

Operation Manual

PLASMAETCH PE-50 (PLASMA-ETCH)

Lab Organization:

[\(SNF Exfab\)](#)

Location:

SNF Exfab Paul G Allen 155A Venice

Badger Area:

[nSiL: 155A Venice](#)

Badger ID:

plasma-etch

Tool Overview

Low power, high pressure plasma; low bias, minimal damage.

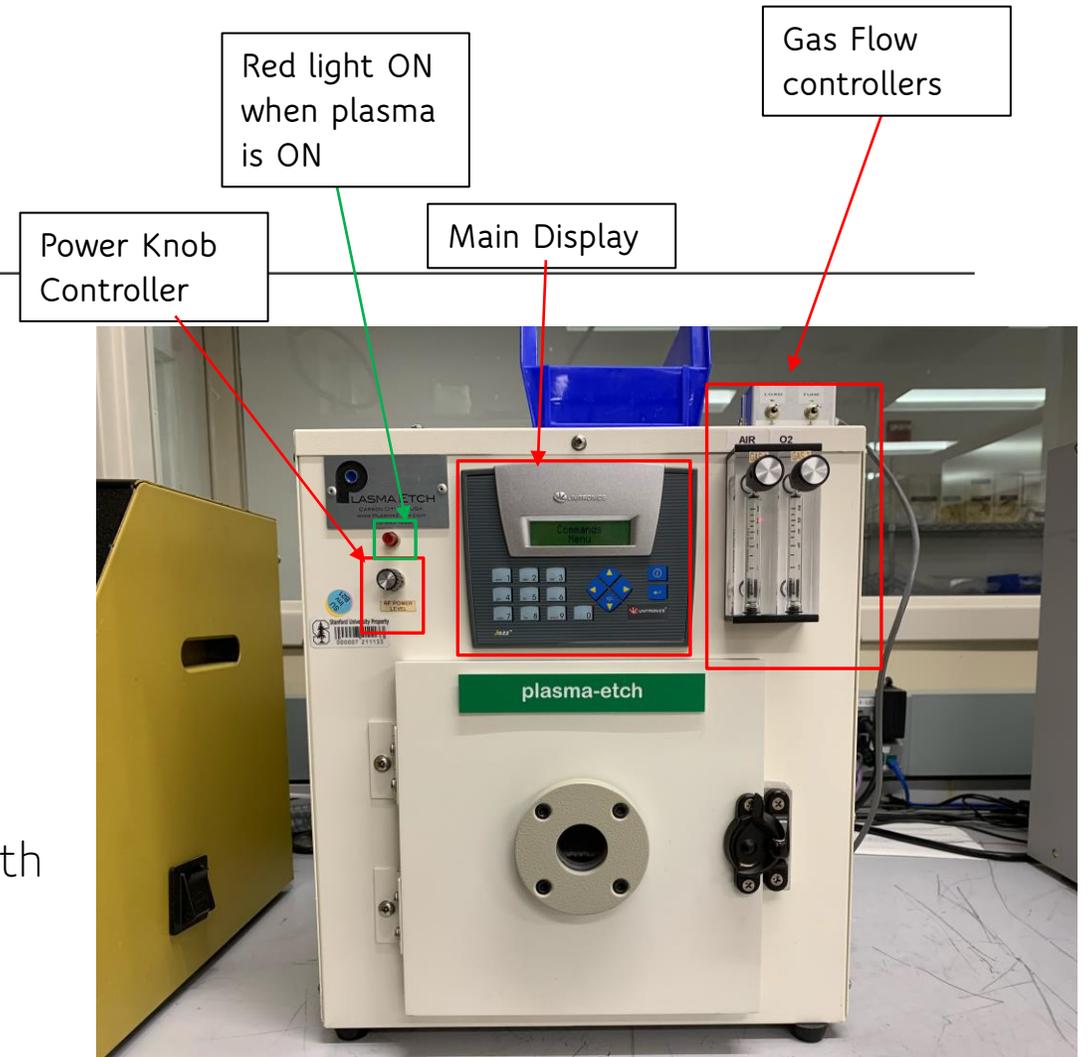
Cleanliness: **Flexible**

Usage: surface cleaning; bonding (polymers; glass)

Gases: #1: Air ; #2: Oxygen

Volume flow rate*: Two 0-25cc/min Rotometers with Precision Needle Valves

Substrate sizes: Pieces - up to 4" wafers



*You have to consider gas law equation ($PV=nRT$) to convert volumic flowrate from SCCM (**$T=273K$ and $P=1am$**) to CCM.

Tool Description

The plasma etching is a dry etching process whereby the surface material is removed by plasma processes at low pressure. The PE-50 plasma cleaning system can use up to two gases simultaneously to clean and modify the surface. The type of the active gases and their ratio is selected depending on the type of material to be etched. The optimum and uniform processing results are obtained when the gas flow rates are selected to maintain the vacuum in the plasma processing chamber in the range of 200 to 350 mTorr. The RF power capability of the plasma etcher is 100 watts which is carefully chosen to avoid the excessive temperature rise in the sample being etched. Active ion species are accelerated towards the sample surface where the adsorption and desorption reaction takes place and the volatile reaction products are exhausted by the vacuum pump.

Notes on RF Power: Always start low at around ~12 W with Reflected power at 0W. If stable, then increase slowly your RF power up to 25 W if needed while maintaining a low Reflected Power. In most cases, a reflected power of 5W for a plasma power of 25W is acceptable. However, to achieve desired high uniformity and repeatability of your process, the golden rule is to have a reflected power less than 10% of your set power, ideally.

Before Starting

- Enable tool on Badger
- Make sure RF power is completely OFF – black knob completely counterclockwise
- make sure gas flows are OFF – knobs completely clockwise (no flow)
- Run a dummy sample before your actual recipe in order to know expected setpoints for a stable plasma time. Then run your sample.

The screenshot shows the Stanford Shared Facilities reservation system interface. The window title is "Stanford Shared Facilities (joannamn@st...)". The main menu includes "Window", "Equipment Actions", "Process Actions", "Reservation Actions", "History Actions", "Supplies", "Reports", and "Help". The "Reservation Actions" menu is open, showing options for "Reservations", "History", "Maintenance", "Policy", and "Equipment Status". The "Reservations" sub-menu is active, displaying "plasma-etch Reservations". The interface has two view options: "Multiple Days Per Machine View" (selected) and "Multiple Machines Per Day View". The reservation table shows a grid for the week of November 30 to December 6, with time slots from 0:00 to 10:30. The left sidebar lists the "Nano Structure Integration Lab" with various equipment and their maximum reservation counts: Cleanroom (shift rules), L104 Stinson (max. 5), 151 Ocean (max. 3), 155 Mavericks (max. 3), 155A Venice (max. 3), aja-evap, hummer, lasercutter* (jxl@stanford.edu), lesker-sputter*, micromill*, optomec, oriel-duv, plasma-etch* (highlighted), and 159 Capitola (max. 2).

Example Recipe

A good starting recipe for a permanent bond for PDMS-PDMS or PDMS-glass:

Gas type: oxygen, ~15 ccm (300 mTorr)

RF Power: 15 W Forward, 0 W Reflected

(Golden Rule: Reflected power not more than 10% of Forward power for best high uniformity and repeatability) (acceptable: 25 W Forward, 5 W Reflected)

Plasma Time: 30 seconds.

Vacuum Set Point: 250 mTorr

PROGRAM OPERATION (1)

Enable tool on Badger

(IF not automatically ON, set the POWER circuit breaker to the ON (Up) position at the rear of the etcher.

Press the “**Enter**” key to proceed to the menu items.

- Use the left ◀ and right ▶ arrow keys to find a menu item within a menu area.
- Use the up ▲ arrow key to go to the previous menu area.
- Use the down ▼ arrow key to go to the next menu area.
- Use the enter ↵ key to select a menu item.



DISPLAY MENU & SEQUENCES

MENU 1: SETUP MENU → (Edit recipe)

- Step 1: Plasma time
- Step 2: Vacuum Setpoint
- Step 3: Atmospheric Vent
- Step 4: Purge Vent
- Step 5: Gas Stabilize
- Step 6: Vacuum Alarm

- To go between SETUP and COMMAND MENU, just press on the 'left' or 'right' arrow
- To enter each MENU, press 'ENTER' button to access the sequences or steps to edit recipe.

MENU 2: COMMANDS MENU

- Sequence 1: COMMANDS PLASMA → RUN recipe
- Sequence 2: COMMANDS CYCLE_OFF → Vent chamber after recipe is done
- Sequence 3: COMMANDS CYCLE_END → stops the recipe in the middle of a run

Editing the Steps in SETUP MENU

To edit each step, input the desired numbers using the keypad on the screen, then press 'enter' button to save parameter and the cursor is no longer flickering. Then press 'right' arrow to move to next step. And so on... Once all steps are edited, press 'up' arrow to go back to main menu, then go to "Commands menu" to run your sequence.

- **Step 1: Plasma time** → your process time
(note that during this time, you will have to adjust your Forward Power by adjusting the power knob)
- **Step 2: Vacuum Setpoint** → keep at 250 mTorr
- **Step 3: Atmospheric Vent** → keep at t=10 sec (controls the time to bring chamber from vacuum to atmosphere during the "COMMANDS CYCLE-OFF" sequence)
- **Step 4: Purge Vent** → suggested t=30 sec (time desired to purge chamber with air before another step of vacuum. This step is to clean the chamber from residual byproducts released in the chamber after a plasma process is made, and is necessary before opening the chamber to take sample out.)
- **Step 5: Gas Stabilize** → suggested t = 30 sec (enough time for you to adjust gas flows and chamber pressure)
- **Step 6: Vacuum Alarm** → keep at t=5 mins

PLASMA PROCESSING PARAMETERS

Setup Menu	Parameter Range	Description
Vacuum Set Point	1.0 to 1000.0 mtorr	Vacuum level set point required before gases are introduced into the chamber.
Gas Stab	0-59 seconds	Delay before RF Power is applied after process gases are on.
Plasma Time	0-59.59 minutes	The amount of required plasma process time.
Auto Cycle-Off	Off/On	Automatically goes into Cycle Off mode (shuts off pump and vents the chamber)
Purge Vent	0-59 seconds	Time allowed for purge air to be introduced in the chamber at the completion of a cycle.
Atmospheric Vent	0-59.59 minutes	Time allowed for chamber to vent to atmosphere when "CYCLE STOP" is initiated.
Vacuum Alarm	0-59.59 minutes	Amount of time required to pump the system down to vacuum set point before initiating an alarm.

PLASMA COMMANDS

Command Menu	Description
Plasma	Select the “ Plasma ” command from the Commands menu to initiate the plasma cycle
Cycle-off	Actuate the Cycle-off Commands for chamber vent after plasma cycle is completed.

RUN PROGRAM

Pushing the left or right arrow key from the menu to select the **Setup menu** or the **Commands menu**. Press the “Enter” key to proceed the selected menu.

Select the **Commands menu** and Press the “Enter” key.



**Commands
Menu**

Select the “**Plasma**” command.



**Commands
PLASMA**

Load material to be processed. Close the chamber door.

Actuate the “Enter” key to start the cycle. Observe the following:

STEPS during SYSTEM OPERATION (1)

STEP 1: PUMPDOWN

- a. The vacuum pump turns on to start evacuating the chamber.
- b. The chamber vacuum reading will be displayed. The following system status message will be displayed:

Plasma: Pumpdown
S:****.*A:****.*
- c. The chamber will pump down to the setting programmed in the “Vacuum Set Point” parameter in the **setup menu**.

STEPS during SYSTEM OPERATION (2)

STEP 2: Gas stabilization

During this time, turn the knobs for the gas controllers in a counterclockwise motion to start flowing desired amounts.

Once vacuum set point has been reached the following will occur:

- The process gases will be introduced into the chamber.
- The gases will stabilize for a period defined in the **“Gas Stab”** setting in the **setup menu**.

The following system status message will be displayed:

Gas Stabilize

S: ** A: **



Note: Adjust gas flow until desired chamber pressure is achieved (you can check pressure of chamber by pressing 'left arrow')

STEPS during SYSTEM OPERATION (3)

STEP 3: Plasma Time

After the process gases are stabilized RF power is enabled. The wattage is determined by the “**RF Power**” setting on the front panel. The following will be observed:

- a. A plasma glow will occur in the chamber.
- b. The plasma process is started and the plasma process timer will start. The process time is determined by the “**Plasma Time**” setting in the **Setup menu**. The time is in minutes and seconds. The maximum time is 59:59 minutes. The following system status messages are available for viewing:

Plasma Time
S: **.** A: **.**

- c. “**Plasma Time**” is the default message to be displayed. The vacuum reading can be viewed by actuating the left arrow button.



STEPS during SYSTEM OPERATION (4)

STEP 4: Chamber Purging

When the Plasma timer completes, observe the following:

- a. RF power is disabled.
- b. Plasma glow is extinguished.
- c. Process gas valves are shut off.
- d. Vacuum Pump is shut off.
- e. Chamber vent valve is opened for time set in "**Purge Vent**" timer. The following system status messages will be observed:

Purge Time
S: ** A: **

- f. At the completion of the timer, the chamber vent valve is shut and the blank-off valve is opened.
- g. The chamber is pumped down to vacuum set point programmed in the "Vacuum Set" parameter in the **setup menu** section. The following system status messages will be observed:

Purge: Pumpdown
S:****.*A:****.*

STEPS during SYSTEM OPERATION (5)

STEP 5: Process Complete (chamber still under vacuum)

When the vacuum set point is reached the process is complete. Observe the followings:

- a. If the Auto Cycle-Off is selected as **on** in the setup menu the plasma etcher will start the step 13 automatically to vent the chamber.
- b. If the Auto Cycle-Off is selected as **off** in the setup menu. The rotary pump will remain at the on position to continue evacuating the chamber. The following system status messages will be displayed.

**Plasma Cycle
Complete**

Proceed the step 13 to vent the chamber and remove the sample.

STEPS during SYSTEM OPERATION (6)

STEP 6: Vent Chamber

Actuate the CYCLE OFF Command under the **Commands menu**. The chamber is vented for a time programmed in the **“Atmospheric Vent”** timer setting in the **setup menu** or until the chamber door is opened. The following system status messages will be observed:

Chamber Vent
S:*.A:*.****

FINAL STEP – RECIPE COMPLETION

STEP 7: Remove sample and leave machine as you found it

Make sure power is completely off

Make sure gas flows are off

Chamber stays vented by default (not under vacuum)

Disable tool on Badger

System Alarms (1)

Vacuum set point alarm: When the cycle is started and the vacuum doesn't reach the configured vacuum set point within the configured time the system will initiate an error aborting any running process. The system will vent to atmosphere.

Error: Vac Set
Venting: **.**

System Alarms (2)

Door open during cycle: If the door switch failed or the door was opened during cycle an error will occur aborting the cycle.

**Door Open
During Cycle**

System Alarms (3)

Danger RF on Door Open: If the chamber door is opened and the RF power supply is on an error will be displayed

**DANGER: RF ON
Door Open**

System Alarms (4)

Vacuum sensor voltage failure: Indicates a problem with the output voltage from the vacuum transducer. The system will initiate an error aborting any running process.

**Vacuum Sensor
Error:*****.***

Troubleshooting

Note: Do not attempt to fix the tool on your own. Always report the problem on Badger, and the tool engineer will assist in troubleshooting and fixing. (this is just for reference)

Symptoms	Possible Cause	Remedy
Vacuum level increasing or not achieving set point.	Chamber door seal faulty. View port O-ring faulty. Chamber vent valve or blank-off valve faulty. Vacuum pump system faulty.	Inspect and replace as necessary. Inspect and replace as necessary. Verify proper power input and replace as necessary. Blank off Vacuum system to verify vacuum level (< 50mtorr), refer to Vacuum system manual.
Vacuum Reading error.	Recorder output on vacuum gauge is < 50mv.	Repair bad connection on recorder output connection on rear of vacuum gauge.
System process results degraded.	Bad vacuum. Chamber and/or electrodes contaminated.	Verify system vacuum. Inspect chamber and electrodes, clean as necessary.

Additional Training Links for PE-050

General operation:

<https://youtu.be/NqceeqzxlZw>

<https://youtu.be/1jh-lPfkpWA>

Programming the recipe:

<https://youtu.be/gw93sJr227o>

Manufacturer Manual: <https://www.plasmaetch.com/pe-50-plasma-cleaner.php>