University of Minnesota Nano Fabrication Center
Standard Operating Procedure

Equipment Name: Trion II RIE (chlorine gases)

Coral Name:	trion2	**Revision Number:**	2
Model:	Trion	**Revisionist**:	K. Roberts
Location:	Bay 3	**Date:**	11/28/11

1 Description

This reactive ion etcher has a load-locked chamber and is used for chlorine-based etching. The system currently has two chlorine gases available: Cl_2 and BCl_3. The system has a four inch wafer platen which can accommodate whole wafers or pieces on whole wafers. The etcher has a dual R.F. power source referred to as an Inductively Coupled Plasma (**ICP**) source to allow for a higher plasma density in the etch chamber.

2 Safety

a As the system uses chlorine gas, be sensitive to any such smells. The system should emit **no** chlorine odor whatsoever. If you smell a chlorine odor, put system in STANDBY mode and contact MTL staff immediately.

3 Restrictions/Requirements

a Must be a qualified user on the Trion II.

4 Required Facilities

a Compressed air
b Nitrogen
c Chilled water
d Oxygen
e Chlorine
f CF_4
g BCl_3
h CHF_3
i Argon

5 Definitions

6 Operating Instructions

a LOGGING ON
  1 Enable "trion2" on CORAL.

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

b SETUP PROCEDURE

1 The RIE should be left in the Standby Mode when it is not in use. If it is not in Standby Mode, select Standby. Once in Standby Mode, press CANCEL, which will take it out of Standby Mode and bring up the Main Menu.

2 From the Main Menu, select the FILES button on the display. Enter the password 1225. This screen will show you which files are available from the hard drive. Select the file you want and press EXIT. The screen will again

show the Main Menu. At the bottom of the screen there is a box confirming the file you have chosen.

3 Select MANUAL MODE and check over each program step to see if it is the process you want. You may alter the parameters in this mode for your run. They will be carried out in the AUTO MODE, but will not be saved. To save a recipe change permanently, contact NFC Trion II process staff.

4 While in Manual Mode, if you wish to change the RF Platen Power, or the ICP Power, note the following:
RF #1 Power Set = ICP Power
RF #2 Power set = Platen Power
- **Typical ICP power setpoints are 100, 200, 300 watts. Do not exceed 300 watts.**
- **Typical platen Powers are 25, 50, 75 Watts. Anything above 75 Watts will likely bake the photoresist on to the point it will no longer come off with acetone.**

5 With regards to the matching network for the RF power supplies:
- **The RF Matching Network is only stable and only works in Auto mode if the chamber pressure is at 50 mTorr or higher.**
- **If Auto mode is not working (high reflected power observed), it may be that the last user drove the matching network to a limit which is not recoverable in Auto mode. See NFC staff for re-setting matching network to mid-range, and then it will work in Auto mode again.**

c SAMPLE LOADING

1 Place your 100 mm wafer sample in the left chamber on the robot arm. If using a smaller sample, place this on a 100 mm carrier wafer. The wafer should be aligned such that it touches the black line.

2 Close the cover.

3 Exercise the lift pins in the Reaction Chamber by using the UP and DOWN buttons in the lower left side of the screen. Usually three cycles should be sufficient. This is only necessary prior to the first loading of a wafer after a period of disuse. If not performed, the pins may not be fast enough to remove the wafer before the robot arm leaves the reaction chamber.

Tip: If you forget to exercise the lift pins and/or the sample is brought back out on the robot arm, simply remove the sample and proceed as if to remove an imaginary wafer from the Reaction Chamber. This will get the system back into the correct state with regards to the 'LOAD' and 'UNLOAD' buttons displayed.

WARNING:
DO NOT PRESS **ABORT** DURING A 'LOAD' OR 'UNLOAD' SEQUENCE UNLESS A REAL EMERGENCY ARISES. ONCE ABORTED, THE SYSTEM GOES INTO A FROZEN STATE AND CANNOT BE RE-STARTED BY ANYONE OTHER THAN MAINTENANCE PERSONNEL WITH THE CORRECT PASSWORD.

4 Press the LOAD WAFER button. The LOAD WAFER routine will only be performed if you have just left the Standby Mode. If, for instance, you have just performed an oxygen plasma clean, you will be instructed to return the system to Standy Mode before continuing. If this is necessary, select STANDBY; once the system is in Standby Mode, press CANCEL to return to the main menu and perform the load sequence. This is to ensure the system is in the proper state with regard to pressures, pumps, and valves before opening the gate valve to the Reaction Chamber.

d OPERATING PROCEDURE

1 Press the FILE icon. Choose the recipe file you are interested in running.

2 Edit or confirm the process parameters by viewing them in MANUAL MODE.

3 Exit MANUAL MODE to go back to Main Menu.

4 Press AUTOMATIC MODE to run modified or original process as viewed in MANUAL MODE.

e SAMPLE UNLOADING

1 Press the UNLOAD WAFER button. The system will automatically cycle purge the reaction chamber 5 times before unloading the wafer.

WARNING:
DO NOT PRESS **ABORT** DURING A 'LOAD' OR 'UNLOAD' SEQUENCE UNLESS A REAL EMERGENCY ARISES. ONCE ABORTED, THE SYSTEM GOES INTO A FROZEN STATE AND CANNOT BE RE-STARTED BY ANYONE OTHER THAN MAINTENANCE PERSONNEL WITH THE CORRECT PASSWORD.

f LOGGING OFF
1 Put system in Standby Mode.
2 Disable "trion2" on CORAL.

7 Problems/Troubleshooting

8 Appendix

Aluminum Etch Recipe:
8 sccm Cl_2
30 sccm BCl_3
30 mTorr
25 Watts (Platen only)

Aluminum Oxide Breakthrough Recipe:
15 sccm Cl_2
30 sccm BCl_3
200 mTorr
25 Watts (Platen only)

Typical Etch Rates of Aluminum Etch Recipe (Etch rate will vary depending on surface area exposed; i.e. 'loading' of chemistry).
Al = 60 – 80 nm/min.
Si = 50 – 60 nm/min.
Resist = 50 – 55 nm/min.
SiO_2 = 30 – 40 nm/min.
$Al2O_3$ = 10 – 20 nm/min.

If etching of aluminum seems to take an unusually long time, it may be necessary to perform an aluminum oxide breakthrough etch prior to etching the aluminum. This may need to be run anywhere from 15 seconds to 1 minute. No precise etch time can be given as it is difficult to know what the user's aluminum film will consist of… how much Al_2O_3 is on top? How dense is it? What is the thickness of the underlying aluminum?