

Reactive Ion Etcher (RIE) Operational Procedures

Revised 08/15/2001

General Notes about the RIE machine:

There is a green binder containing information about the PECVD and the RIE. Both of these machines use the same controller unit, which is very important to remember. The green binder is located in the bottom drawer of the file cabinet in 1511.

A RIE machine uses either a DC or an RF frequency EM signal to split gas molecules into electrons and ions. The ions are then accelerated in the E-field and bombard the surface of the sample. The DC signal can cause the ions to be accelerated more than the RF field, which provides a quicker etch rate only if the sample is highly conductive (metal or heavily doped semiconductor). For dielectric materials it is usually beneficial to use the RF signal to prevent charge from building up in the sample, which can cause a repulsion of the ionized gas molecules.

Start Up:

- 1) Turn on the big LN₂ tank located in the maintenance corridor and check that the pressure is between 65 and 75 PSI. If the pressure is too low, increase the pressure from the regulator or change out the tank.
- 2) If performing an O₂ plasma etch, turn on the O₂ (two valves).
- 3) If performing an CF₄ plasma etch, turn on the CF₄ gas.
- 4) Turn on the small tank of N₂ (two valves). This tank is used for venting. Check that the flow meter on the black pump reads about 8 scfh. If not, adjust the N₂ flow to 8 scfh.
- 5) Plug in the white pump filter. This pumps the oil through 3 paper filters and activated alumina particles into the black pump. The black pump should not be turned on at this point.
- 6) Turn on the chiller (brand name Coolflow). There are two toggle switches, one in the front and one in the back, which say "on/off"; turn on both switches and press the button marked "start".
- 7) Open the N₂ valve on the wall. CCW opens, CW closes.
- 8) There is a three-phase switch on the back of the PECVD. Turn this on. This turns on the black pump in the outside corridor. (Note that the PECVD and the RIE share this pump, which is why the switch is located on the PECVD machine.)
- 9) On the RIE, the red "off" light indicates that the machine is off. Hit the green "reset" button on the top of the RIE, which will turn on the machine and the red "off" light will go off.
- 10) On the controller box, hit the blue power button. Now you are ready to proceed with the etch.

- 11) When the machine is first on, the machine actually considers this to be an error and the "interface" light blinks. This indicates an error and you need to press the "stop" button to stop the indicator light from flashing and proceed. If after pushing stop the interface light continues to blink, do not proceed. Contact the super user and fill out an incident report that is located at the entrance to 1511.

Loading the Sample:

- 1) On the function keypad, hold down the "manual" button and hit the "vent" button. The red light above the "vent" button will start to blink meaning that the chamber is currently venting. (The venting is performed in a cycle in which the chamber is first rough pumped to eliminate any toxic gasses and then pumps up the chamber with N₂. You will initially notice that pressure will first decrease and then increase after you press the "vent" button.) When the red light above the "vent" button stops blinking and stays on, the venting cycle is complete.
- 2) On the function keypad, hold down the "manual" button and press the "hoist up" button. The red light above the "hoist up" button will start to flash and will stop flashing when the chamber is ready to be hoisted.
- 3) Push up on the two white chamber hoist switches. The chamber will open up.
- 4) Place your sample in the chamber and center it.
- 5) Push down on the two white chamber hoist switches. The chamber will lower back into place.

Programming a Run:

- 1) If you have already stored a set program, then you can skip on to the "Performing the Run" section.
- 2) Turn the key to "modify memory".
- 3) On the "data" keypad, hold down the "process" button, and push the number of the process you want to program.
- 4) On the "data" keypad, hold down the "step" button, and push the number of the step you want to program. Most times, you can program all the data for a run into just one step and therefore, you do not need multiple steps. In the case that you require multiple steps, consult the operating manual and check with the super user.
- 5) On the "function keypad", hold down the gray "set" button, and press the button of the parameter you want to program.
- 6) All of the lights above the "data keypad" will begin to flash red. Enter the numerical value for the parameter you selected.
- 7) Hit the "step/enter" button on the data keypad.
- 8) Repeat these steps to program all of the data you need for a run. The important parameter buttons, that you should program for every run are:

rough/pressure: Enter the pressure you want to rough to (in mT), before flowing the gasses.

gas1/flow: Enter the flow rate of gas1 (O₂), as a % of the total flow rate.

gas2/flow: Enter the flow rate of gas2 (CF₄), as a % of the total flow rate.

Throt/Pres: Enter the pressure that you want in the chamber (in mT). This button controls an APC (automatic pressure control) valve. It determines what the pressure in the chamber is going to be, during the process.

Timer/time: Enter the amount of time you want to etch (in min).

Power/level: Enter the RF power level that you want to ignite the plasma with, as a % of the total power available. (10% seems to give about 50 watts.)

- 9) Make sure that the "steps" you're not using, are all cleared of data. If the other steps have data in them, then the RIE will assume it should proceed on to the next step...
- 10) Return the key to the "manual" position. Don't leave it in the "modify memory" position.

Performing a Run:

- 1) On the data keypad, select the proper program. (hold down the "process" button, and push the number of the process you want to run).
- 2) Hit the "run" button. It will do everything automatically. It will first rough the chamber, then flow the gasses, then ignite the plasma, wait the proper time, shut the plasma down, vent, and get the chamber ready to hoist.

NOTE: If, during the run, you decide you want to modify the parameters used, you can do that. For example, if you programmed the machine to do a 5 minute etch, but then you decide you want to etch for 10 minutes, you can change it while the run is going. Move the key to "modify memory", hold down the "set" button, and select the parameter you want to modify". Enter the new data on the data keypad, and push "step/enter".

NOTE: To abort a run, you can just hold down the "stop" button for 5 seconds. (It will start beeping at you to warn you that you are about to abort the run). The run will be aborted, and the machine will automatically do a venting cycle.

NOTE: If you have programmed particular steps, then you can actually stop the machine at a given step, by pushing the "stop" button for less than 5 seconds. Then if you push "run" again, the machine will start up at the beginning of the last step.

NOTE: The RF reflected power should be low (< 5 Watts). This should be automatically done by the automatic RF tuning device. If for some reason this tuning device fails to tune the RF reflected power, you can manually adjust it by flipping the two switches above the reflecting unit to "manual" (from auto), and then using the +/- buttons to tune the RF reflected power manually. Make sure you return both switches to "auto" when you're finished tuning.

- 3) After the run is finished, push the two white "hoist" buttons upwards, and remove your sample from the chamber.
- 4) Push the two white hoist buttons downwards to close the chamber.

Shut Down

- 1) Turn off the O₂ tank outside in the hall (2 valves).
- 2) Turn off the CF₄ tank outside in the hall (2 valves).
- 3) In general, you don't need to backfill the CF₄ and O₂ lines with N₂. If you want to backfill, see the notes on backfilling at the end of this section. Otherwise, proceed.
- 4) Manually hit the "rough" button, so as to pump down the chamber, and leave it pumped down. After the "rough" finishes, the red light above that button will be solid red. Manually hit the "rough" button again to turn off the rough.
- 5) On the controller box, hit the blue power button
- 6) Hit the red "off" button on the top of the RIE. That turns the machine off; the red "off" light will go on.
- 7) There is a three-phase switch on the back of the PECVD. Turn this off. This turns off the black pump outside in the hall.
- 8) Close the N₂ valve on the wall. CCW opens. CW closes
- 9) Turn off the small N₂ tank outside in the hall (two valves)
- 10) Unplug the white pump filter.
- 11) Turn off the chiller. (There are two toggle switches, which say "on/off". One towards the front of the machine, and one towards the back. Turn them both off.
- (12) Close the valves on the big tank of liquid N₂ (two valves).

Backfilling the O₂ and CF₄ lines:

- 1) If you haven't already done so, close the CF₄ and O₂ gas tanks out in the hall. (2 valves each).
- 2) Manually turn on the "rough". (Hold down the "manual" button, while pushing the rough button). The light above the rough button will blink until it roughs down, whereupon the light will become stable.
- 3) Manually set the gas1 and gas2 flow rates to their maximum. (100%). (See notes about programming to see how to set things).
- 4) Manually turn on gas1 and gas2 ". (Hold down the "manual" button, while pushing the "gas1" button...then do the same for "gas2").
- 5) Go have lunch for an hour. At least.
- 6) When you come back, the gases should be flowing at much less than their maximum 100%. Ideally they'll be almost flowing at zero.
- 7) Manually turn off gas1 and gas2 by again holding down the manual button while pushing "gas1" and "gas2".
- 8) Manually turn off the rough.
- 9) Manually hit the "vent" button. This is to make sure that we've vented the chamber, after having flowed those gases out of the lines and into the chamber.
- 10) When the vent is finished (the red light stops blinking and becomes solid), manually hit the "vent" button again. This stops the vent.
- 11) Continue where you left off in the "shut down" notes.

