boat making sure they are situated properly in their slots.
3. Place the quartz boat in the center of a glass quartz boat loader/unloader

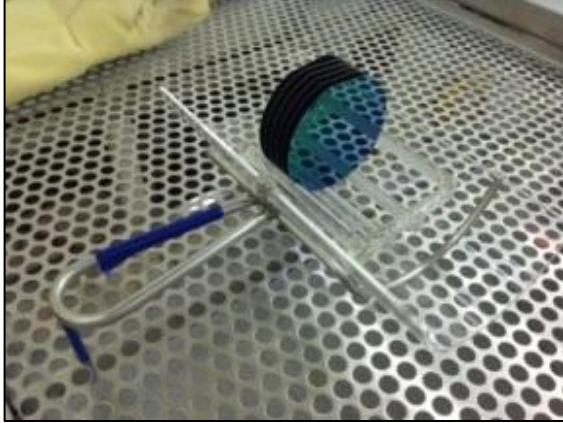


Figure 5 – Wafers in a Quartz boat sitting on a Glass Quartz Boat Loader/Unloader

4. Wear the thick padded protective gloves to begin loading.
5. Remove the end cap off the furnace tube.
6. Hold the end of the glass loader flush with the bottom of the furnace tube.
7. Push the quartz boat into the furnace with the short quartz push rod.



Figure 6 – Quartz boat being loaded/unloaded using the short quartz rod and glass boat loader/unloader.

8. Use the long push rod to push the quartz boat towards the center of the furnace tube at a rate of about 1 inch every 5 seconds.

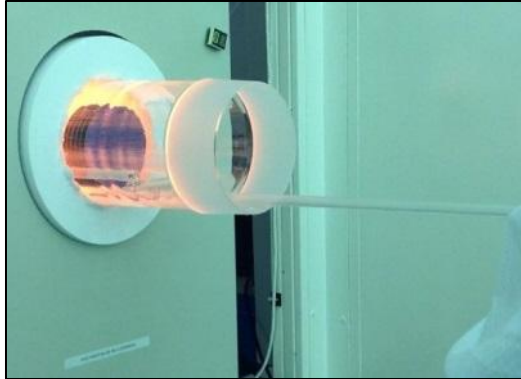


Figure 7 – Long push rod being utilized to load/unload quartz boat

9. Remove the long push rod and place the end cap back on the tube

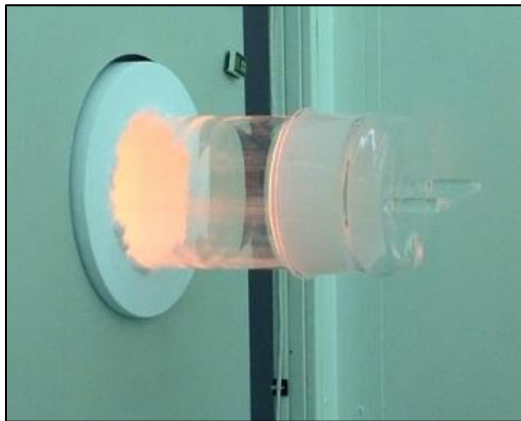


Figure 8 – Furnace with end cap in place. The end cap hole should be on the bottom.

10. Refer to **Figure 4**: Turn the bubbler vent valve to direct flow into the furnace (vapor to process position).
11. Refer to **Figure 9**: Turn on the Wet O₂ switch and set the flow to a **setting of 10-20** on the Wet O₂ flowmeter.

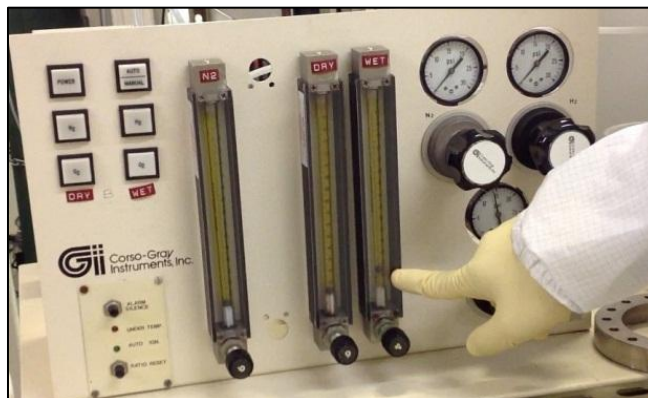


Figure 9 – Flowmeters on the gas panel for the Lindberg/Blue Oxidation Furnace

12. Use a timer to keep track of the oxidation time.
13. Shut off the bubbler and the Wet O2 switch once your timer indicates the end of the oxidation process.
14. Return the vent valve to the vent to air position.
15. Using the padded gloves CAREFULLY remove the end cap off the tube. Occasionally, the end cap becomes hard to remove. Quick bursts of twisting motion using your wrist has been found to be useful!
16. Place the end cap on the metal processing table next to the furnace.
17. Use the push rod to pull the boat slowly and carefully out of the furnace and onto the boat loader.
18. Place the end cap back on the tube.
19. **DISABLE** the furnace on CORAL.
20. Allow the substrates to cool down, typically 10-15 minutes, before handling.
21. Refer to **Figure 10**: You could use the handy wafer oxide color display located on the furnace processing table to determine approximate oxide thicknesses on your Si substrates. This is mainly for trouble shooting and educational purposes. More exact measurements have to be done on the ellipsometer or reflectometer located in the Class 100 metrology bay.



Figure 10 – Wafer Oxide Thickness Color Guide

Furnace Temp.	Left Zone	Center Zone	Right Zone
950 C	966	965	988
1000 C	1042	1016	1038
1050 C	1092	1066	1085

TABLE 1 – Oxidation Temperature Settings

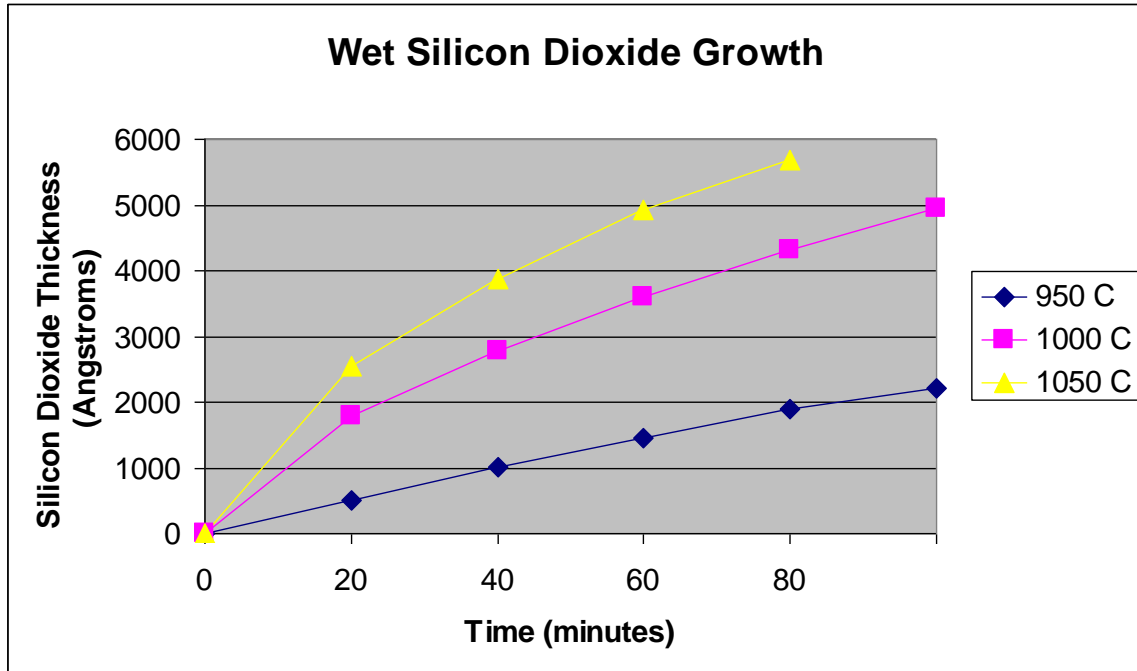


FIGURE 3 - Si Thermal Oxide Growth vs. Time in the Furnace Tube

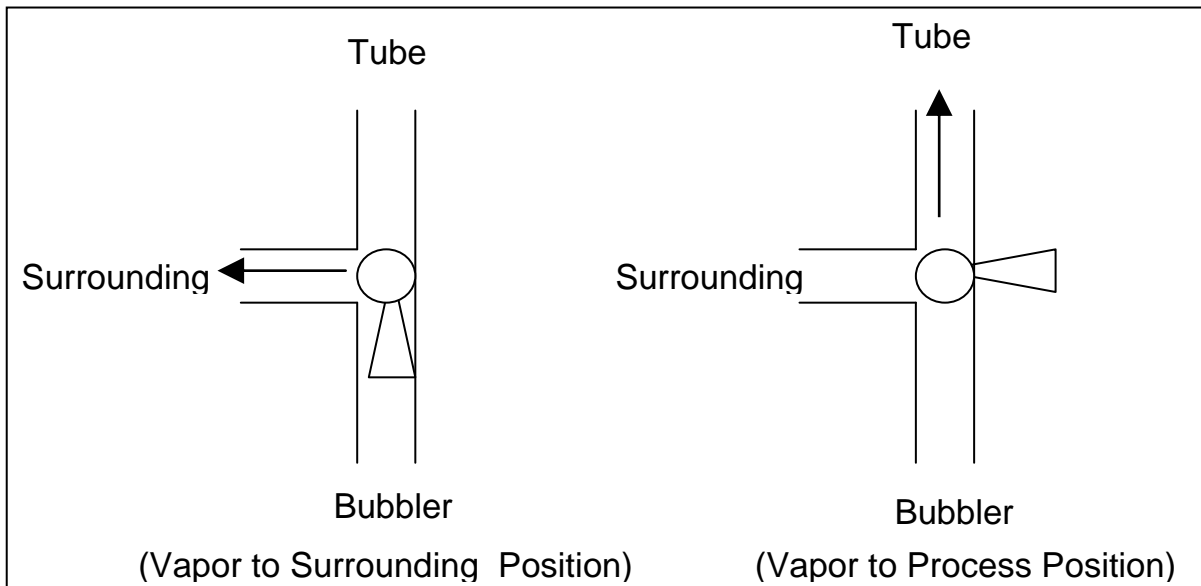


FIGURE 4 - Bubbler Valve Positions