



Metal TCP Etcher Chapter 7.41

Lam7 Metal (Al) TCP Etcher***(lam7)******(584)*****1.0 Equipment Purpose**

- 1.1** Lam7 is an automatic, cassette-to-cassette, TCP metal etcher in the NanoLab . This tool is currently dedicated to etching Al, Ti, and W films. Lam7 operates under upgraded GUI software, Envision®. This system is capable of etching deep sub-micron features with near vertical sidewalls and provides good selectivity over the underlying oxide with the over etch recipes. The system also includes a microwave passivation/strip chamber to prevent metal film corrosion by etch residuals (currently offline). The robot is set up for 6-inch wafers. A 6-inch carrier wafer or a 6-inch pocket wafer can be used to process a 4-inch wafer or samples of other dimensions.

2.0 Material Controls & Compatibility**2.1 Allowed Exposed Materials**

- 2.1.1** Al, Ti, Nb, W, TiW, and TiN

- 2.1.1.1** Other materials may be approved on a case by case basis.

2.2 Allowed Substrates

- 2.2.1** Single Crystal Silicon (P-type, N-Type, 110, 111)

- 2.2.2** Semi-Standard flats only. Chamber mechanics cannot run notched wafers!

- 2.2.3** Transparent Substrates:

- 2.2.3.1** Quartz

- 2.2.3.2** Fused Silica

- 2.2.3.3** Sapphire

- 2.2.3.4** Transparent substrates require an opaque coating all the way to the edge of the wafer to allow the flat-finder to read and position the wafer. Transparent wafers without this coating will be rejected by the tool.

- 2.2.3.5** Always check with process staff and equipment staff when running a transparent substrate.

2.3 Prohibited Substrates:

- 2.3.1** Transparent substrates of impure composition. Pyrex, Borofloat, etc. “Glass” wafers. “Glass” is a type of material structure, not a composition. The “glass” category is an extremely broad term and includes several types of materials with significant impurity content. Always check with staff before using “glass” substrates, as they can dramatically contaminate lam7 and degrade performance of devices passing through it.

- 2.3.2** Molybdenum etch byproducts have been shown to cause various unpredictable process effects for several wafers after they are processed, therefore the film is not allowed to be exposed to the plasma in lam7.

3.0 Training Procedures

- 3.1 This tool requires members to pass the Nanolab Plasma Etch Technology test (etchclass). Once you have passed a workshop, you do not need to retake it for any other tool it covers. Workshops typically never expire.
- 3.2 Timeline:
 - 3.2.1 Take etchclass. (If you have already passed the etchclass test, skip to training).
 - 3.2.2 Pass technology test. (If you have already passed the relevant technology test, skip to training).
 - 3.2.3 Get trained by any qualified member.
 - 3.2.4 Take the online test in the Nanolab office (open 8A-12P, 1P-5P).
 - 3.2.5 Arrange a qualification session with a superuser to show competency on the tool.
 - 3.2.6 Estimated time to completion: 1 week.
- 3.3 Superusers and staff qualify members on this tool.

4.0 Definitions & Process Terminology

- 4.1 **Envision:** Lam7 operating software.
- 4.2 **TCP Etcher:** The TCP etcher has an upper TCP coil and lower electrode powered up simultaneously during etch process. The TCP coil generates high density plasma, while the plasma bias can be independently controlled by the powered lower electrode.
- 4.3 **Automatic Endpoint Detector:** An optical device that traces the light emitted from the etch byproduct in the plasma. It can be programmed to end the etch process at a specified condition.
- 4.4 **Etch Rate (ER):** The thickness of the film etched away, per unit time and usually in Å/minute.
- 4.5 **Etch Non-Uniformity:** A measure of the etch uniformity. NanoLab process monitoring sites defines as $(\text{max ER} - \text{min ER}) / (\text{average ER})$, usually in %.
- 4.6 **Isotropic/Anisotropic Etch:** An etch process that has the same ER in all directions is isotropic. An etch process that etches in the direction perpendicular to the substrate surface is anisotropic. A plasma etcher, e.g. Lam7 usually etches anisotropically.
- 4.7 **Etch Anisotropy:** The degree of anisotropy is defined by $1 - (\text{lateral etch rate} / \text{vertical etch rate})$. A value of zero means isotropic etching and one is perfect anisotropic.
- 4.8 **Etch Selectivity:** The ratio of etch rates between the etched thin film (top layer) and the underlying substrate, if/when etched with the same recipe.
- 4.9 **Over-Etch:** An optional second etch step with etch chemistry that maximizes the etch selectivity. It removes the residual film due to previous etch non-uniformity with minimum damage to the underlying substrate/film. The etch rate is usually lower in this step.
- 4.10 **Pocket Wafer:** A six-inch wafer with a 4-inch **pocket** (recessed etched area), which enables one to load 4-inch wafer into a 6-inch process tool.
- 4.11 **Kapton Tape:** A special polyimide tape with silicon adhesive on it, which is good for high temperature application, and can withstand temperature range of -100°F to $+500^{\circ}\text{F}$.

5.0 Safety

- 5.1 **RF Power Hazard:** LAM7 uses two 13.56MHz, 1250W RF power generators. Never touch a RF power cord when the RF power is on. Do not look at the plasma for a long period of time.
- 5.2 **Chemical Hazard:** All process gases used by LAM7 are confined in the gas delivery system and the vacuum chambers. However, if you smell bleach or other un-usual odor, stop the etch process and evacuate the area. Inform NanoLab staff immediately. There may be a leak in the system, or problem in the ventilation.
- 5.3 **Pinch Hazard:** The wafer cassette elevators may pinch your fingers. Load/unload wafer cassette with caution.
- 5.4 **Rule Applied to New Recipe or Modifying Existing Recipe:** It is required that you consult the process staff before creating a new recipe or modifying old ones outside of the window provided in the Available Processes section. A recipe defined outside the machine specification may damage the tool and/or create potential hazardous situation.

6.0 Process Data

- 6.1 See NanoLab lam7 process specification for 7001_AL_ME data on aluminum
- 6.2 AIN data for 7001_AL_ME:
 - 6.2.1 Three wafer test:
 - 6.2.2 10s etch - 80nm (first wafer) (8nm/s)
 - 6.2.3 30s etch - 216nm (second wafer) (7.2nm/s)
 - 6.2.4 30s etch +10s OE - 252nm (third wafer) (7.2nm/s + 3.6nm/s for OE)
 - 6.2.5 Note AIN does exhibit some seasoning behavior, though limited.

7.0 Available Processes, Gases, Process Notes

- 7.1 Available Standard Processes
 - 7.1.1 See Appendix for further recipe details.
 - 7.1.2 **Recipe 7001:** Anisotropic Al Etch. The same process parameters (steps) used for the Main Etch part (steps) of the 7003 recipe.
 - 7.1.3 **Recipe 7002:** This Al etching can accomplish better selectivity over a thin underlying oxide compared with Recipe 7001. The same process parameter is used for the Over Etch part (step) of the 7003 recipe.
 - 7.1.4 **Recipe 7003:** Standard Al Etch with main etch and over etch steps. This recipe provides a faster etch rate with the main etch steps followed by a slower, but better selective (Al to oxide) Over Etch steps.
- 7.2 Process Gases
 - 7.2.1 **Cl₂:** Used in Al main etch for high etch rate.
 - 7.2.2 **BCl₃:** Used to etch native Al oxide.
 - 7.2.3 **O₂:** Used in chamber cleaning and future developments of heavy metal films.
 - 7.2.4 **SF₆:** Used to etch Al cap films, e.g. W, TiW and etc.
 - 7.2.5 **CF₄:** not used currently.

- 7.2.6 He:** Used as diluent to improve etch uniformity. Also used in He Clamp to improve the wafer backside cooling

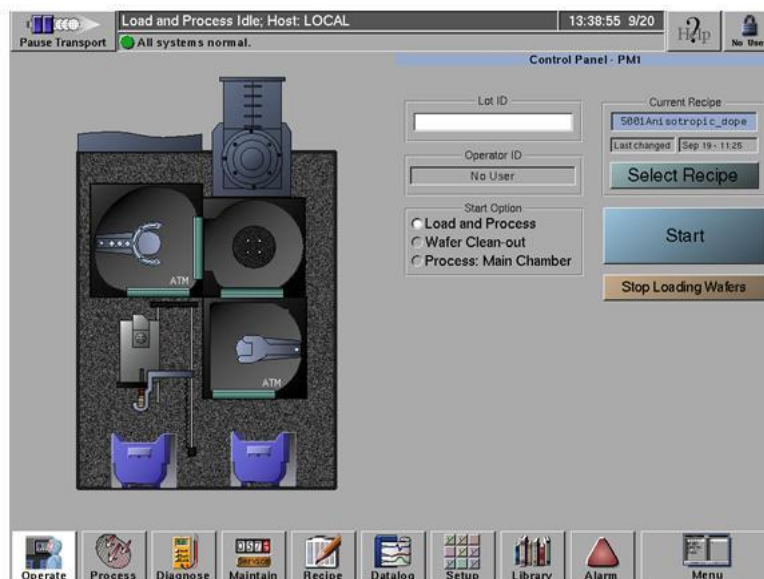
7.3 Process Notes

- 7.3.1** Lam7 uses ESC (Electro-Static Chuck) clamp to secure the wafer on the lower electrode. Helium gas then flows on the backside of the wafer to cool it uniformly. **The backside of the wafer needs to be smooth, free of particles and/or any etch patterns.** Otherwise, the excess leakage of helium from the backside of the wafer could create process pressure stabilization and helium clamp pressure stabilization and abort the process.
- 7.3.2 Note:** The lower electrode is domed .050" center to edge. When the wafer is clamped down, it is domed as well.
- 7.3.3** Always use the bright green inspection light in bay 584 to inspect the backside of your wafers for particles before running them through any etch tool with a clamping helium chuck.
- 7.3.4** Lam7 uses high RF power (up to 800W) to etch metal films. Photoresist on top of the wafer needs to be properly hard-baked prior to etching. The preferred hard baking is UV-Bake or oven bake. Failure to do so will result in burning of photoresist that is very difficult to be removed.
- 7.3.5** No photo-resist (PR) should be on the back side of the wafer while etching the metal film in front. Do not send wafers with PR face down in the chamber, either. High force of ESC clamp combined with high chuck temp, and RF power will melt the photo-resist and glues the wafer to the chuck. This in turn will cause the robot arm strike and damage/break the wafer that is stuck to the chuck. In addition, photo-resist on the back side of the wafer will contaminate/damage ESC.
- 7.3.6** The endpoint detection signal increases as the Al film is etched away and the underlying oxide starts to expose. You should always run a test layer when designing an endpoint recipe. Use that run to determine your target emission count numbers.
- 7.3.7** Use a 6-inch pocket wafer with a 4-inch recessed area to etch blanket film/s on 4-inch wafers or smaller samples without using adhesive material/s. Do not use a pocket wafer to carry photo-resist patterned wafers/samples inside the tool. Photo-resist on such wafer/sample will be burnt due to the fact that the heat transfer between sample and pocket area will be hindered by the existing gap (space) between 4-inch wafer and the pocket wafer. This results in elevated temperatures during the etch process and a burnt resist layer that is all but impossible to remove.
- 7.3.8** Secure your PR patterned 4-inch wafer or smaller samples onto a clean handle (flat) wafer by using methods from the "Handle Wafer Bonding" manual. A carrier wafer in good contact with a PR coated sample can provide adequate heat transfer away from your sample onto the water-cooled electrode.
- 7.3.9** The only kapton tape allowed in Lam7 and/or any other etcher is 2345-1D, manufactured by Dupont. This is a stock item in the NanoLab office. Place a small amount of tape on top edges of your sample to hold it down in a good contact with your carrier wafer. Clean your carrier wafers thoroughly before reusing them in this tool, as the glue left behind by the Kapton tape can contaminate the etcher chamber and/or other members' devices/runs. This typically requires a chemical clean – check sink procedures for methods of cleaning.

- 7.3.10** Make sure that the glue residues from previous etch sessions are thoroughly cleaned via wet chemical cleaning if you reuse a carrier wafer. Such residues could easily contaminate the etch chamber and severely impact consequent etch processes.
- 7.3.11** Note: Do not use Lam7 Dummies as carrier wafers for processing your 4-inch or smaller substrate in this tool. Use your own carrier wafers instead to prevent cross contamination.
- 7.3.12** You can save a file name, e.g. a customized recipe on the Lam7 system hard drive for your future use or as a backup. Your file name cannot contain special character/s or space/s. Start the file name with your login name followed by an underscore _, e.g. **ferrari_metaetch1**.
- 7.3.13** Chlorine etches leave a small amount of chlorine bound to the surface metal and will create intergranular corrosion of your sidewalls if left unchecked. Immediate water immersion or photoresist strip is recommended. See staff for details.
- 7.3.14** The Micro-Wave strip chamber is not available for use currently. Use Matrix to strip photo-resist on the wafer processed in Lam7 as soon as possible to prevent metal corrosion.

7.4 User Interface:

- 7.4.1** Lam7 is a fully automatic etcher. All operations, except wafer cassette loading/and unloading, are controlled by the software. The system is operated by the keyboard with trackball and a monitor display on the front of the etcher. **Do not touch any other hardware switches.** On the CRT display, the GUI screen is divided into three major areas: Header (top), Control/Info Pages (center), Page Group Buttons (bottom).



(bottom).

Figure 1 - Envision Operate Page

- 7.4.2 Header:** The header contains the followings:
- 7.4.3 Wafer Transfer Button:** When clicked, it pauses or resumes wafer transport. It does not affect the etch process in the etch chamber.

- 7.4.4 **Non-edit field for Time/Date, Machine Status, and Alarm Status:** During normal operation, the Machine Status should show only *Load and Process Idle*, *Load and Process Active*, or *Wafer clean out*.
- 7.4.5 **Help Button:** Provides limited help on the tool.
- 7.4.6 **Security Button (padlock icon):** Click this button to login/out the system.
- 7.4.7 **Control/Info Pages:** There are a total of 9 control/info pages available on the Envision system. These pages can be selected by invoking the desired menu options (page buttons) available at the bottom of the screen. Only 5 of these pages are accessible by a qualified Lam7 lab member, as per follows:
- 7.4.8 **Operate Page:** Select recipe and start/stop wafer loading.
- 7.4.9 **Process Page:** Monitor wafer movement and etch chamber process parameters. Manually End-Point a process step, or abort the whole process.
- 7.4.10 **Recipe Page:** Write new recipe or edit existing recipe.
- 7.4.11 **Data Log Page:** Monitor endpoint signal traces.
- 7.4.12 **Alarm Page:** View and clear/purge alarms.
- 7.4.13 **Note:** Diagnose, Maintain, Setup, and Library pages can be viewed by users. **Only Equipment staff is allowed to change the system settings on these pages.**
- 7.4.14 **Page Buttons:** These are the 9 page buttons discussed earlier located at the bottom of the screen. Click a button to select/display the corresponding control/info page. There is a Menu button on the left lower corner. Click it to access to the sub-pages of the displayed control/info page.

8.0 Equipment Operation

8.1 System Operation

- 8.1.1 Enable Lam7 on mercury.
- 8.1.2 **Note:** On the GUI screen, there will be a Red alarm that is caused by previous disabling of the tool. Go to the Alarm page and click **[Clear All]** button to clear the alarm. Check with equipment staff if there are other alarms.
- 8.1.3 On the GUI screen of Lam7, check the header line. It should read **Load and Process Idle: Host: LOCAL**, and the alarm status below should read **All system normal**. Do not use lam7 if the header line reads otherwise.
- 8.1.4 You may need to log in before accessing various control/info screens and be able to etch your wafers.
- 8.1.5 Click **[Security]** Button (padlock icon) to open the User Login Window. Enter the ID "Super User", and the password "Secret".
- 8.1.6 Load wafers to be processed in a blue cassette and load the cassette onto the entrance indexer (left side). Make sure the **H bar** on the bottom of the cassette sits properly in the slot at the center of the indexer. The indexer will lower to the first slot occupied by a wafer.
- 8.1.7 **Note:** Lam7 has an automatic flat finder for alignment. Make sure the wafers seat all the way to the end of the slots. A wafer sticking out will cause problem for the flat finder.

- 8.1.8 Load another blue cassette on the receiving indexer (right side). It will lower to the last empty slot position. If a cassette already loaded on the receiving indexer and it is in the up position, tilt it toward you about 30 degrees and then release. It will start lowering down.
- 8.1.9 Click **[Operate]** Page Button, the screen displays the Control Panel page. If not, click **[Menu]** Button on the right lower corner, and select Control Panel. On the left side of the **[Start]** Button, make sure that **Load and Process** is selected (white bullet means selected; grey means not).
- 8.1.10 Click **[Select Recipe]** Button, and select the recipe you plan to use.
- 8.1.11 **Note:** Do not overwrite the standard recipes, if modifications are to be made, and then save as a different recipe/name, as described in Section 9.3.2.
- 8.1.12 Click **[Start]** Button to start the etch process. The header line change from **Load and Process Idle** to **Load and Process Active**. It may take up to a minute for all the robots to home themselves.
- 8.1.13 Click **[Process]** Page Button to monitor the wafer transport and etch. If the screen does not display the Main Chamber Page, click **[Menu]** Button on the right lower corner, and select Main Chamber. During the etch process, you can select to perform the following tasks:
- 8.1.14 Click **[Manual Endpoint]** Button to skip to next recipe step.
- 8.1.15 Avoid clicking **[Abort Process]**. This is to be used only when a substrate may be damaged by the recipe.
- 8.1.16 **Note:** End point can be monitored in Data Log page.
- 8.1.17 If you want to change the etch time or select a new recipe for the next and following wafers, click **[Pause Transport]** Button on the top left corner of the screen. The wafer in the main etch chamber will continue and complete its original process.
- 8.1.18 Refer to Section 8.3 to change the etch time. Save, then load your updated recipe on the operate page.
- 8.1.19 Click **[Resume Transport]** Button to resume processing the wafer paused in the load lock or load station.
- 8.1.20 After the process is complete, and the last wafer is loaded into the receiving cassette, the receiving indexer will rise up. If not, make sure the robot arm has retracted, then tilt the cassette it toward you about 30 degrees and then release. It will start rising up. Wait till the indexer stop, and then remove the cassette to unload your wafers.
- 8.1.21 **Note:** Do not remove wafer cassette when it is in DOWN position. It will damage the sensors of the system.
- 8.1.22 Disable Lam7 on Mercury.

8.2 Recipe Editing/Writing

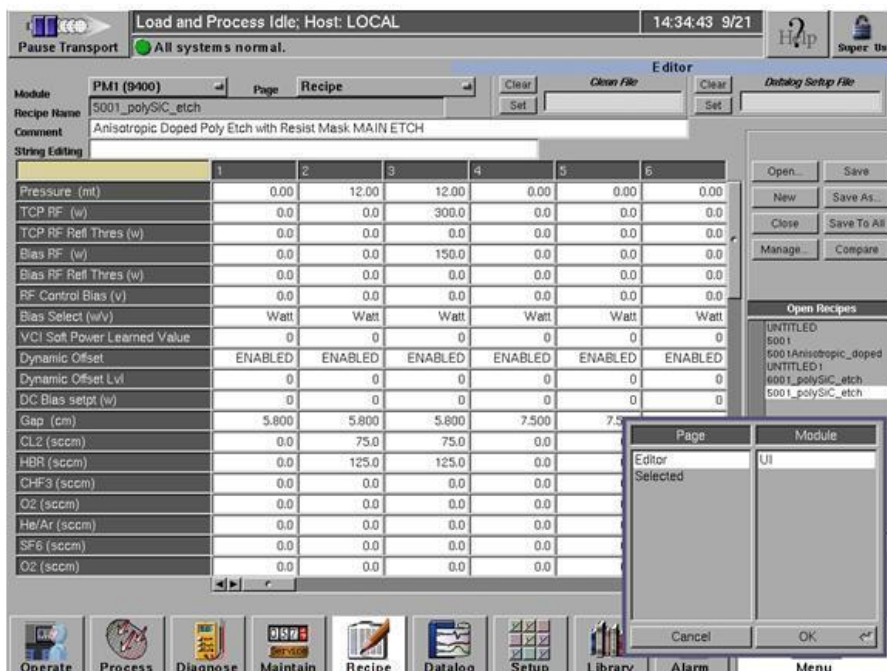


Figure 2 –Envision Recipe Page

- 8.3 Click **[Recipe]** Page Button to access the recipe editor page.
- 8.4 Below the header, there are two buttons: one for Module selection (only PM1 9600 available) and the other for Page selection. Make sure **[Recipe]** shows on the button. If not, Click the Button and select **Recipe** from the pull-down menu.
- 8.5 On the right hand side of the screen, there are 8 buttons for recipe file managements, e.g. copy, delete, and etc. It is recommended that you modify an existing recipe for your process, instead of writing new one from scratch.
- 8.6 Click **[Open]** Button to open an existing recipe, or click **[New]** Button to write a new recipe. If you are writing a new recipe, enter the recipe name in the Recipe field, and a line of description in the Comment field.
- 8.7 **Note:** A recipe, created by lab member, should start with the member's login name, followed by an underscore, then the remaining of the recipe name. **Important!** Any recipes not saved this way will be deleted.
- 8.8 You can enter/edit the process variables in every process steps. The basic variables use in the standard recipes are:
- 8.9 **Pressure** – The minimum pressure depends on the total gas flow.
- 8.10 **TCP RF** - Upper electrode power. (Max 800, Min 200)
- 8.11 **Bias RF** - Lower electrode power. (Max ½ TCP power, 200W whichever is lowest, Min N/A)
- 8.12 **Gap** – 5.8 cm for all recipes
- 8.13 **Note:** Lam7 has a fixed electrode gap. The gap entry has no effect on process.
- 8.14 **Process Gas Flows** – Only Cl₂, BCl₃, SF₆, and He are used.

- 8.15 He Clamp** – 4 Torr for all standard recipes – higher clamping pressures up to 8 Torr are allowed if you are experiencing heat issues. Pressures higher than 8 Torr require staff approval.
- 8.16 Completion** – There are 6 options for this field.
- 8.17 Stabl:** If the process condition is stabilized within the time specified in the Time field below, the recipe advanced to next step. Otherwise, the recipe holds and the system alarms. You have to clear the alarm to continue.
- 8.18 Time:** The recipe step will run the whole length of time specified in the Time field below.
- 8.19 EndPt:** The recipe step will run till the Endpoint condition specified in the Endpoint fields (explained at the end of this section) is reached. If the Endpoint condition is not reached within the time period specified in the Time field below, the system alarms. You have to clear the alarm to continue.
- 8.20 EndPt2:** Not used.
- 8.21 OverEtch:** The recipe step will run the percentage, specified in the Time field below, of the length of time of the previous EndPt step.
- 8.22 Recipe:** This entry terminates the recipe. This process step and following steps will not be executed.
- 8.23 Time (sec):** The maximum length of time the recipe step will run. In case for the over-etch, it set the percentage of time of the previous EndPt time.
- 8.24 Note:** Do not select **Recipe Params** from the pull-down menu. The Recipe parameter page set up the chamber temperature, the lower electrode temperature and other machine parameters. The chamber and lower electrode temperature are controlled by two separate chillers in the service area. If you need to change these temperatures, contact equipment staff.
- 8.25 Setting up Endpoint Triggers in the Main Etch Step (EndPt step)**
- 8.26 Channel:** The automatic Endpoint detector channel. Enter **A** for AI etch.
- 8.27 Delay:** In this time period, the endpoint signal is ignored due to plasma stabilization, and etc.
- 8.28 Norm (sec):** In this time period, the endpoint signal reading is normalized (averaged).
- 8.29 Norm Value:** The system will shift the normalized endpoint signal reading to a number that is easy for calculation, e.g. 5000 in the standard recipes.
- 8.30 Trigger (%):** If the endpoint signal falls below this percentage of the norm value, the recipe step ends and continue on next step.
- 8.31 Note:** Do not select **EndPoint2** from the pull-down menu since it is not used in Lam7.
- 8.32 Process Variable Tolerance Setups**
- 8.32.1** There two types of tolerances can be set in a recipe: hard tolerance, and soft tolerance. If a process variable exceeds the hard tolerance, the system will alarm and the recipe step will abort and you have to clear the alarm to continue. If a process parameter exceeds the soft tolerance, the system will just alarm and continue. The default tolerance setting for all steps in a recipe is 10% for both soft and hard tolerance.

- 8.32.2 To change the tolerance of a process variable, click the **[Recipe]** button next to the work **Page**, and select **[Recipe Tolrnc]** from the pull-down menu. You can now change the variable tolerance of process variables.
- 8.32.3 It is recommended to increase tolerance of Pressure in the recipe step that plasma strikes. When the plasma strikes, the pressure jumps up a few mtorr for a very short of time. If the pressure was below 20 mtorr, the pressure increase will exceed the 10% hard tolerance.
- 8.32.4 Save the recipe to the hard drive by click **[Save]** Button on the right side of the screen. Do not over-write the standard recipes on the hard drive. If you are saving a modified standard recipe, click **[Save As]** Button. And save the recipe with the a new name that starts with you login name.
- 8.32.5 **Note:** Only the recipes saved on the hard drive can be selected on **[Operate]** page. If you have modified a recipe but have not saved it on the hard drive, you will be running the un-modified version of the recipe when you select it on **[Operate]** page.

8.33 Endpoint Signal Tracing

- 8.33.1 Click **[Datalog]** Page Button and the Graph Page shows on the screen. If not, Click **[Menu]** Button, then select **Graph**.
- 8.33.2 On the lower left corner of the Graph page, there are four signal channel fields, i.e. A, B, C and D, that you can select. Select a channel, then click **[Load Config]** Button below the field. A window with all the preset signal channel configurations will pop up. Select the signal, e.g. Endpoint Channel A, TCP RF, and etc. Do the same for other signal channels.
- 8.33.3 Click **[Manual On]** Button below the graph to start the signal tracing. The signal traces will show up when the recipe is running in the process chamber.
- 8.33.4 On the top and bottom of the Y axis, you can enter the range each tracing signal. Adjust the range according to you preference.
- 8.33.5 If you are satisfied with your set up and plan to use the same set up in the future, Click **[Save Set]** Button on the lower left corner. Save the set up with the name started with your login. In the future, you can load the same setup by clicking **[Load Set]** button, and then select the set up you saved.
- 8.33.6 **Responding to an Alarm**
- 8.33.7 **Alarm Indicator Symbols** – There are three type of alarm symbols with a brief message displayed in the second line of the header area of each page screen.
- 8.33.8 **Green Circle:** All system Normal.
- 8.33.9 **Red Triangle:** Indicates an emergency condition, process abort by user, or a process variable exceeding hard tolerance. Wafer transport suspended; and the alarm must be cleared by the user.
- 8.33.10 **Yellow Square:** Indicates a less severe condition. The wafer in the process chamber will either hold at a stabilization step, or complete the etch step. However, the wafer transport will be suspended until the alarm condition has been corrected and the alarm cleared itself.

- 8.33.11** Viewing alarm Status and Clearing Alarms – Click **[Alarm]** Page Button, the alarm status page will show up. If not, Click **[menu]** Button, then select **Status** from the popup menu. There are 4 buttons on the lower right side of the page.
- 8.33.12 Clear:** Select the alarm line you want to delete, and then click this button to clear the alarm one at a time.
- 8.33.13 Clear All:** Click this button to clear all the alarms. However, problems that can not be cleared by the system will show up as a new alarm.
- 8.33.14 Note:** Cleared alarms remain displayed, but appear dimmed.
- 8.33.15 Purge:** Click this button to remove all the cleared alarm from screen. Do not purge any alarm. Alarm history provides important information for equip staff when diagnose problems.
- 8.33.16 Enable/Disabled:** Click this button to toggle between audible and silent alarm modes.

9.0 Troubleshooting Guidelines

- 9.1** Wafer In The Entrance Cassette Not Picked Up By The Wafer Shuttle
- 9.1.1** Cause: The wafer cassette is not loaded properly.
- 9.1.2** Solution: Adjust the cassette slightly to correct the problem. Do not lift the cassette because the wafer shuttle is in the cassette.
- 9.1.3** Cause: The wafer is not loaded properly, e.g. cross slots, in the wafer cassette.
- 9.1.4** Solution: Report the problem on Mercury, or ask help from the equipment staff. Do not try to remove wafer cassette or wafer from the cassette. Doing so may bend the wafer shuttle stuck in the cassette.
- 9.2** Load Point Vacuum Alarm
- 9.2.1** Cause: Wafer backside too rough or contaminated with particles/film.
- 9.2.2** Solution: Ask equipment staff to remove the wafer for you.
- 9.2.3** Cause: Wafer Shuttle vacuum problem
- 9.2.4** Solution: Wait a few seconds, this problem usually clears itself. If not, Report on Mercury.
- 9.3** Chamber/Electrode Temperature Out of Tolerance Alarm
- 9.3.1** Cause: Previous user may set a different temperature.
- 9.3.2** Solution: Wait for a few minutes for the temperature to stabilize. If not stabilizing, report on Mercury.
- 9.3.3** Cause: The chiller is not working. This is the case if the temperature is at or cooling toward room temperature.
- 9.3.4** Solution: Report the problem on Mercury. The equipment staff will check the chiller.
- 9.4** Helium Clamp Pressure Stabilization Problem
- 9.4.1** Cause: The backside of the wafer is too rough, patterned, or contaminated with particles/film.

- 9.4.2** Solution: Abort the process run. Unload the wafer and check the backside. Try a clean dummy wafer with the same recipe. If problem repeats, see the following section.
 - 9.4.3** Cause: The lower electrode surface was contaminated with particles, wafer chips, and/or films.
 - 9.4.4** Solution: Report the problem on Mercury.
- 9.5** Chamber Pressure Stabilization Problem
 - 9.5.1** Cause: The total gas flow may exceeds the pump capacity (for customized recipe)
 - 9.5.2** Reduce the gas flows or increase the process pressure setting in the customized recipe.
 - 9.5.3** Cause: The Helium clamp flow too high. The clamp flow can be checked on the lower right side of Process Page.
 - 9.5.4** Solution: same as the helium clamp pressure problem above.
- 9.6** RF Stabilization Problem
 - 9.6.1** Cause: This is complex problem. It could be the process wafer, customized recipe, or equipment problem.
 - 9.6.2** Solution: Abort the process and unload the wafer. Run a clean dummy wafer with a standard recipe. If problem repeats, report the problem on Mercury.
- 9.7** Wafer Lost In the Chamber
 - 9.7.1** Cause: Various mishandling errors or backside contaminants.
 - 9.7.2** Solution: Follow these steps
 - 9.7.2.1** Click [Stop Loading Wafers] button on the [Operate] page
 - 9.7.2.2** Clear the alarm and the wafer will come out automatically
 - 9.7.2.3** If this does not successfully return the wafer, do not etch anymore wafers. Report the problem on Mercury. Equipment staff will remove the wafer for you. The wafer may be broken.
- 9.8** No Signal Trace or Signal Trace Doesn't Change (Horizontal Line) on Graph Page
 - 9.8.1** Cause: Y axis Range not set properly.
 - 9.8.2** Solution: Reset the Y axis Range.
 - 9.8.3** Cause: Wrong signal channel selected.
 - 9.8.4** Solution: Select the right channel.
 - 9.8.5** Cause: Etch area on the wafer too small.
 - 9.8.6** Solution: no solution to this problem.
 - 9.8.7** Cause: Endpoint detector malfunction, or window dirty
- 9.9** XLL Pump Down Failed Alarm

9.9.1 Cause: XLL and ELL are pumped by the same roughing pump. If the ELL starts pumping while the XLL is in the middle of pumping (a common occurrence) it can cause the XLL pressure to spike and time out before finishing the pump

9.9.2 Solution: Go to Diagnose -> XLL Macro. Select XLL_Soft_Pump_Vlv and set it to OPEN. The system should proceed to pump out and automatically take over operation once it satisfies the pumpdown condition. The system will close the valve automatically, do not alter the diagnose page further without engineer assistance

10.0 Study Guide

10.1 No study guide available for this tool

11.0 Appendix A: Standard Recipes

11.1 Recipe 7001_AI_ME: Standard AI Main Etch

	Step #1	Step #2	Step #3
PRESSURE [mtorr]	8	8	0
TCP RF [watts]	0	800	0
Bias RF [watts]	0	100	0
GAP [cm]	5.3	5.3	0
Cl ₂ [sccm]	90	90	0
BCl ₃ [sccm]	45	45	0
He Clamp [torr]	4	4	0
COMPL	Stable	Time	End
TIME (Seconds)	30	30	0

11.2 Recipe 7002_AI_OE: Standard AI Over Etch

	Step #1	Step #2	Step #3
PRESSURE [mtorr]	8	8	0
TCP RF [watts]	0	700	0
Bias RF [watts]	0	100	0
GAP [cm]	5.3	5.3	0

Cl ₂ [sccm]	45	45	0
BCl ₃ [sccm]	60	60	0
He Clamp [torr]	4	4	0
COMPL	Stable	Time	End
TIME (Seconds)	30	30	0

11.3 Recipe 7003_AI_ME_OE: Standard Al Main Etch + Over Etch

	Step #1	Step #2	Step #3	Step #4	Step #5
PRESSURE [mtorr]	8	8	8	8	0
TCP RF [watts]	0	800	0	700	0
Bias RF [watts]	0	100	0	100	0
GAP [cm]	5.3	5.3	5.3	5.3	0
Cl2 [sccm]	90	90	45	45	0
BCl3 [sccm]	45	45	60	60	0
He Clamp [torr]	4	4	4	4	0
COMPL	Stable	Time	Stable	Time	End
TIME [seconds]	30	30	30	30	0
Channel		A			
Delay [seconds]		15			
Norm [seconds]		10			
Norm Value		2000			
Trigger [%]		150			

11.4 The over-etch step is designed to clear the interface film between sputtered Al and underlying SiO₂. The selectivity of the over-etch step is not better than main etch for the current standard recipes. Lam7 users are strongly encouraged to customize their over-etch steps to fit their own designs.

11.5 Recipe 7006_Ti: Titanium Specialty etch

	Step #1	Step #2	Step #3
PRESSURE [mtorr]	8	8	0
TCP RF [watts]	0	800	0

Bias RF [watts]	0	100	0
GAP [cm]	5.3	5.3	0
Cl2 [sccm]	90	90	0
BCl3 [sccm]	30	30	0
He Clamp [torr]	4	4	0
COMPL	Stable	Time	End
TIME [seconds]	30	30	0

11.6 Nb specialty etch recipe:

	Step #1	Step #2	Step #3
PRESSURE [mtorr]	8	8	0
TCP RF [watts]	0	400	0
Bias RF [watts]	0	100	0
GAP [cm]	5.3	5.3	0
Cl2 [sccm]	130	130	0
BCl3 [sccm]	0	0	0
He Clamp [torr]	4	4	0
COMPL	Stable	Time	End
TIME [seconds]	30	30	0

11.6.1 Nb Etch rate ~120 Å/s

11.6.2 Chlorine corrosion occurs in Nb after exposure to atmosphere. DI water rinse in APM supplemented with DI pour highly recommended.