



## Oxford Instruments - Plasmalab System100

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### Safety

- The system operates with voltages high enough to cause shock or burn injury. Never open panels or remove covers from the system.
- The system produces electromagnetic radiation from audio to 2.45 GHz frequencies, which can have field strength strong enough to cause death or injury if not properly shielded. Never remove covers or protective shielding.
- The system contains compressed gases including fluorine compounds that can leave toxic residues in the system. Use appropriate caution with gases, never defeat interlocks or try to fix equipment problems, and never open the chamber without appropriate pre-cleaning and without appropriate personal protective equipment and training.
- Etched materials or their byproducts may be toxic. Never open the chamber without proper pre-cleaning and appropriate personal protective equipment and training.
- The system uses liquid nitrogen (LN<sub>2</sub>) to cool the sample. Direct skin contact with liquid nitrogen or the plumbing carrying it can cause frostbite. **Never tamper with the tank blow off valves or other LN<sub>2</sub> safety features.** This can result in over pressurization and catastrophic/explosive tank failure. A massive LN<sub>2</sub> leak constitutes an asphyxiation hazard, evacuate the lab.
- The system has a substrate heater that can operate at very high temperatures, capable of causing burns on contact. Care must be taken when using the heated stage to avoid contact with any hot areas. The chamber walls are also heated to 60 C.

### Allowed Materials and Processes

- Si DRIE (Bosch/DSi, etc.), Si mixed, SiO<sub>2</sub>, various polymers

### Restricted Materials and Processes

- Cryogenic Si etching
- Metal etching (W, Mo, etc.)
- Metal hard masks (Al, Cr, Ni, etc.)
- III-V etching
- LN etching

### Important Notes

- Do not ever press the STOP ALL AUTO PROCESSES button in the upper right side of the screen. If you do press it by accident, carefully read the message, and then press No to avoid shutting the system down.
- Do not ever enter service mode. If you do enter service mode by accident, do not press any valves. Press System and then Exit Service. Read the message and click Ok to exit service mode. Do not worry, there is no real DANGER!!! despite the daunting message.
- Be careful not to hit the EMO button accidentally on the front of the tool.
- Do not ever run process steps with **IGNORE TOLERANCE** selected.
- If you are running long switched processes, for example a DSi or DRIE etch, make sure to monitor the process regularly for a change in temperature and to make sure the plasma is still on and the correct color. The switching process is too fast for any tolerance errors to show up.



## Operating Procedures

1. Check reservations and make one.
2. If necessary, login to the equipment. Press **System** then **Password**. Then enter OPT and OPT for the username and password. (Note: you may need to accept a “YELLOW ALERT” that says, “End of process reached”, when you come to the tool.)
3. Equipment checks.
  - Press **System** then **Pumping**. Ensure there are no red alerts present, and that all the interlocks on the bottom right of the screen are green except for the Gas-Pod Interlock – it is normal for this to be red before starting a process.
  - Check base pressure. Check that the penning gauge on the process chamber reads less than  $5.0 \times 10^{-6}$  Torr. If the tool has been used recently, the pressure may be higher. This is acceptable if the pressure is decreasing. If the pressure is above  $5.0 \times 10^{-6}$  Torr and is not decreasing, leave a note that the tool is inoperable and report the issue to staff.
  - Check the CM gauge. Press Process, Chamber1. The CM gauge reading, shown in the APC CONTROLLER box (“Chamber Pressure”) on the Chamber1 screen, should be 0.1 mTorr while the system is at base pressure. If the CM reads 0.0 mTorr or reads  $>0.3$  mTorr, report the issue to staff. If you have extremely critical processes, wait for the tool owner to adjust the CM gauge back to 0.1 mTorr before continuing.
  - Take the Eurotherm 2404 controller out of manual mode by pressing the left circular button and verifying that the **AUTO** LED lights up. The **OP2** light will turn on when the actual temperature (top reading) is above the setpoint (lower reading).
  - Turn on the liquid nitrogen in the maintenance area. Check the gauge in the center on the top of the tank to ensure that greater than a quarter of a tank of LN<sub>2</sub> remains. These gauges are notoriously inaccurate, so proceed with caution and expect that the level might be lower than it appears. If the level is less than one quarter, inform staff and make a conscious decision about whether to proceed with your samples.
  - Set the chuck temperature. Press **Process** and then **Recipes** and set the operating mode to Manual and No Wafer (i.e. make sure both buttons have yellow dots on them). Press **Load**, select the “System – Set Temp” recipe, and press **Ok** (Note: do not save previous recipes, but you may need to acknowledge that you are overwriting a previous recipe). Edit the chuck temperature by left clicking the only step in the recipe, then selecting **Edit Step**, changing the temperature in the **CRYO** box to the desired temperature, and pressing **Ok**. Once back on the **Process, Recipes** screen, click **Run**. Read and accept the yellow alert, and then check that the new set point on the Eurotherm 2404 is correct.
4. Confirm that the chuck temperature is approaching the setpoint.
5. Load a dummy wafer or monitor wafer. Typically, a dummy wafer is left in the load lock. Check that it is resting snugly against the cams with the flat facing away from the process chamber. If there is no wafer present, you will need to load one following the instructions below.
  - Loading a wafer. Press **System** then **Pumping**. Then, on the left-hand side loadlock controls, (note: never vent the process chamber!) press **Stop**, read and accept the pop-up message, and press **Vent**. When the load lock vents, open the lid and load a wafer snugly against the cams with the flat away from the chamber. Close the lid, press **Stop** and then **Evacuate** on the load lock controls, provide a wafer name, and press **Ok**. Wait for the load lock to report “Cycling Loadlock Pumping” and process chamber to report “Base Pressure Reached” before beginning a process.



6. Run “MMF – O2 Clean XXC”. Press **Process** then **Recipes** and set the operating mode to **Automatic**. Make sure a dummy wafer is in place and that it is intimately seated with the cams. Load and run the recipe. If you are not running at 20 C, there may be a similar recipe with the appropriate temperature. Otherwise, edit the temperature in each step of the recipe before running it. (Note: do not save the recipe with the edited temperatures.) Verify that the chamber is clean by monitoring the plasma color (generally: dim, slight purple = clean, bright whitish-blue = dirty). If the plasma is dim, it is ok to stop the recipe and return the wafer to the load lock. When the process is over, read and accept the pop up messages.
7. Run conditioning recipe (Optional). Press **Process**, then **Recipes**. Select **Automatic** for the operating mode (note: do not save over a recipe unless it is YOUR recipe). Then select and run your recipe. Operating in Automatic mode, the tool will load the wafer, run the recipe, and unload the wafer automatically.
8. Run process. Unload the dummy wafer, load your wafer, and evacuate the loadlock by pressing **Stop** and **Evacuate** on the loadlock controls. Enter a wafer ID. The system will report “Cycling Loadlock Pumping” and “Base Pressure Reached” when the loadlock and process-chamber are ready to process. Next, edit your etch time and run your recipe. Verify that the wafer loads, the plasma strikes, and the reflected powers for the ICP and RF supplies are less than 10 W. Verify that the chuck is at the proper temperature and monitor the temperature during the run. If the temperature increases by more than two degrees, the liquid nitrogen may be out. Monitor and record all parameters to help with troubleshooting and process development.
9. Unload wafer. After the process, acknowledge the Yellow Alert indicating the process has finished and press **OK** if the Process Status widow says Process Completed OK. The tool will automatically transfer wafer to load lock after processing. Confirm that the chamber is at base pressure and loadlock has reached “Cycling Loadlock Pumping” before proceeding. Press **Stop** and then **Vent** on the loadlock controls. Wait for the loadlock to vent, remove your wafer, and replace the dummy wafer. Evacuate the loadlock by pressing **Stop** and **Evacuate** on the loadlock controls.
10. Run clean recipe. A chamber clean is required for etches containing fluorine etch chemistry. Run an automatic recipe with “MMF – O2 Clean 20 C.” (Note: if your etch contained C4F8 or CHF3, and the total etch time for your condition and etches was more than 10 minutes, you must edit the cleaning time to be at least 1.25x the total of your condition and etch time.)
11. Close the liquid nitrogen valve on the tank by turning it clockwise. Use caution; the knob may be very cold. Press the **AUTO/MAN** button on the Eurotherm controller. Make sure the **MAN** LED is on, that the set point reads 0.0 by pressing the up and down arrows, and that **OP1** and **OP2** are **not** lit.

## Troubleshooting

- A Red Alert is shown on the screen.
  - If you tried to run a clean and it didn’t strike or during your periodic check during a clean, you see a Red Alert window saying, “Forward Power Out of Tolerance,” or, “Auxiliary Reflected Power Our of Tolerance,” accept the message and try restarting the clean a second time. If it fails a second time, shut the tool down in CORAL and note in CORAL how much time is left on your chamber clean.
  - Otherwise, shut the tool down.
- Message reads “Do you wish to run a second process on the wafer in the loadlock?”
  - If it is a dummy wafer, go ahead! If it is a product wafer, make sure you haven’t accidentally tried to run a second time.



- You had to stop a process in the middle of a run using the STOP button below Process Control, and a pop up reads, “All processes attached to this Recipe Task have been stopped manually. Do you wish wafers to be automatically returned to Loadlock?”
  - Press **Yes** to return wafer to loadlock. Read and accept the pop up message.
- Temperature is increasing during process.
  - Stop process using the stop square on the upper left side of the screen. A message should pop up saying, “All processes attached to this Recipe Task have been stopped manually. Do you wish wafers to be automatically returned to Loadlock?” Press **Yes**. Check LN2 level. Ask staff to replace LN2 if you are not qualified to do so.
- You accidentally clicked into service mode.
  - Do not press any other buttons. Click “System” and “Exit Service”. Read the DANGER message, and press “Ok” to exit service mode.

### **Version History**

2020.1 – Original document written by Benjamin Raymond and Andrew Lingley.

2020.2 – Included LN2 level check to reduce risk of running out.