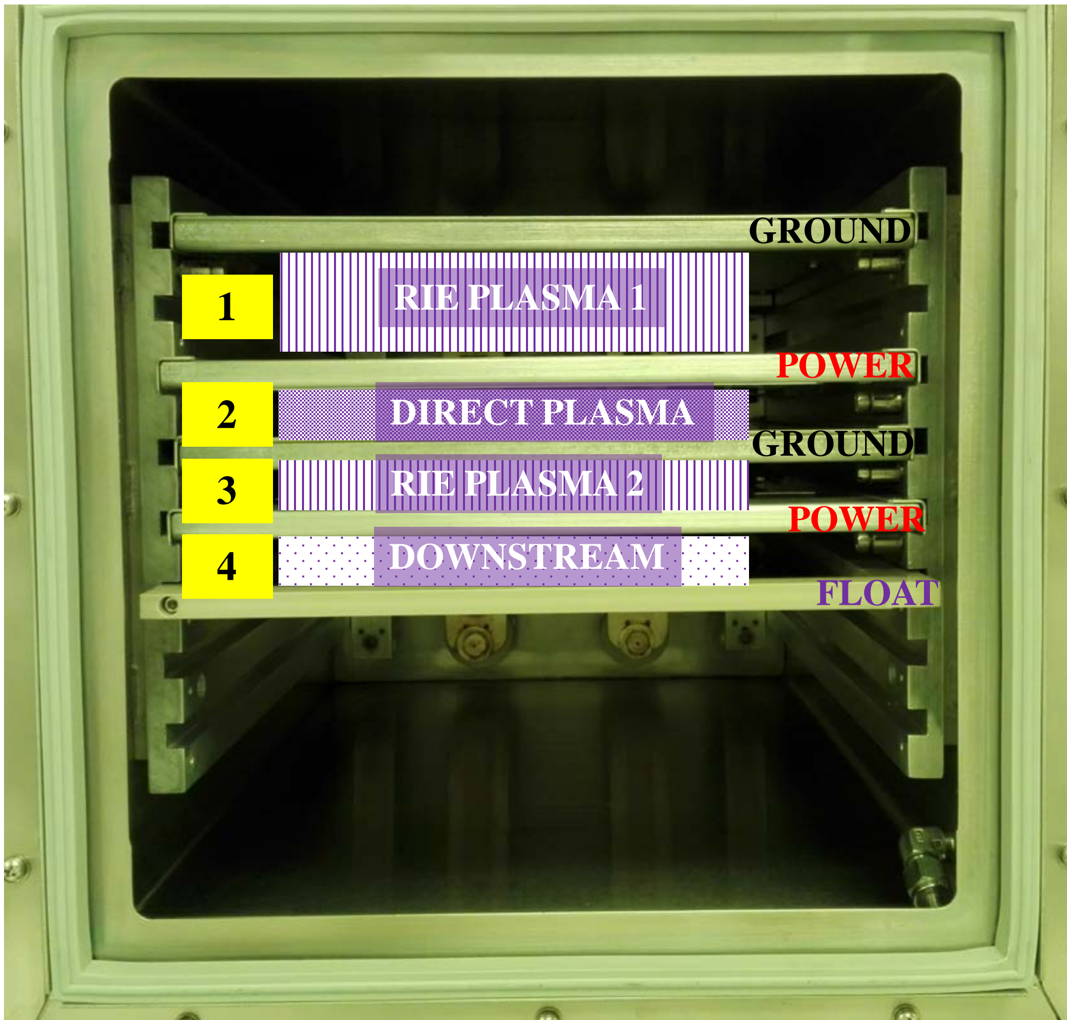
Plasma Asher: March PX-500
User guide

(May-30, 2017)

This is a highly versatile plasma etch tool that can etch using a direct plasma configuration (Oxygen plasma cleaner), a downstream plasma (Remote plasma), and a directional plasma (Reactive Ion Etch). We supply Oxygen (gas 1) and Argon (gas 2) for use. Power can set up to 600 W, and working pressure is controlled by gas flow. There are totally 9 programs for automatic process and can be modified by users.

Shelf configuration



Program #9 is set for chamber cleaning. User can modify the other programs (#1-#8)

For RIE plasma(Directional):

Ground shelf upper then power shelf bottom with samples on the power shelf. Floating not used. Pressure should be in the 0.1 - 0.5T range. RIE is a very aggressive etch with heavy ionic bombardment. The etch is directional and isotropic, mainly used for Oxygen plasma cleaning and Argon plasma physical etching.

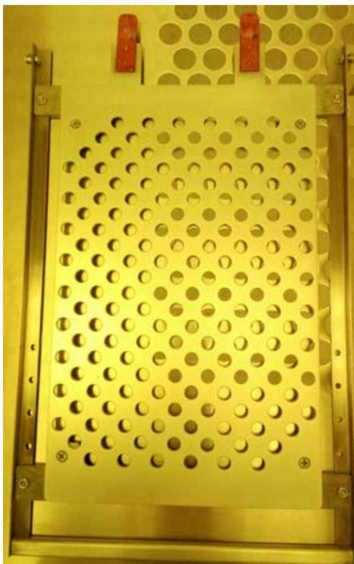
For Direct plasma:

Power shelf upper then ground shelf bottom with samples on the ground shelf. Floating not used. Pressure should be in the 0.5 - 1T range. This is a less aggressive etch but does include ions but ions are not necessarily directed towards the samples. The plasma is anisotropic.

For downstream plasma:

Ground shelf upper then power shelf in middle then floating shelf bottom with samples on the floating shelf. Pressure should be in the 0.5 - 1 T range. In this configuration, all of the ionic activity is contained between the powered and ground shelves and only non-charged particles (free radicals) are able to pass through the power shelf to the area below it. This is the least aggressive type of etch and is typically used when samples are sensitive to ion damage.

Shelves

POWER SHELF	GROUND SHELF	FLOAT SHELF
		

Tool Operation

1) Log on to the FOM

2) LOAD THE SUBSTRATE

- Press the "MAN OP" button and then press the "BLEED" button to vent the chamber.
- When the chamber is vented (about 60 s for venting), unlatch the chamber door and insert sample.
  - Put your sample on desired shelf (see shelves configuration above and test result in Appendix B)
  - Close and latch the chamber door.
  - Press the "MAN OP" button again to activate the automatic operation mode ("MAN OP" LED light is extinguished for auto operation).

3) PROGRAMMING

Standard setting for parameters:

Pressure=0

END/PT= 100

BP/RP= 50 mTorr

- Press the "PROGRAM" button to select your program
- Press the "L DISP" button repeatedly until the "TIME" label lights up
  - Press the "SET" button to illuminate its LED light
  - Press the "DECR or INCR" buttons to set the plasma "on" time (sec) by decreasing or increasing the time in the left display above.
  - When the correct time appears in the display, press the "SET" button again to extinguish the

LED light. This saves the value.

- Press the "L DISP" button to light up the "POWER" label.
  - Press the "SET" button to illuminate its LED light
  - Press the "DECR or INCR" buttons to set the plasma power (Watts) by decreasing or increasing the Power in the left display above.
  - When the correct power appears in the display, press the "SET" button again to extinguish the LED light. This saves the value.
- Press the "R DISP" button on the right side to illuminate the "GAS1" label.
  - Press the "SET" button to illuminate its LED light
  - Press the "DECR or INCR" buttons to set the O_2 (or Ar) flow rate, (% of 100 sccm), by decreasing or increasing the value in the right display above.
  - When the correct flow value appears in the display, press the "SET" button again to extinguish the LED light. This saves the value.
  - Consult the percent O_2 (Ar) flow vs pressure chart in Appendix B to determine the proper flow value for your process pressure. The actual values may drift somewhat over time as the vacuum pump oil becomes contaminated, so some variance from the table may be required as experience dictates.

4) RUNNING THE PROCESS

- Press the "START" button in the

upper left corner. This starts the process:

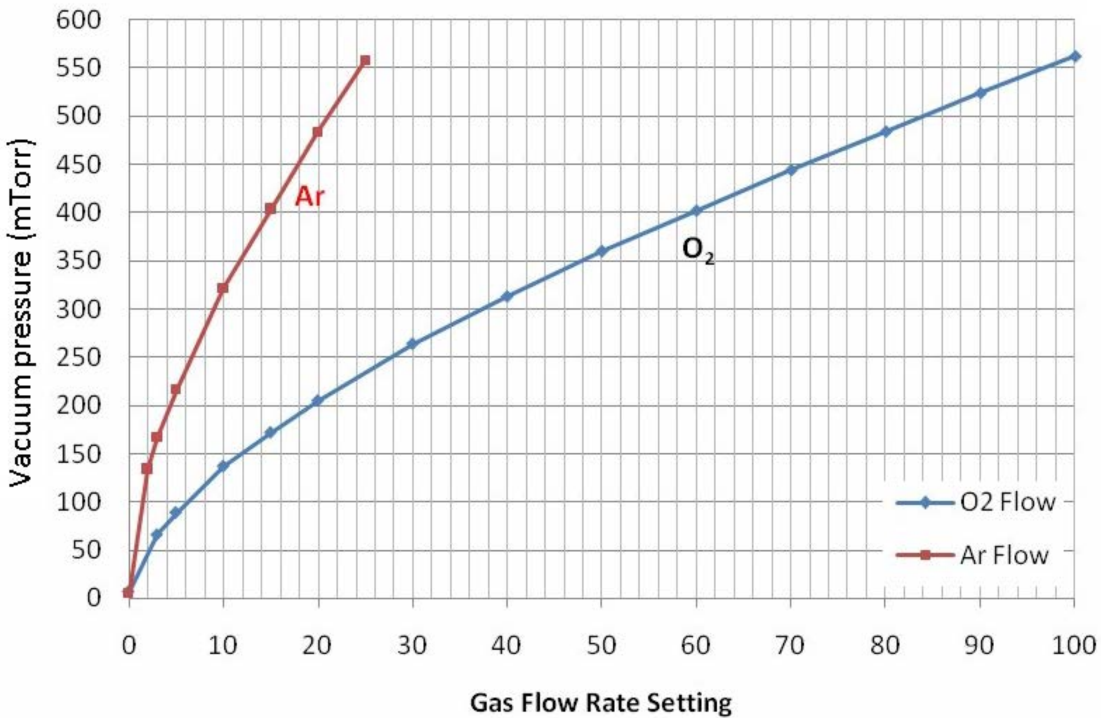
  - Chamber is pumped down to 50 millitorr
  - Gas flow is started
  - RF Power is turned on – Note the forward and reflected power values on the RF power supply to the left of the process control module. If the reverse power is more than 50%, shut off the system with the BIG RED EMO button and call a staff member.
  - Time counts down from your set value
  - At the conclusion of the time, the RF power and Gas flow are turned off and the chamber is pumped down to base pressure.
  - After achieving base pressure, the chamber is vented with Nitrogen for 45 seconds.
  - At the conclusion of the vent cycle, a beeper peeps softly.

5) RETREVING THE SUBSTRATE

- At the end of the vent cycle, shut off the beeper by pressing the “STOP” button. Open the door and retrieve your sample. Be careful to note the temperature of the substrate shelf as it can get hot on long runs.
- When the sample is out, close and latch the chamber door
- Press the “MAN OP” button and the “VAC ON” button to pump the chamber down again. Allow the vacuum to achieve base pressure and then shut off the “VAC ON” valve.

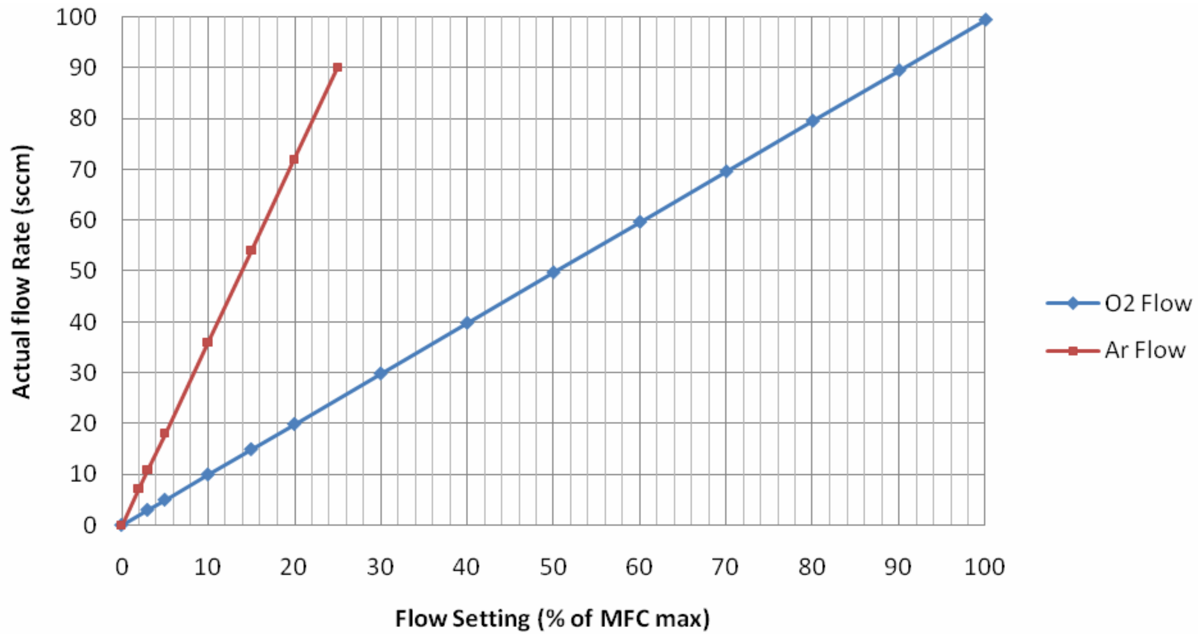
Appendix A

Chamber Pressure vs Gas Flow Rate



Use this chart to decide what approximate gas flow is needed to establish the pressure you need for your plasma. You may have to fine adjust the flow to achieve accurate pressure. As time goes on, the base pump pressure may degrade and shift the lower end of this correlation curve somewhat. Argon mass flow controller maximum flow is 250 sccm, and the Oxygen meter is 100 sccm – thus the large difference in pressure curves.

Actual Flow Rate vs Flow Setting

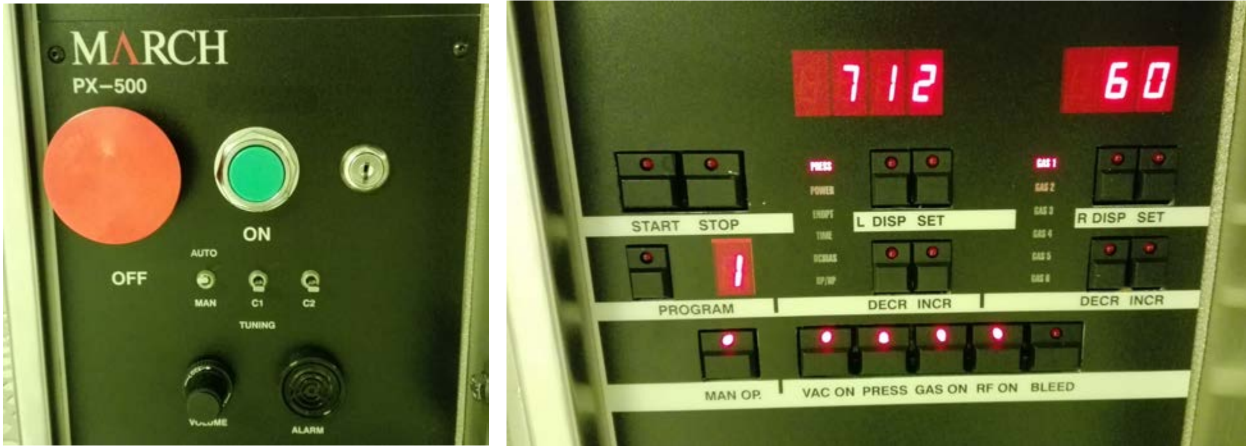


This chart calibrates the flow setting to actual flow in units of Standard Cubic Centimeters per Minute (sccm). The Argon Mass Flow Controller maximum flow is 250 sccm, and the Oxygen meter is 100 sccm – thus the large difference in pressure curves.

Appendix B

Ashing Rates for Photomask SC1827 Resist						
Process	RF Power (Watts)	O2 Flow (%)	Ar Flow (%)	Pressure (mTorr)	Plasma type	Etch Rate (Å/Min)
1	500	40	0	278	RIE1	1400
					Direct plasma	250
					RIE2	1200
					Downstream	
2	600	80	10	600	RIE1	1300
					Direct plasma	660
					RIE2	1500
					Downstream	130
3						
4						

Appendix C
Process Controller Module



The Process Controller monitors and controls the various parameters of the process. The basic ON/OFF portion of the control panel is shown on the left, and the parameter input and monitor panel is shown on the right.

The machine is switched on by pressing the medium sized green button. The big red emergency OFF button is used to turn off the machine. The Key is a lock-out for parameter change operations. For general use, the tool will not be locked. The "Auto/Man" switch enables manual RF tuning to match the plasma impedance with the output impedance of the RF generator. The Alarm beeps at the end of process and the volume knob sets the loudness of the enunciator. The alarm is silenced by pushing the "STOP" button.

The parameter input section of the control panel consists of 4 sections. The first is the START/STOP buttons, which do just that – start the automatic program or stop it. The second section, "PROGRAM," is the program selection button. By repeatedly pushing this button you can cycle

through all 9 possible programs. When a program is selected it is available for execution by the start button. Parameter input is achieved through the 8 buttons in the upper right section of the panel. The term “L DISP” denotes the “Left Display” lights above the buttons. If the “SET” button is pushed and the LED lights up, you can change the numbers by repeatedly pressing either the DECR or INCR buttons just below the SET button. The particular parameter you are selecting is set by repeatedly toggling the “LDISP” button until the corresponding label is lit. The third set of 4 buttons in the upper right selects the process gas by toggling the “RDISP” (Right Display) “SET” button, and sets the flow in units of “% of Mass flow meter capacity.” There are six gas sources that can be selected by repeatedly pressing the “R DISP” button. Currently we have two gases available – “GAS 1” for Oxygen and “GAS 2” for Argon. Pressure is determined by the flow rate as this tool has no vacuum level throttle valve control. A table to correlate pressure with gas flow is attached in Appendix A.

The fourth set of buttons deals with manual operation. These are in the bottom row to the right of the “Manual” toggle button. These buttons are active when the “MAN OP.” light is on, and consist of the “VAC ON” button which toggles the vacuum valve on or off; the “PRESS” button which toggles a valve to expose the vacuum gauge to the vacuum line; the “GAS ON” valve, which toggles the process gas on or off; the “RF ON” button which toggles the RF power on or off; and the “BLEED” button, which pumps the chamber down to a minimum set point, then vents the chamber.

CAUTION: Take care not to open the “PRESS” valve when the pressure gauge is at vacuum and the vacuum line is at atmospheric pressure. This will send a pressure shock

wave into the vacuum diaphragm triggering a calibration drift and possibly causing damage to the gauge. The proper procedure is to open the valve and wait at least 15 seconds before opening the vacuum line to the gauge.

RF Power Generator

The RF power generator is a separate unit sitting just to the left of the Asher system. It provides the 13.6 MHz RF power to drive the plasma. It is remotely controlled by the process controller microprocessor, therefore the buttons on the front panel of the RF generator are inactive but the power meter indicates the forward and reverse power delivered to the plasma chamber. This meter should indicate mostly forward power and very little reverse power. If you notice the reverse ratio shut off the plasma with the big red EMO button to protect the RF generator from overheating and contact NFCF staff.