

# University of Minnesota Nano Fabrication Center

## Standard Operating Procedure

**Equipment Name:** TRION-1 etcher

**Coral Name:** trion1

**Revision Number:** 2

**Model:**

**Revisionist:** Tony Whipple

**Location:** Bay 3

**Date:** 4/21/04

### 1 Description

The Trion 1 etch system is a process tool that does Reactive Ion Etching of Silicon or other materials in the manufacturing semiconductor, MEMS, or NANO technology devices. The etch chamber is a single wafer etcher with a load lock. The etcher has a dual R.F. power source in an Inductively Coupled Plasma ( ICP ) to allow a higher plasma density in the etch chamber. The following list of instructions were adjusted to use the system **without** the load lock and **without** the transfer robot arm. If the ICP power supply is to be used check that section first before loading wafers so the correct power may be set first.

### 2 Safety

The system does not have any large safety items to watch for; the only safety concern is that the system does use electrical power. There are two type of gases, one that is dangerous, and the other type of gases that are not dangerous except in large amounts they could limit the amount of Oxygen a person gets. If there is dangerous activity from the etcher, the system can be powered down in an emergency manner by pressing the Emergency off button. This is some times referred to as the EMO button or EMO switch. It is the large red switch on the upper right side of cabinet. Any other emergencies call 911 on any phone and also inform NFC staff of the emergency.

### 3 Restrictions/Requirements

- a Must be a qualified user for Trion 1
- b Limitations on substrate materials are normal semiconductor materials such as oxides, Silicon, GaAs , GaN, Nitride, resists, safe metals as from e-beam system and polyimide type of products. What is NOT allowed is non normal material such as bonding wax, rubber cement, oil, bad metals like Zinc, In or materials that could damage the system or other people's samples. Contact the NFC process person if there are any questions

### 4 Required Facilities

- a Compressed air 60psi
- b Nitrogen gas
- c

### 5 Definitions

- a Process Chamber Lid: is where the wafers are placed during processing.

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- b R.F. power supply: The power that does the etching.
- c Load lock: This is the chamber for loading in samples, but is not used now.
- d Computer display panel: This is the main user interface, located on the right.
- e Vent chamber: a manual process which opens the process chamber.
- f ICP: Inductively Coupled Plasma, a process that increases plasma density.

### 6 Operating Instructions

The operating instructions are limited to only a few steps that need to be done in the correct sequence for a successful process run.

Enable system using the coral ENABLE function.



Fig 1. The Trion-1 main areas of interest which are mentioned below.

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### Loading wafer

Loading a wafer into the chamber is done by first venting the system.

Press the **CANCEL** option to exit the **STANDBY MODE**. Select the option to enter the maintenance control area, on the lower right select the option labeled **MAINTENANCE**. From this you will need to enter the password which is 1225 into the password area, and press **ENTER**. From this select the center option that says **VENT REACTOR**. If the **VENT REACTOR** is not displayed you might need to press the **Turn Reactor Vacuum off** first to get it to appear. After a few minutes the chamber will be at atmosphere. Carefully open the lid as the gas line is connected to the lid. The lid **WILL NOT** stay open by itself, so you must keep it open during the whole time.

Place your wafer or sample on the center of the chuck. If the wafer or sample is smaller than a normal 4" (100 mm) wafer please use another replacement object to protect the chuck. Using a bare Silicon wafer or another 4" (100 mm) substrate. This object will depend of what is being etched and the process being ran.

### Pumping down the chamber

Once the wafer or sample is loaded slowly close the lid and make sure that there is nothing on the O-ring area of the lid seal. From the display panel select the option **TURN REACTOR VACUUM ON**. After 2 to 3 min the pressure in the chamber will be at a low enough level to continue to the next step. **Exit** the maintenance section and enter the section called **MANUAL PROCESS CONTROL**. If the option for **MANUAL PROCESS CONTROL** is not there you must first load in a recipe. From this select the **VAC OFF** so it then displays **VAC ON** and then select the **PRESSURE OFF** option so it displays **PRESSURE ON**. Once the pressure reaches around ~ 100 mtorr you can turn on the AR gas by pressing the **GAS OFF** option so it displays **GAS ON** and selecting the Ar and setting this to 20 sccm. The process chamber pressure should be at 100 mtorr. If it is not correct, select the pressure option and set it for 100 mtorr. Allow the chamber to purge for 1 to 2 min. removing any remains of the atmosphere from venting the system.

### Start Gasses

Next turn off the Ar gas by setting the gas flow to 0 sccm. Turn on the needed gases at the flows that are required for the process to be ran. Also adjust the chamber pressure and the R.F. power to a level that will be needed using the display screen options. Once the gas flow rates and the chamber pressure values settle to the correct set point the power can be applied to the system. Using a programmed recipe can be loaded if one has been set for the processing needed. This will have the values set so no adjustments are needed.

### R.F. Power on

The power value that is listed on the display panel is the power for the bottom electrode. Select the **RF OFF** option to turn it to **RF ON** and watch that the section labeled RF Reflected. This needs to be kept to a low level, something below 10 Watts. The reflected power might be high the first 10 to 20 seconds. If the value does

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not come down in time press the **RF ON** option to stop the power. Re-trying this sometimes works as the second attempt allows the auto tuning to work from another starting point. If this attempt does not work, doing a manual tuning of the system might be needed. If the reflected power value can be lowered by using the manual controls, return the controls back to auto tune. The tuning works better when the chamber pressure is at a higher value than at lower pressures.

### ICP power

R.F. power for the ICP head is controlled by a second power supply and this is controlled manually. See the display photo in Fig.1 above indicating the location of the ICP R.F. supply controller. To start the ICP power you must first have the power switch for the controller turned on. The next item is to set the power level. This is done by pressing and holding the **SETPOINT** button and turning the power level knob until the needed power level is displayed. The power level knob might be locked so check this before forcing the knob to turn as the knob turns very easy when unlocked. Once the power level is set, release the set point button, and lock the power level knob. Do not adjust this over 300 Watts.



Fig 2. The ICP power supply control panel is used only when ICP etching is needed.

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Press the **RF ON** button to turn on the ICP power. Watch the reflected power level and make sure this does not stay above 10 Watts for more than the first 10 seconds when power is applied.

### Run the Process for needed time

Once the ICP power is on begin recording the time. Run the power for the needed time, and run any other process steps that are needed. The selection of another process step is done by pressing the **NEXT PROCESS STEP** button. This should have been programmed in the recipe before running.

### End the Process

Once the needed time is reached turn off the ICP power by pressing the **RF OFF** button. Turn off the RF controller by press the Power switch. The **RF ON** option on the display panel can be turned off, stopping all etching in the chamber. Select each gas that is on and give it a set point value of zero. Once all gas values are set for zero flow the system is now ready to be purged. A recipe could have another step that has all the gases off, this would make things easier to run.

### Purge the system

To purge out the system all gas values must be set to zero. Next, set the Ar gas flow for 20 sccm. While this is on set the pressure to 100 mtorr. Allow the Ar to flow for 30 seconds. Adjust the setpoint to zero and allow it to pump down to the minimum pressure. This might take 60 seconds to reach the minimum value. Do the Ar ON and OFF sequence two more times.

### Vent system

Turn off the **GAS\_ON** option and the **PRESSURE\_ON** and the **VACUUM\_ON** options. Now **EXIT** the Manual Process Control menu. Select the **MAINTENANCE** option as before with the 1225 password. Select the center option labeled **VENT\_REACTOR**. After a short while the Process Chamber Lid can be opened and the wafer can be removed from the chamber. If another wafer is to be etched place it on the etch chuck and close the lid slowly and continue as above in the pumping down the chamber section. If this was the last run of the day, go to the next step for pumpdown the system.

### Pumpdown

With the wafer removed the chamber can be pumped back down. Slowly close the lid and press the **TURN REACTOR VACUUM ON** option. Once the pump has started pumping down the chamber exit the **MAINTENANCE** menu and select the **STANDBY** option. Disable the system using CORAL and complete the log sheet.

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### 7 Problems/Troubleshooting

#### **Reflected power is too high.**

Most problems might be with the tuning and reflected power. Turning the power off and then back on is one item to try. The next step would be to adjust the tuning using the manual tuning of the system.

#### **Can not pump system down.**

Make sure that the door seal is made correctly and there is no debris on the O-ring and surface. If this is good check that the pump controller is on and working.

The display screen has locked up and nothing can be done. Contact NFC staff so that the system can be reset.

If there are other problems contact NFC staff. If you have a problem that can not be solved, use **CORAL** to **SHUTDOWN** or **REPORT A PROBLEM**. Be sure to include enough detail for NFC to know what you had a problem with. Not just the short info of "It does not work", as this will help in solving the problem.