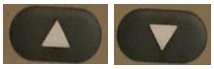
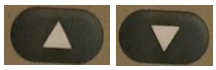
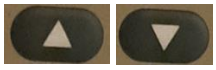
Tube Furnace Operation

1. Plug into 220 VAC.
2. Turn the "Main Power" switch to the **ON** position.
3. Enter the desired heating curve. An example of a heating curve is shown on the next page.
    a. Press 
    b. **C01** will be displayed on the red PV screen.
        i. Use the  buttons and set the starting temperature to 0.*
        ii. Press return,  , to set the time, **t01**.**
            1. Use the  to adjust the time.
            2. To change to a higher value, press the  until the correct place value is selected.
            3. The dot is NOT a decimal, it's the place value selected.
            4. Use the  buttons to enter the desired values.
        iii. Press return,  , to change **C02**.
            1. Use the  to adjust the time.
        iv. Press return,  , to set **t02**.
            1. Use the  to enter the desired time.
        v. Repeat all steps to enter the rest of the heating curve.
        vi. The last step is the kill code, -121 on **t0x.**
    c. To start the program, press the green button, 

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    d. Now press the  for 2 seconds to run the heating curve.

*The starting temperature is always 0.

**THE MAXIMUM TEMPERATURE INCREASE RATE IS 10 °C/MIN.

Heating Curve

C01	0	Initial Temperature, always start at 0.
T01	20	Running time from C01 to C02 at 10 °C/min max.
C02	200	Target temperature
T02	20	Running time from C02 to C03, maintain 200 °C for 20 minutes.
C03	200	Target temperature
T03	40	Running time from C03 to C04 at 10 °C/min.
C04	600	Target temperature
T04	20	Running time from C04 to C05, maintain 600 °C for 20 minutes.
C05	600	Target temperature
T05	50	Running time from C05 to C06 at 10 °C/min.
C06	1100	Target temperature
T06	600	Running time from C06 to C07. See below.
C07	1100	Target temperature
T07	140	Running time from C07 to C08 at 5 °C/min cool down.
C08	200	Target temperature
T08	-121	Kill code. Furnace will stop and cool down naturally.

ATTENTION:

- **Segments C01 to C05 are necessary, this is the pre-heat process.**
- **Segments C06 to C07 are when the oxidation is done. Oxidation will NOT take 600 minutes. Oxidation may only take 1 hr 30 min, 15 min dry, 60 min wet, 15 min dry.**
- **When oxidation is done, adjust T06 to 1 and press**  **together and wait 1 min to make sure the temperature is ramping down.**
- **Segment T07 is the cool down from 1100 °C to 200 °C at 5 °C/min.**
- **When the tube furnace cools down to around 400 °C, the tube furnace can be switched off.**

Thermal Oxidation Standard Operating Procedure

1. Load the wafer(s) into the center of the quartz wafer boat and insert them into the tubel furnace with the polished side toward the gas flow. Center the wafer boat as much as possible.
2. Insert the 2 thermal blocks and close the door. Secure the door by hand tightening the screws.
3. Fill the bubbler with de-ionized (DI) water about 2/3 of the way.
4. Turn the tube furnace on per the **Tube Furnace Operation** and enter the heating curve, if necessary.
5. Turn on the N_2 gas. Make sure its on outside.
    a. On the left, rotate the valve labeled “Nitrogen” counterclockwise 3 full turns.
    b. On the right, turn the valve also labeled “Nitrogen” to the ON position.
    c. Set the flow rate on the ALICAT N2 to 60 SCCM (standard cubic centimeters per minute).
    d. Allow the N_2 gas to flow during the pre-heat process.
6. Once the tube furnace has reached 1100 °C, the wafers are ready to be oxidized. Heating up to 1100 °C may take 2 to 3 hours.
7. Turn on the bubbler and heat the DI water to 98 °C. This only takes a few minutes.
8. Start with dry oxidation followed by wet oxidation and finish with another dry oxidation.
9. Turn on the O_2 gas. Make sure it’s on outside.
    a. On the left, rotate the valve labeled “Oxygen” counterclockwise 3 full turns.
    b. On the right, turn the valve labeled “Dry Oxygen” to the ON position.
    c. Set the flow rate on the ALICAT O2 to 3 SCCM.
    d. On the right, turn the valve labeled “Nitrogen” to the OFF position.
    e. Dry oxidize for 15 minutes.
    f. When complete, turn both valves on the bubbler counterclockwise 3 full turns.
    g. Turn the “Dry Oxygen” valve to the OFF position.
    h. Turn the “Wet Oxygen” valve to the ON position.
    i. Wet oxidize for 60 minutes.
    j. When complete, turn both valves on the bubbler clockwise 3 full turns and turn the bubbler off.
    k. Turn the “Wet Oxygen” valve to the OFF position.
    l. Turn the “Dry Oxygen” valve to the ON position.
    m. Dry oxidize again for 15 minutes.
    n. When complete, turn the “Dry Oxygen” valve to the OFF position.
    o. Turn the “Nitrogen” valve to the ON position.
10. Modify **T06** on the tube furnace to 1 and wait for it to start ramping down.
11. Allow the tube furnace to cool down to at least 400 °C before turning it completely off. This may also take a couple of hours.
12. Remove the wafers and put them each in a wafer carrier labeled with the date and position in the wafer boat.
13. Proceed to ellipsometry to measure the oxide thickness.

14. Proceed to the wafer cleaning steps.