MONTANA STATE UNIVERSITY | Montana Microfabrication Facility

2-MODU-LAB- Oxidation Furnace (Wet)

Safety

- The furnace gets extremely hot and remains hot to the touch hours after it has been turned off. Use extreme caution and appropriate PPE. Do not grab the quartz cover or a boat without testing if they are hot first.
- Use caution when unplugging and plugging in the furnaces.
- Do not place your hands or other body parts inside furnace.

Allowed Materials and Processes

- The MODU-LAB Oxidation Furnace is only used for growing a silicon dioxide layer on silicon wafers.

Restricted Materials and Processes

- Do not place sources from other furnaces in the Oxidation Furnace.
- Do not put wafers that have been metallized at any point into this furnace.
- Do not operate the furnace above 1050 °C without explicit permission.

Important Equipment Notes

- Be extremely careful when handling the quartz boat and quartz rod.
- Wafers may be loaded and unloaded at temperatures higher than 400 °C. If you do so, you must load and unload slowly to not thermally shock the wafers.
- Once unloaded, the wafers should be placed on one of the metal tables to completely cool (usually around five minutes) before being stored in a plastic cassette.
- Heating and cooling times:
    - To heat up to 400 °C, the furnace takes around 5 minutes.
    - To heat up to 1000 °C, it takes about 15 minutes.
    - To cool down from 1000 °C to 400 °C, it takes about 1.5 hours.
- Be careful when loading quartz ware during a wet oxidation – water dripping on the rods or boat can cause a thermal shock and shatter them.

Operating Procedures

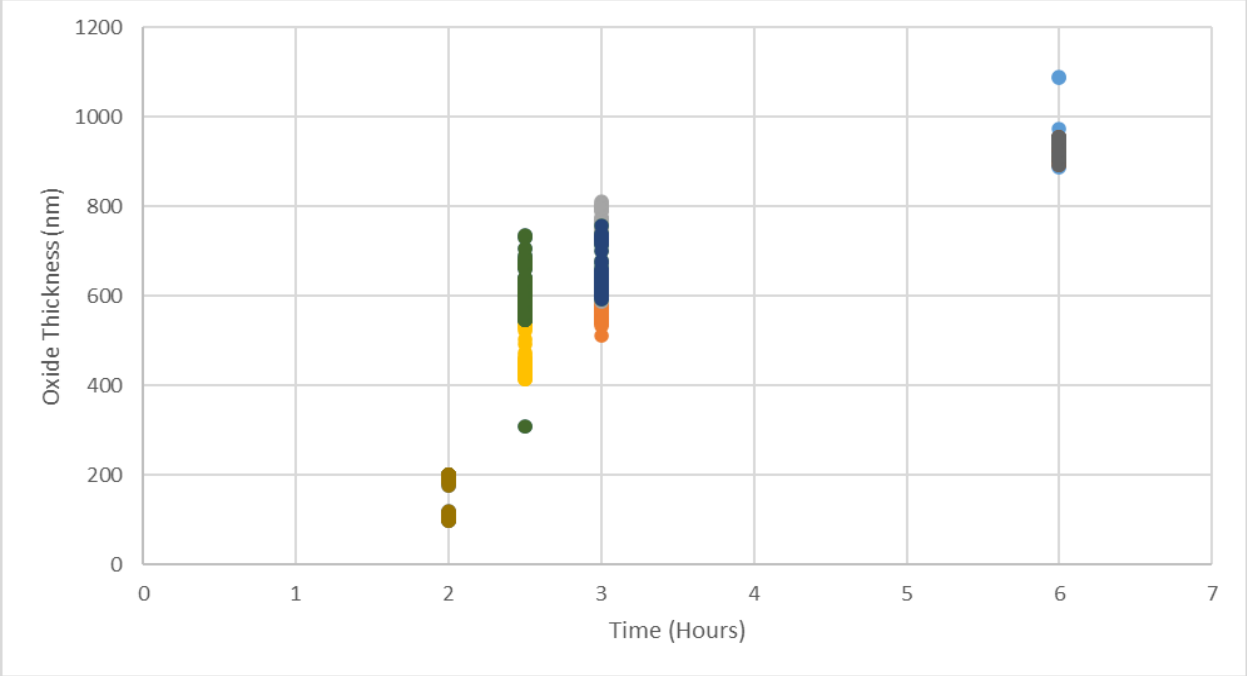
1. Check reservations and make one at the MMF tool reservation site.
2. Check lab status.
    a. Check that the N_2 is on for lab.
    b. Check that the O_2 bottle pressure is above 400 PSI.
    c. Check that the N_2 bottle pressure is above 400 PSI
3. Plug in the furnace and turn it on.

   a. To turn on the furnace, hold the circular power button while switching the main power switch (looks like a breaker switch) to the on position.
   b. Continue holding the reset button until the temperature readings appear on the display.
4. Turn on the DI water, in wet processing bench, and let run for at least 2 minutes before filling the flask and verify that the resistivity is above 15 MOhm-cm on the resistivity meter in the mechanical chase behind the bench.
   a. It will take several minutes for the resistivity to increase. It usually starts at less than 10 MOhm-cm. Let the tap run and wait for the gauge to reach 15. This is because 523 doesn't have a recirculating DI water system, so the water in the pipes is not always truly DI.
5. Loosen the black stopper on the DI water flask, and then lift the flask off the hotplate so you can remove the tube that goes into the flask. Be extremely careful when removing flask from the hotplate because there are fragile tubes and quartz pieces surrounding the flask.
6. Fill the flask with de-ionized water
   a. Rinse the flask for at least 2 minutes with DI water.
   b. Fill the flask to the top of the "PYREX" lettering.
7. Replace the flask on the hot plate, ensuring that the black stopper is firmly secured and that the feeder tube is placed in the fitting connected to the oxidation furnace.
8. Turn on the Staco hotplate heater power and set the knob to 50.
9. Clean the quartz rod and metal tray with isopropyl alcohol and clean wipe.
   a. Use the rod and metal tray that are labeled "OXIDATION Furnace."
10. Unload quartz boat from furnace.
   a. Check that it is not still hot, and then remove the quartz furnace cap from the entrance to the furnace and place it on a clean metal surface.
   b. Place the metal tray at the entrance of the furnace, making sure the furnace tube and the metal tray are lined up and flat.
   c. Slowly push quartz rod into furnace, making sure to keep the end of the rod as low as possible.
   d. Hook the end of the rod through the loop on the quartz boat.
   e. Slowly pull rod and quartz boat towards entrance of the furnace.
   f. When you reach the end of the furnace tube and the start of the metal tray, align the metal tray to the entrance of the quartz tube to prevent shocking the quartz boat.
   g. Continue to pull the quartz boat until most of the quartz boat is on the metal tray.
   h. Lower the metal tray back down to its original resting position.
   i. Pull the quartz boat all the way out of the furnace tube and fully onto the metal tray.
11. Load desired number of wafers into quartz tray between the two "baffle" wafers.
12. Reload the quartz boat into the middle of the furnace.
   a. Place loaded quartz boat on metal tray.
   b. Hook the end of quartz rod into loop of quartz boat.
   c. Gently push the quartz tray into the middle of the furnace. You can check if the tray is in the middle of the furnace by marking the spot on the quartz rod that is at the entrance of the furnace. Remove the rod from the furnace and line up the marked spot with the entrance of the furnace on the outside. Where the end of the rod is located is where the start of the quartz boat is located.
   d. Replace the quartz furnace cover.
13. Set desired temperature on the master control (center panel).

   a. The other two zones will be automatically set by the master control. Do not set the temperature above 1050 °C.
14. Turn on the nitrogen gas with the quarter turn ball valve and set the flow to 7 using the black knob. This valve is located at the right-hand side of the furnace.
   a. Must be done with any chamber temperatures greater than 400 °C.
15. When the temperature of all three zones reaches the desired temperature, turn on the oxygen, turn off the nitrogen, and set the oxygen flow to 9.
16. Run the oxidation for the desired amount of time.
17. When the desired time has elapsed, turn the nitrogen back on at a flow of 7, and turn off the oxygen.
18. Set the temperature on the master control of the furnace to 0 °C.
19. Turn off bubbler.
20. Allow the temperature of the furnace to decrease below 400 °C before moving on.
21. Turn off the Nitrogen gas flow valve.
22. Clean the metal tray and quartz rod with isopropyl alcohol.
   a. Use quartz-ware labeled oxidation furnace
23. Unload quartz boat from the furnace.
   a. Place metal tray at the entrance of the furnace, making sure the furnace tube and the metal tray are lined up and flat.
   b. Slowly push the quartz rod into the furnace, making sure to keep the end of the rod as low as possible.
   c. Hook the end of the rod through the loop on the quartz boat.
   d. Slowly pull rod and quartz boat towards entrance of furnace.
   e. When you reach the end of the furnace tube and the start of the metal tray, slightly lift the metal tray on the side closest to you.
   f. Continue to pull the quartz boat until most of the quartz boat is on the metal tray.
   g. Lower the metal tray back down to its original resting position.
   h. Pull the quartz boat all the way out of the furnace tube and fully onto the metal tray.
24. Remove wafers from quartz boat leaving the “baffle” wafers.
25. Reload the boat into the furnace once wafers are removed.
   a. Please load the front of the boat to just inside the insulation surrounding the glass chamber.
26. Turn off furnace by switching the Main Power Switch back.

Process Parameters for Desired Oxide Thickness

Data is from wet oxidations at 1000 °C for EELE 407. Note that oxide thickness can vary significantly between runs.



Troubleshooting

- Furnace is plugged in but will not turn on.
- Check that someone is logged into SUMS
- If no one is logged into SUMS contact MMF Staff

Version History

- 2020.1 – Original document written by Geneva Feist, Andrew Lingley, and Andrew Oliver.
- 2022.1 – Changed “beaker” to “flask” for accuracy. Updated formatting and wording in several places. Added temperature restrictions. Added degree symbol to temperature values.
- 2024.1 – Changed 16 and 18 for better clarity.
- Added oxide thickness table and sample oxidation process.
- 2025.1 Updated for accessibility by Owen Bunn