

Approved by Principal Investigator \_\_\_\_\_ Date: \_\_\_\_\_

Approved by Super User: \_\_\_\_\_ Date: \_\_\_\_\_

**Standard Operating Procedure  
BNC  
IPC Branson 3000  
Version 2017 November 16**

### **I. Purpose**

This Standard Operating Procedure (SOP) outlines requirements to be considered by an authorized user of the IPC Branson 3000 (IPC) plasma etcher as well as describes the normal operation of the plasma etcher and any hazards that may be encountered during normal operation. Finally, the SOP explains how to minimize any hazards and how to respond in an emergency situation. This document is to be reviewed one year from the date of approval or as conditions warrant, whichever is the shorter time period.

### **II. Personnel**

- A. Authorized Personnel: The IPC may be operated only by authorized personnel who are fully cognizant of all safety issues involved in the operation of such a device. These personnel are to ensure that the IPC is only operated in the manner laid out in this document. To become an authorized user, one must:
1. Complete Environment, Health & Safety (EH&S) training class.
  2. Take the baseline BNC Safety Orientation class
  3. Read and fully understand the SOP
  4. Receive training on the IPC by an authorized user.
  5. Sign the authorized user sheet to affirm that the above steps have been completed.
- B. Unauthorized personnel: No unauthorized personnel may enter the BNC clean room facility unless accompanied by an authorized user. All visitors must be briefed on proper safety protocol and must wear appropriate protective eyewear located on the premises.

### **III. Hazards**

- A. Electrical Hazards: electrical shock or electrocution could result from direct contact with high voltage. Such hazards are typically interlocked by the IPC system. High voltage RF electrode and conductors are located inside the IPC system chassis. In addition, the external RF power supply unit has connections behind the RF power supply chassis. Do not disconnect the external RF lines. Use normal precautions with external house (110VAC) and 208VAC single phase connections behind the IPC and RF Power chassis.

- B. Chemical: Bottled gases are used with the IPC. Do not disconnect or tamper with gas lines behind the IPC.
- C. Pressure Hazards: Pressurized bottled and house gases are used with the IPC. Do not disconnect or tamper with gas lines behind the IPC. Contact lab management for information.
- D. Other: UV radiation is generated and emitted through the IPC chamber viewing port. Wear protective eye wear when looking through the chamber view port.

#### IV. Hazard Controls

##### A. Electrical

- I. Enclosures for protection against the high voltages of the IPC or RF power supply may only be removed after the power supply has been unplugged from the outlets and after following the safety procedures outlined in the safety and operations manual provided by the manufacturer.
- II. Only qualified personnel may perform all internal maintenance to the IPC and more than one user must be present when performing said maintenance.
- III. Every portion of the electrical system, including the printed circuit cards, should be assumed to be at dangerous voltage level.

##### B. Chemical and Pressure

- 1. Enclosures for protection against valves and internal gas plumbing may only be removed after the system has been turned off and gases have been valve off and relieved of line pressure.
- 2. Only qualified personnel may perform all internal gas maintenance to the IPC and more than one user must be present when performing said maintenance.

##### C. Other

- 1. Proper eye protection must be worn at all times in the clean room and while operating the IPC.

## V. Normal Operation

A. Inspect all electrical and water connections for damage and connectivity.

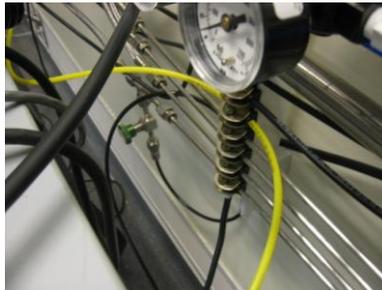
B. Complete the “check-in” log.

C. Preliminary Setup. Turn IPC Main Power ON (If it is off).

1. Turn on the designated vacuum pump in the service corridor (The vacuum pump is normally left OFF at all times). Allow the pump to run for at least 10 minutes to stabilize, if it was off.



2. Turn ON the IPC MAIN POWER (front panel switch).
3. Turn ON RF Power Supply. Allow 5 minutes for the pump, power supply, and system to stabilize.
4. Note that there is no Auto Mode available. There is only Manual Mode. You will need to use a stop watch or external timer for process timing. The timer on the system will not operate. If you attempt to use the Auto Mode or timer, do so at your own risk.
5. Turn on the Oxygen gas in the service corridor (tank valve and the line valve). Do not adjust the gas regulators. Regulated gas pressures should not exceed 10 PSI. If the tank pressure is noted to be below 100 PSI, lab management should be immediately notified to order another tank. The utility gases (CDA and nitrogen) should always be on and should not be adjusted.



6. Turn ON IPC Oxygen gas valve on the wall (Green valve on the wall). Do not overturn. Several (3) turns is sufficient. Overturning may result in valve falling apart.

D. Plasma Etching Operations.

1. **Note that at this time, it is preferred to perform a system setup and a trial run without any actual wafers. If possible, test wafers can be used. The objective is to setup the desired gas flow and power levels. Once this has been done, actual wafers can be used. If you prefer not to do a process setup, then skip to step 13.**
2. Turn ON Purge to vent the chamber if not already at atmosphere. The Vacuum Gauge should indicate 760 torr and the chamber door should open unlatched. Else be patient, watch the vacuum gauge as it slowly vents and reach 760 torr.
3. Open chamber latch and Turn OFF purge.
4. Place your wafers or substrates standing vertically on the quartz holder slots. Smaller substrates can be affixed to larger wafers and placed on the quartz holder notches. It is best not to remove the quartz holder from the chamber.
5. Close the chamber door and latch.
6. Turn ON vacuum and observe the vacuum gauge meter. It should immediately decrease from 760 torr towards the millitorr range. The baseline vacuum level is 20-100 mtorr. The lower the better to ensure the removal of gas molecules from the substrate surface. How rapidly it decreases to the 20-100 mtorr range depends upon the amount of surface gas or water molecules in the chamber, chamber walls, and sample.
7. When baseline vacuum level has been achieved, switch ON oxygen gas (upward position). Note that the gas switch has 3 positions. (Up position is Oxygen gas, Middle position is gas OFF, Lower position is for alternative gas which has not been installed).
8. Immediately adjust the gas flow control valve knob for desired gas partial pressure. (CCW increases the gas flow, CW decreases the gas flow). Note that the flow control is slow and needs time to settle, the adjustments should be done slowly while monitoring the vacuum gauge meter.
9. The RF power should either be set to zero or set at the desired RF power level.
10. If the desired RF power level has not been set, turn ON RF power and monitor the RF Forward power level. The autotune system will maximize forward power by minimizing the reflected power.
11. When the desired RF power level has been achieved, you may begin timing your etching process. If this is only a trial as to establish the desired RF power and gas flow, you may leave the RF power settings alone and turn OFF the RF power switch (NOT THE RF MAIN POWER) and switch OFF oxygen gas (Middle position). Do not change the gas flow control valve knob. Allow the vacuum level on the vacuum gauge to return to baseline value. Then switch OFF vacuum.
12. **At this time, both desired gas flow and RF power have been established. You may perform the desired plasma etch per your gas and RF settings.**
13. Turn ON Purge to vent the chamber if not already at atmosphere. The Vacuum Gauge should indicate 760 torr and the chamber door should open unlatched. Else be patient, watch the vacuum gauge as it slowly vents and reach 760 torr.
14. Open chamber latch and Turn OFF purge.

15. Place your wafers or substrates standing vertically on the quartz holder slots. Smaller substrates can be affixed to larger wafers and placed on the quartz holder notches. It is best not to remove the quartz holder from the chamber. Note, it's very expensive and fragile.
  16. Close the chamber door and latch.
  17. Turn ON vacuum and observe the vacuum gauge meter. It should immediately decrease from 760 torr towards the millitorr range. The baseline vacuum level is 20-100 mtorr. The lower the better to ensure the removal of gas molecules from the substrate surface. How rapidly it decreases to the 20-100 mtorr range depends upon the amount of surface gas or water molecules in the chamber, chamber walls, and sample.
  18. When baseline vacuum level has been achieved, switch ON oxygen gas (upward position). Note that the gas switch has 3 positions. (Up position is Oxygen gas, Middle position is gas OFF, Lower position is for alternative gas which has not been installed).
  19. The gas flow level having been set to the desired levels, the desired oxygen partial pressure will rise and settle. Allow a minute or so for the vacuum level to settle.
  20. The RF power having been set to the desired RF power level can be turned ON.
  21. When the desired RF power level has been achieved, you may begin timing your etching process.
  22. When the time has been achieved, turn OFF the RF power, and turn OFF the oxygen gas (Middle position is gas OFF).
  - 23. If there are more wafers or substrates to etch, go back to Step 13.**
  24. If this is the last wafer of substrate, Turn ON Purge to vent the chamber if not already at atmosphere. The Vacuum Gauge should indicate 760 torr and the chamber door should open unlatched. Else be patient, watch the vacuum gauge as it slowly vents and reach 760 torr.
  25. Open chamber latch and Turn OFF purge.
  26. Remove your wafers or substrates from the chamber. Wipe down the chamber door and gasket.
  27. Close the chamber door and latch.
  28. Turn ON vacuum and observe the vacuum gauge meter. It should immediately decrease from 760 torr towards the millitorr range. The baseline vacuum level is 150 - 200 mtorr. The lower the better to ensure the removal of gas molecules from the substrate surface. How rapidly it decreases to the 150-200 mtorr range depends upon the amount of surface gas or water molecules in the chamber, chamber walls, and sample.
- F. When usage of IPC is complete, shut down the system by performing the following:
1. Use a clean room wipe and gently wipe down vacuum chamber wall and door.
  2. Close door and securely latch.
  3. Shut off front panel circuit breaker. Red Light should be off.
  4. Turn off Oxygen (Green Valve on wall) and oxygen cylinder valve.
  5. Turn off Vacuum pump switch.

6. Complete the log book.

G. Emergency Shutdown of the IPC system. (See Section V. F. above)

## **VI. Emergency Procedures**

A. IPC accidents: Notify lab management and PI immediately.

B. Power outage: If there is a power outage, turn off the IPC per the IPC Emergency shutdown procedure to avoid a hazardous situation when power is restored.



**Appendix A** – In case of medical emergencies, consult lab safety protocol or lab safety plan.

In the event of an IPC accident, follow the procedure below:

1. Ensure that the IPC is shut off.
2. Provide for the safety of the personnel (first aid, evacuation, etc.) as needed.
3. Obtain medical assistance for anyone who may be injured.

UC Optometry Clinic (Normal Hours)	642-2020
UC Optometry Clinic (24 Hour Emergencies)	642-0992
University Health Services (Emergency)	642-3188
Ambulance (urgent medical care)	9-911

4. If there is a fire, pull the alarm, and contact the fire department by calling 9-911. Do not fight the fire unless it is very small and you have been trained in fire fighting techniques.
5. Inform the Office of Environment Health, & Safety (EH&S) as soon as possible.
6. During normal working hours, call the following:

EH&S Office	642-3073
BNC Safety Officer	666-3356
EH&S Health & Safety Manager	642-3073

After normal working hours, call 642-6760 to contact the UC Police Department who can contact the above using their emergency call list.

7. Inform **(PI NAME)** and the BNC safety officer as soon as possible. If there is an injury, **(PI NAME)** will need to submit a report of injury to the Worker’s Compensation Office.
8. After the incident, do not resume use of the IPC system until the lab manager and EH&S has reviewed the incident and approved the resumption of research.