

## FURNACES SOP

Thermal Oxidation Furnace  
Diffusion Furnace  
Anneal Furnace

Revised April 2020

Steps to program the furnace controller are the same for ALL THE FURNACES.

Program your thermal cycle with a ramp rate, dwell temperature, dwell time, and ramp down.

1. Turn on the furnace controller by activating the circuit breaker on the left side of the control panel.
  - Let the controller run thru the self-test
  - The controller will display a flashing **AL1** and read the current temperature
  - Press the lower center and scroll to **AL1**
  - Press the '**SECRET**' button located on the digits. A click should be heard. The controller will display **CLR**
  - The Excess Temperature features will be cleared allowing the furnace controller to operate properly
2. Open the door below the first row of buttons.
3. To make a ramp up and soak time program do the following.
4. Press and hold the far right scroll button. This will put you in the programming mode, allowing the program to be modified.
5. **PR1** is the ramp rate. Press the up arrow key to modify this number.
6. **PL1** is the operating temperature the furnace will reach. Use the up and down arrow keys to modify this value.
7. **Pd1** is the dwell time or soak time of the furnace. The value is in hours. Set the time using the up and down arrow keys.
8. Move onto the next program to program a ramp down.
9. **PR2** is the ramp rate. Press the up arrow key to modify this number.
10. **PL2** is the operating temperature the furnace will ramp down to. Use the up and down arrow keys to modify this value.
11. **Pd2** is the end time. Hold the down arrow key until the **END** is displayed. This will end the program.
12. Press the scroll key to display the amount of time left in the ramp program.
13. If the program is entered properly, wait for the program mode to exit.
14. Press the **RUN/HOLD** key to start the program running.

15. To modify a program while it is running, go into the program mode. Cycle to the value to be modified.
16. Press the **HOLD** key. A dot should be blinking next to the value.
17. The value is now safe to modify using the up and down arrow keys.
18. When done modifying the program, press the **HOLD** key again.
19. Allow the program to exit and return to the normal operating mode.

Don't forget to log into your FOM account and login to your session to use the furnace.

### Thermal Oxidation in the Trash Furnace

#### Prepare the bubbler

1. If the water level in the quartz bubbler is below 1/3 of the capacity of the bubbler it will need to be refilled. Also, fill the thermowell for the thermometer with water to complete heat transfer. For the highest quality oxides, change the water before each run.

**NOTE:** If you need to refill the bubbler, please contact a MNTC staff members and they can do it for you.

OR

This can be done by removing the side fill cap, clamp and disconnecting the inlet line and outlet lines. Empty and refill the water bubbler to 1/2 full with fresh DI water from the goose neck spouts available at one of the wet benches!!!

2. Turn on the Thermolyne bubbler controller to the designated line for the bubbler temperature to achieve a temperature between 90°C and 100°C. Do not exceed 100°C.
3. Turn the heat tape controller to the designated line. This prevents steam from condensing before it reaches the tube furnace. Let the water temperature stabilize between 90°C and 100°C. Do not exceed 100°C before wet oxidation

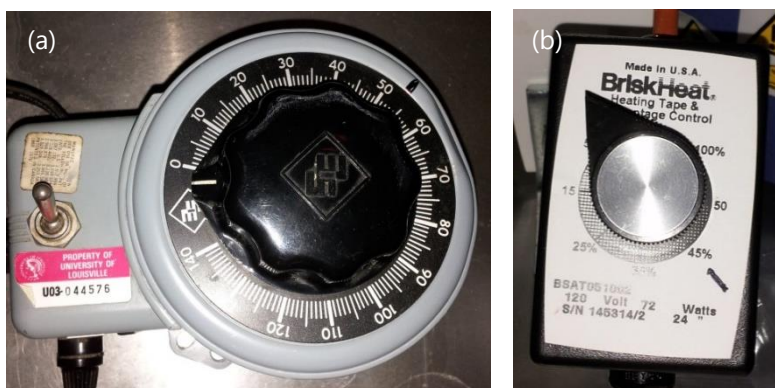


Figure 1. (a) Thermolyne bubbler controller, (b) heat tape controller

#### Loading Wafers

1. Using the white thermal gloves on the metal rack remove the end cap from the tube furnace and place onto the ceramic plates.
2. Remove the glass pull-rod corresponding to the trash furnace from its holder on the lower section of the metal rack.
3. Using the u-shape boat holder (also known as a paddle) and the pull-rod, remove the wafer boat and place it onto the ceramic plates. Place the rod back into its holder making sure to place the hooked end into the tube first.

4. Load wafers into the boat
5. Once again using the boat holder and pull-rod, push the quartz boat into the mouth of the furnace.
6. Use the rod to push the boat into the center of the tube slowly at a rate of approximately 1" per 5 seconds (12" per minute). Exceeding this rate can cause the wafers to warp. Push the boat to the scribed line on the rod.
7. Return the pull-rod to its holder.
8. Place the end cap loosely onto the end of the tube furnace and do not push it in all of the way. These tubes and caps have a design error where the cap can become stuck due to heating and cooling of the both components.

### Gas Controls

**NOTE:** All gas valves and selectors are labeled (1) through (14)

### Nitrogen

1. Turn on the green Nitrogen valve (2), Figure 2.



Figure 2

2. On the gas distribution panel set up the Nitrogen Selector (5) to the Trash Furnace, and the Trash Furnace Selector (11) to the Nitrogen (Figure 3).

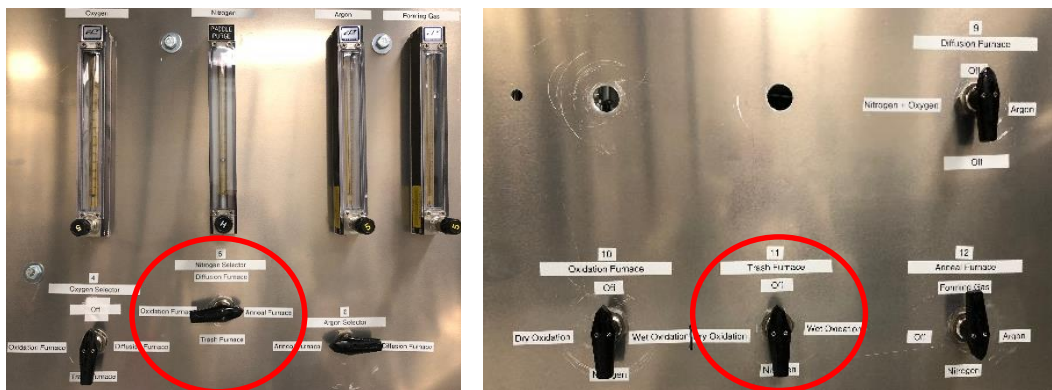


Figure 3

### *Dry Oxidation*

1. At the Trash Bubbler Selector (**14**) choose the Bubbler Vent position, Figure 4



Figure 4

2. When desired temperature is reached (typical oxidation temperature is 1000°C), close green Nitrogen Valve (**2**) and open green Oxygen Valve (**1**), see Figure 2.

**NOTE:** Oxygen should be flowing at a rate of 1L/min or a setting of **30** on the flow meter. **PLEASE, DO NOT ADJUST OR CHANGE IT.**

3. Set the Oxygen Selector (**4**) to the Trash Furnace, then set the Trash Bubbler (**8**) to the Dry Oxidation position, and choose the Dry Oxidation on the Trash Furnace selector (**11**).
4. Perform dry oxidation for 0.1 hours or longer (optional), which will be followed by wet oxidation (next section).

### *Wet Oxidation*

1. When dry oxidation is complete (optional), set the Trash Bubbler (**14**) valve to the Wet Oxidation position (Figure 4).
2. Open the green Oxygen Valve (**1**).
3. Set the Oxygen Selector (**4**) to the Trash Furnace, then set the Trash Bubbler (**8**) to the Wet Oxidation position, and choose Wet Oxidation on Trash Furnace selector (**11**) (Figure 3).

You should start to see oxygen bubbling through the bubbler, then perform wet oxidation for your desired duration.

**NOTE:** Make sure that the thermometer well does not become dry during your program by refilling it frequently with DI water in the provided bottle (Figure 5).

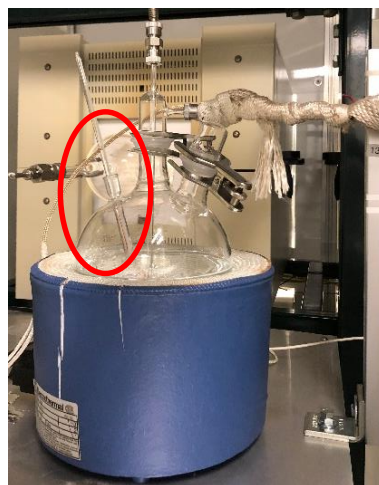


Figure 5

### *After Wet Oxidation & Turning off Oxygen*

1. After the wet oxidation is complete perform dry oxidation for 0.1 hours or longer (optional).

- Turn off the Green Nitrogen Valve (2) on the gas distribution panel (Figure 2).

### Unloading wafers

- After the oxidation program is complete turn off the bubbler heat controller and heat tape.
- Using the white thermal gloves on the metal rack remove the end cap from the oxidation tube furnace and place it onto the ceramic plates.
- Remove the oxidation rod from rod Tube 2 on the lower section of the metal rack. Take care to not touch the rod past the line etched in the rod for this will help keep contamination from entering the tube furnace.
- Pull out the boat at 100-200°C slowly at the rate of 1" per 5 seconds. Allow the wafers to cool at the end of the oxidation tube furnace for five minutes before removing the quartz wafer boat from the furnace using the u-shaped wafer boat holder.
- At the end of the 5 minutes cool-down period, remove the wafer boat using the u-shaped boat holder and push rod. Place the wafer boat only on the ceramic plates.
- Place the rod back into the rod Tube 2 making sure to place the hooked end into the tube first.

### Diffusion Furnace

#### Gas controls: Nitrogen + Oxygen

- Turn on the green Oxygen Valve (1) and the green Nitrogen Valve (2) on the gas distribution panel, Figure 2.
- Set the Oxygen Selector (4) to the Diffusion Furnace and Nitrogen Selector (5) to the Diffusion Furnace position, and choose the Dry Oxidation Diffusion on the Furnace selector (11) (Figure 6).

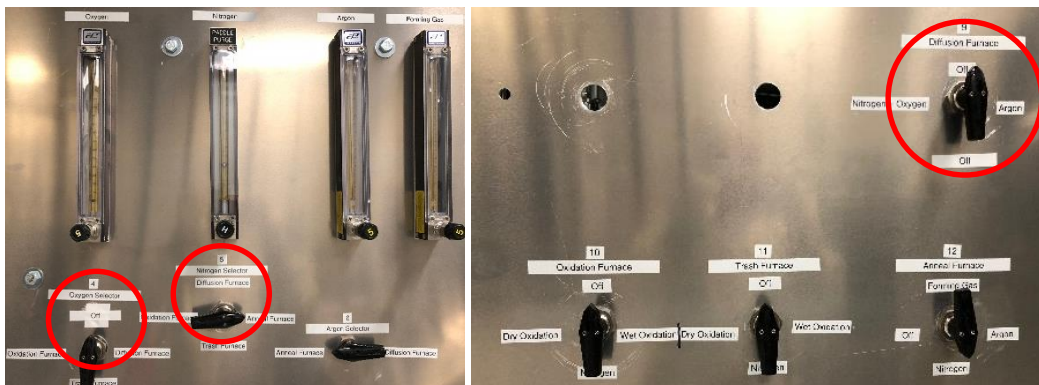


Figure 6

- After the diffusion is complete, set the Oxygen Selector (4) and Nitrogen Selector (5) to the OFF position, and turn off the green Oxygen Valve (1) and the green Nitrogen Valve (2) on gas distribution panel.

## Anneal Furnace

Gas controls: *Nitrogen or Argon ONLY*

1. Turn on the green Nitrogen Valve (2) on the gas distribution panel (Figure 2).
2. Set the Nitrogen Selector (5) or Argon Selector (6) to the Anneal Furnace position, and then choose Nitrogen or Argon on the Anneal Furnace selector (12) (Figure 7).



Figure 7

3. After the anneal process is complete, set the Anneal Furnace Selector (12) to OFF position, and turn off the green Nitrogen Valve (2) on the gas distribution panel.

**NOTE:** When you finished using the furnace, don't forget to logout in your FOM account