

TRION METAL ETCHER SOP

Revised April 2020

Introduction

The Trion ICP Phantom Minilock III Metal Etcher is designed to use chlorine based chemistry to etch metals from 4" wafers and 5" photomasks. Other substrates may also be capable of metal etching using the machine with slight modifications. The Trion metal etcher uses 7 gasses for chemistry: CHF₃, SF₆, CF₄, O₂, Cl₂, BCl₃, and Ar. Different gasses will be used for etching different materials. Observe the chart at the end of the SOP for approximate etch rates or the Trion metal etcher log located next to the machine for recent etch rates.

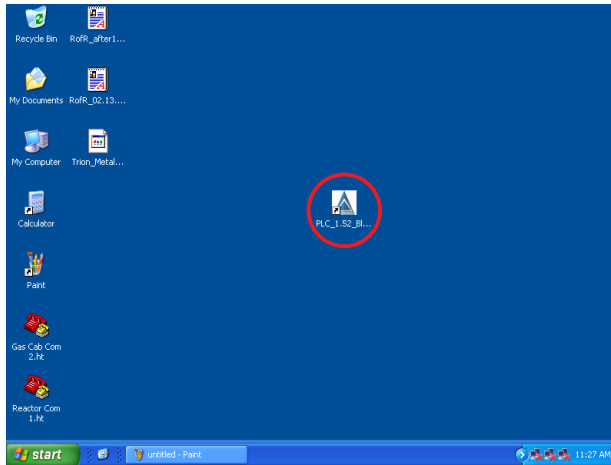
Getting Started

The first step in starting the Trion will be to turn on the support machines in the chase behind the Trion Metal Etcher. Find a staff member to help in this. There is a chiller and two pumps that will need to be turned on before the Trion can be started.

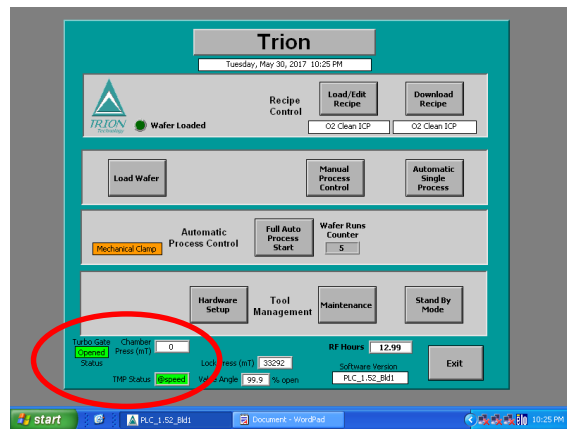
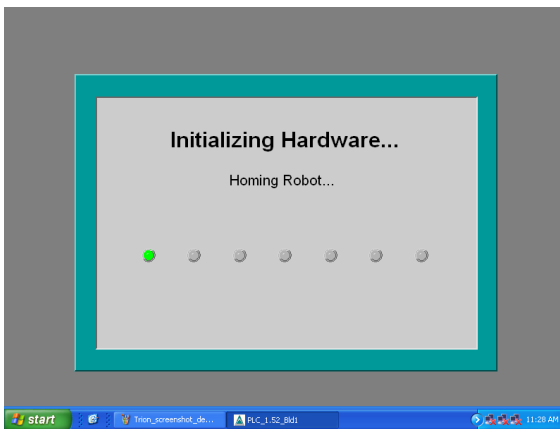
Turn **ON** the Trion metal etcher by hitting the "**MAIN**" button located near the keyboard. There should be no need to hit the "**Pump**" button as that should turn on automatically. Log in on FOM to turn on the screen.



Once the computer has booted, hit the "PLC 1.52" application on the desktop to begin running the software.



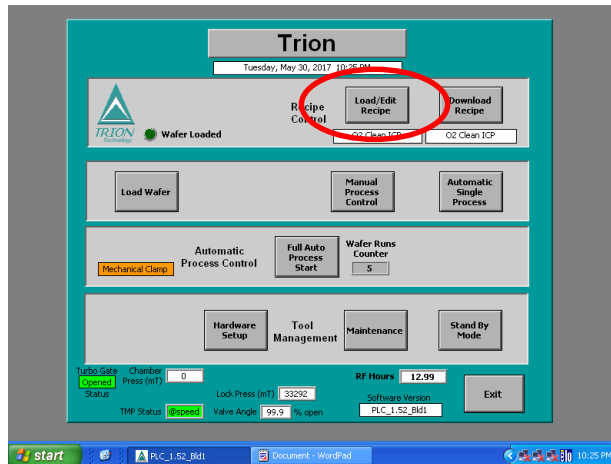
The software will open and begin with a hardware initialize screen. Here it will find the home position of the robot and ensure that the roughing pump has created a good enough vacuum to switch over to the turbo pump. The turbo status can be observed in the lower left corner of the startup screen. It will take about 10 minutes to speed up, but once it reads “Open” and “@speed” it is ready for processing.



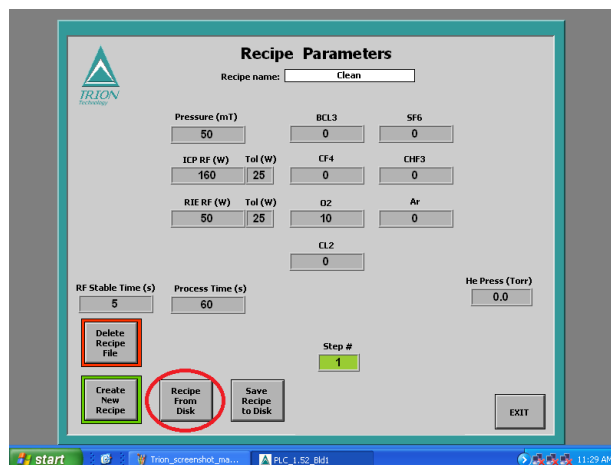
Automatic Mode – Recipe Selection

The first step after startup will normally be to select a recipe. Sometimes a user may wish to run the machine in manual mode. This allows the person to adjust parameters while the etching is taking place. If this is the desired mode, please consult the manual mode section later in the SOP.

If running in Automatic mode (suggested), select the “Load/edit recipe” button on the startup screen.



From here we can either load up an old recipe or create a new one. To load a previous recipe hit the “Recipe from Disk” button and choose the proper recipe from the list and verify that it has the intended parameters. The recipe files are stored in **C://Trion/recipes** if they ever need to be retrieved. Once you are satisfied with the recipe select exit to load it on to the metal etcher.



To create a new recipe, start by hitting either “Create New Recipe” to get a blank slate or “Recipe from Disk” to start from a previous recipe. Settings for the recipe will change greatly depending on what is intended to be etched and at what speed. We can, however, take a look at what each setting is intended to do:

Recipe Parameters

Recipe name:

Pressure (mT) BCL3 SF6

ICP RF (W) Tol (W) CF4 CHF3

RIE RF (W) Tol (W) O2 Ar

CL2

RF Stable Time (s) Process Time (s) He Press (Torr)

Delete Recipe File

Create New Recipe

Recipe From Disk

Save Recipe to Disk

Step #

EXIT

- **Pressure (mT)** – This parameter sets the goal pressure that the system tries to maintain during the etch
- **ICP RF (W) and Tol (W)** – This parameter sets the wattage being used by the Inductively Coupled Plasma (ICP). Some materials can only be etched in this system by using ICP. The “Tol” parameter sets a percentage that the power can fluctuate without generating an error. It is generally advised to keep the “Tol” above 20.
- **RIE RF (W) and Tol (W)** – This parameter sets the wattage being used by the Reactive Ion Etch (RIE). It works in the same way as the ICP.
- **Gasses (BCL₃, CF₄, etc.)** – These parameters control the flow rate of each gas during the current step. Gas flow rate may need to be adjusted if the system pressure has a hard time reaching equilibrium.
- **RF Stable Time (s)** – This parameter controls the time it allows for the system to adjust the magnets in the chamber correctly. These magnets shape the field generated by the ICP and RIE and is related to the “Tol” settings we use there. The magnets will try to adjust themselves to within these tolerance settings in the time allotted here. If it fails, an error is generated and the process is aborted.
- **Process Time (s)** – This is the total etch time of the current step.
- **He Pressure (torr)** – This setting controls the amount of gas flow for He, which is used for backside cooling of the sample. If you are using a sample holder, it will have minimal effect and therefore should be left at 0.0. If you are placing a sample directly, you may have some use for backside cooling, but the setting should probably be left at less than 5.0 torr.
- **Step #** - Changing this setting will allow you to select multiple steps for your process. Make sure the step following your final processing step has zeros in all fields to end your recipe.

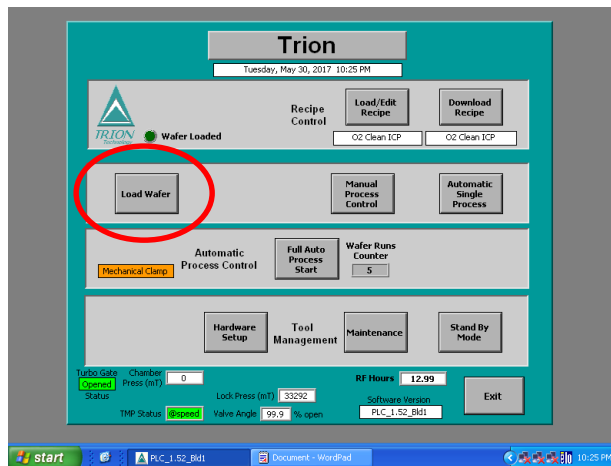
Once all of the settings are adjusted to satisfaction, press “**Save Recipe to Disk**” and give your recipe an appropriate name. Feel free to take a look at other recipes to help get an idea of

settings for yours, but please don't overwrite anyone else's recipe. Press "Exit" to leave the recipe screen and automatically load your recipe into the PLC.

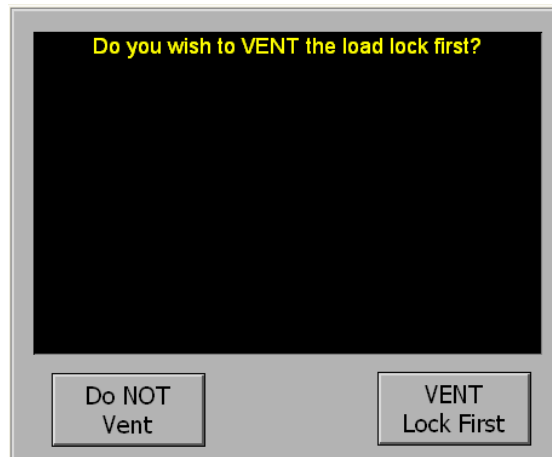
Sample Loading

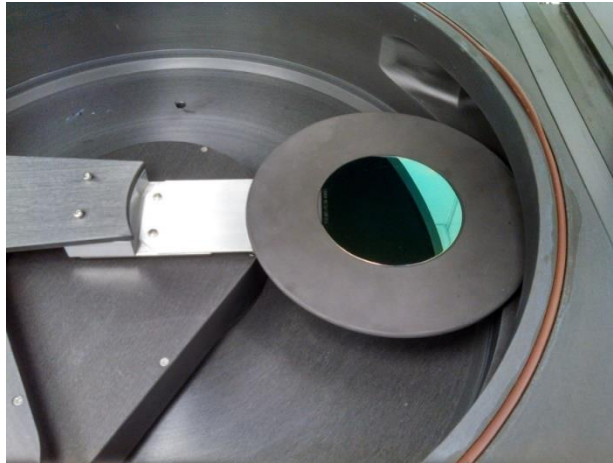
Once we have selected a recipe and loaded it into the system, we are ready to begin the process of loading our wafer. Select the "Load wafer" button to begin the loading sequence.

A screen will immediately pop up and ask if you wish to vent the loadlock. You must select "vent loadlock first" for the machine to automatically open up after a minute and allow you to put in your wafer. If you select "Do not vent" it will skip ahead and load whatever is currently on the arm into the chamber.

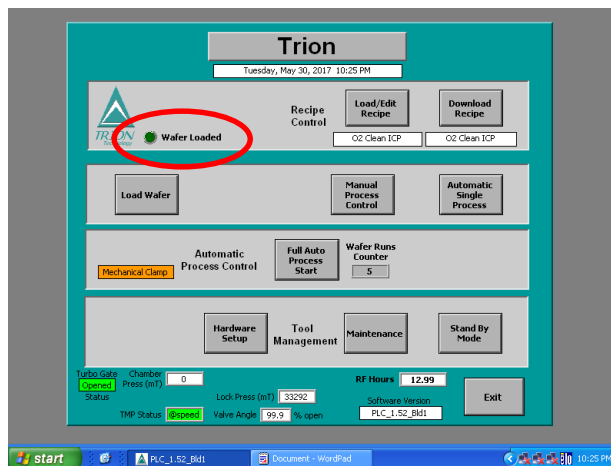


Now you will place your wafer onto the robot arm as shown in the following picture. Try to position the wafer holder so that it lines up with the partial circle that is drawn on the arm to help with balance for the wafer. The machine comes with two silicon carbide holders for different types of substrates: 4" circular depression designed for silicon wafers and a 5" square depression designed for photomasks. If you are working with something smaller than 4" silicon wafer it is advised that you secure it onto a dummy wafer using kapton tape and then use the holder. Press OK after placing your sample. Also, do not try to close the lid manually as it will automatically lower.





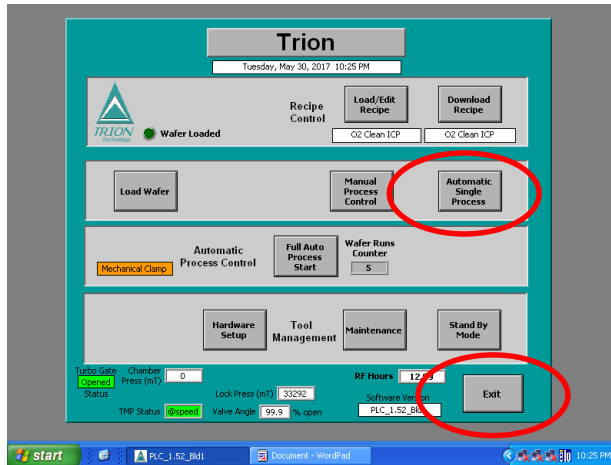
The loadlock will now pump down so that it can transfer to process chamber. Press **OK** when prompted by the software. You are ready to continue processing if the Loaded icon turns green.



However, if your sample is somehow incompatible to use with the robot arm, you should be able to manually open the chamber and place your sample directly onto the processing surface. This is not an optimal solution as it will be very difficult to ensure stability without the mechanical clamp. Also, be aware that the chamber is frequently filled with dangerous chlorine gas during operation. If direct placement is necessary for you, please consult the cleanroom staff for assistance.

Automatic Mode

The next step for most processes will be to start the procedure by hitting “**Automatic Single Process**”. This will immediately begin processing the downloaded recipe on whatever is in the chamber.

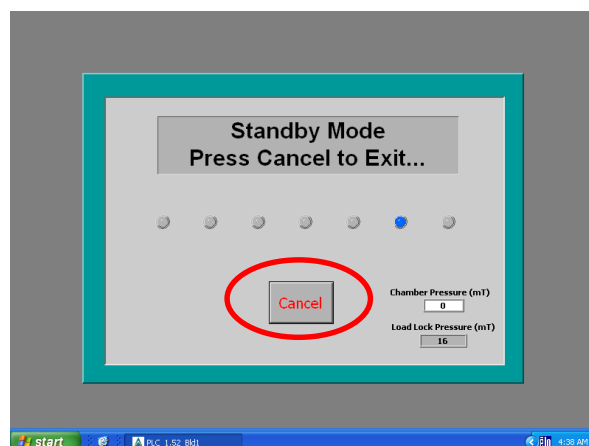


The processing will take however long the recipe prescribes. One of a few things can go wrong during the automatic processing.

- If the system pressure does not stabilize at the correct pressure, it is a good sign that your recipe has too high of a flow rate for your gasses. Abort the process and try modifying these flow rates to see if that improves the system stability. Also the cause may be that the turbo has shut itself off. Check the “**TMP Status**” at the bottom of the main screen, if it is not green then let the staff know that the turbo needs to be restarted.
- Another problem that may occur is that the system is unable to meet the proper tolerances on the ICP or RIE power. This means that the magnets are unable to find a stable solution in the time you are providing. You can try either adjusting the recipe to compensate or running in manual mode and controlling the position of the magnets yourself.

Once the recipe is completed it will return to the main screen where you can either begin the unload sequence or select, download, and run a new recipe.

Every time after Cl_2 or BCl_3 was run, users need to purge the gas line of Cl_2 or BCl_3 by hitting the button of **Stand By Mode** marked by the red circle. At the end of this recipe, users should see the following picture. Get back to the main screen by hitting the button of **Cancel**.



Wafer Unload

To begin the wafer unload process hit the “**Wafer Unload**” button on the main screen. You will receive a pop-up letting you know that the sequence is starting and asking if you want to vent the chamber once the wafer has unloaded into the loadlock. Hit **OK** to proceed. The process should move the wafer into the loadlock, vent the chamber, and then automatically raise the lid to allow you to remove the wafer. If the loadlock fails to rise automatically, contact the cleanroom staff to set the machine to a longer vent time. Once you have retrieved your wafer, hit **OK** on the new popup to automatically pump down the chamber. If you are processing additional wafers, make sure to place them in the machine before hitting the **OK** button.

When you are done with the metal etcher, leave the machine running. Make sure that the loadlock is pumped down. Leave the pumps and chillers on if you had to turn them on.

NOTE: Don't forget to log out from the tool in your FOM account.